National Institute of Technology, Tiruchirappalli - 620 015.
Department of Mathematics

COURSE OUTLINE TEMPLATE

Course Title	Numerical Techniques		
Course Code	MAIR41	No. of Credits	3
Department	Mathematics	Section	Mechanical – A & B
Pre-requisites Course Code	MAIR11, MAIR21, MAIR31 / MAIR32		
Faculty	Mr. V.Tamilselvan	Course Coordinator(s) (if, applicable)	NIL
Other Course Teacher(s) / Tutor(s) E-mail	tamilv@nitt.edu	Telephone No.	9791601391
Course Type	Core course		

COURSE OVERVIEW

To have general awareness and understanding of
- Various numerical techniques to compute solutions of linear systems, to find the dominant eigen value and eigen vector and to find solutions of nonlinear equations .
- To impart the basic concepts of interpolation of two-dimensional data.
- To understand and obtain various numerical solutions of ODEs and PDEs with

COURSE OBJECTIVES

Learning Objectives: Objective of the course is to introduce
1. Numerical Methods for Solving Linear Systems.
2. Methods to solve equations of One Variable as well as system of equations with two variables.
3. Interpolating Polynomials and best curve fitting methods for the given data.
4. Numerical Differentiation and Integration.
5. Numerical Solutions of Ordinary Differential Equations.
6. Numerical Methods to solve partial differential equations.

COURSE OUTCOMES (CO)

Course Outcomes	Aligned Programme Outcomes(PO)
1. Understanding and applying the methodologies to solve the system of linear equations numerically for exact/approximate solutions.	The engineering under- graduates will apply their knowledge of Transforms and Partial differential Equations techniques to solve industrially applicable problems.
2. Understanding and applying the techniques to compute real and complex roots of a given nonlinear equations with error analysis.	
3. Understanding and applying methods for the interpolation of engineering data(two dimensional) with equal/unequal interval, numerical differentiation and integration and to find the best fit curve.	

4. Understanding the basic concepts of solving ODEs and its applications to Engineering problems.

5. Understanding and applying the numerical methods to compute the numerical solutions of Partial Differential Equations.

MAIR41 Numerical Techniques

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method for $f(x) = 0$ and for $f(x,y) = 0$, $g(x,y) = 0$ - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.

Newton's forward, backward and divided difference interpolation – Lagrange's interpolation – Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 and 3/8 rules - Curve fitting - Method of least squares and group averages.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations - Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation.

S.No.	Week	Topic	Mode of Delivery
		COURSE TEACHING AND LEARNING ACTIVITIES	
1.	**Week- 1**	Introduction to numerical methods, explanation of Gaussian elimination method and problems	
	Week- 2	Numerical solutions of several linear systems by using Gauss-Jordan, LU decomposition and Crout's techniques.	
	Week- 3	Explanation of Gauss-Jacobi and Gauss-Siedel iterative methods to solve problems. Sufficient conditions for convergence-Statement. Compute the dominant eigenvalue and eigenvector of a matrix by power method.	
2.	**Week- 4**	Introduction to concepts of Bisection, Secant and Regula falsi methods. Derivation of formula of Newton-Raphson method for $f(x) = 0$ and some problems. Order of convergence.	**Chalk and Talk**

	Week- 5	Solving $f(x,y) = 0$ and $g(x,y) = 0$ by Newton Raphson method. Finding a root of $f(x) = 0$ by Horner's method. Computing complex roots of $f(x) = 0$ by Bairstow's method.	
	Week- 6	Computing complex roots of $f(x) = 0$ by Graeffe's method.	
3.	Week- 7	Introduction to interpolation and its applications, Newton's forward and backward formulas. Newton's divided difference and Lagrange's interpolation formulas, Solving problems using numerical differentiation.	
	Week- 8	Some problems using Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Curve fitting methods of least squares and group averages.	
4.	Week- 9	Introduction to numerical solution of ordinary differential equations (ODE's), Euler's method, Euler's modified method, some problems and Taylor's series method for simultaneous ODEs.	
	Week- 10	Runge-Kutta method for simultaneous ODEs, Taylor's series and Runge-Kutta methods for simultaneous differential equations and second order ODEs, Some problems to be solved.	
	Week- 11	Introduction to multistep methods and their advantages, some problems of Milne's predictor corrector formula. Some problems, Adam's predictor-corrector method and solving some problems.	**Chalk and Talk**
5.	Week- 12	Computing numerical solutions of Laplace equation and Poisson Equation by Liebmann's procedure.	
	Week- 13	Solution of one – dimensional heat flow equation by Bender – Schmidt recurrence relation – Crank – Nicolson method.	
	Week- 14	Explicit scheme to compute numerical solution of one-dimensional wave equation and some problems.	

COURSE ASSESSMENT METHODS

S.No.	Plan	Week/Date	Duration	% Weightage
1.	Assesment – I	7th week	1 Hour	20%
2.	Assesment - II	12th week	1 Hour	20%
3.	Assesment - III	14th week	1 Hour	
4.	Assignments (each units two marks weightage)			10%
5.	End Semester Exam		3 Hours	50% Total : 100 Marks

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

Reference Books:

1. David Kincaid and Ward Cheney, Numerical Analysis\, 3rd edition, American Mathematics Society, (Indian edition) – 2010.
2. Gerald C.F., and Wheatley P.O., Applied Numerical Analysis, Addison-Wesley Publishing Company, 1994
3. Jain, M.K., Iyengar, S.R. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age international,2003
4. Atkinson, K.E., An Introduction to numerical Analysis, John Wiley & Sons, 2008

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

1. Feedback from students during class committee meeting.
2. Anonymous feedback through questionnaire (as followed previously).

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

1. Examination:

a) Students who have missed the first or second Assesment test or both can register for Assessment - III examination which shall be conducted soon after the completion of the second Assessment test and before the regular semester examination.

b) The Assessment - III examination shall be conducted for 20 marks comprising the syllabus of both first and second Assesment tests.

c) Students should submit assignments before last date of submission. In case students fails to submit their assignments, he/she will get zero mark for that particular assignment.

2. Attendance:

a) The minimum attendance for appearing for the semester examination is 75%.

b) Those students, whose attendance falls below 75% but above 50% in a subject, shall attend mandatory classes before the semester examinations to qualify to write semester exam.

c) The students who are having attendance less than or equal to 50% has to redo the course.

3. The Institute follows relative grading with flexibility given to teachers to decide the

mark ranges for grades. All assessment of a course will be done on the basis of marks.

4. The Performance Analysis Committee, which shall meet within couple of weeks after the completion of all examinations, shall analyze the relative cumulative performance of students in all examinations (continuous and end-semester) of a course and finalize the letter grade ranges for the course.

5. The letter grades and the corresponding grade points are as follows:

Letter	S	A	B	C	D	E, R	F, I	V	FF	X
Grade(GP)	10	9	8	7	6	5	0	-	2	-

a) Students scoring less than the passing minimum marks in the assessments defined in the course plan shall be deemed to have not successfully completed the course and be given an 'F' grade.

b) Students awarded F grade may REDO the course or opt for formative assessment.

c) 'V' indicates lack of required attendance. Students awarded 'V' grade must compulsorily redo the course.

d) 'I' grade indicates incompletion of formative assessment.

e) A student who gets an 'I' grade must necessarily convert it to a 'R' grade by completing the formative assessment.

f) An 'FF' grade is awarded for not completing the formative assessment in the prescribed maximum period of study due to gross negligence. An 'FF' grade will have a grade point of 2 and it will remain on the grade card permanently. This will be used in the CGPA calculations.

g) A student who earns a minimum of 5 grade points (a 'E' grade or a 'R' grade) in a course is declared to have successfully completed the course.

h) If the students fails to appear semester examination due to genuine/medical reason, can register for special end semester examination after approval from course teacher & Head of department of Mathematics/Dean(academic). The special end semester examination will be conducted within ten days from reopening of institute for next semester. Students should register their names with course teacher to appear for special end semester examination within three days from reopening of institute for next semester. Grade issued as per the guidelines followed for his/her batch students.

i) There will be one reassessment (for 90 marks) for the students who have secured "F" in this course and will be conducted within ten days from reopening of institute for next semester. Students should register their names with course teacher to appear for reassessment within three days from reopening of institute for next semester. If the students satisfy the criteria fixed by the faculty to promote E grade will be given E grade and others given 'F' grade.

j) Pass mark = Min{Max./3, Average/2}

ADDITIONAL COURSE INFORMATION

Faculty is available for discussion after the class hours at the Department on the first floor of Lyceum. Room No. 218.

FOR SENATE'S CONSIDERATION

Course Faculty _____ CC-Chairperson _____ HOD _____

(V. Tamilselvan)   (T. RAMESH)

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