NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF MATHEMATICS

COURSE PLAN – PART I			
Name of the programme and specialization	**M.Tech. Welding Engineering**		
Course Title	**Engineering Mathematics**		
Course Code	**MA613**	**No. of Credits**	**3**
Course Code of Pre-requisite subject(s)	**NIL**		
Session	**July 2023**	**Section**	**-**
Name of Faculty	**Anandasrinivasan S**	**Department**	**Mathematics**
Email	**anandasrinivasans@gmail.com**	**Telephone No.**	**+91 9791748528**
Name of Mentor	**Dr. R. Gowthami**		
Official E-mail	**gowthami@nitt.edu**	**Telephone No.**	**+91 8903844986**
Course Type	☑ **Core course**	☐ **Elective course**	

Syllabus (approved in BoS)

Partial Differential equations – basic concepts – One dimensional heat flow equation - Two dimensional heat flow equation in steady flow in Cartesian and Polar coordinates.

Calculus of variations - Euler's equation - Variational problems in parametric form - Natural boundary condition – Conditional Extremum - Isoperimetric problems.

Numerical Solution of ODE's – Euler's, Taylor's and Runge Kutta methods – Milne's and Adams' predictor-corrector methods.

Finite difference scheme for elliptic, parabolic, and hyperbolic partial differential equations.

Introduction to Finite Element Method - Rules for forming interpolation functions - Shape functions - Application to fluid flow and heat transfer problems.

ESSENTIAL READINGS: Textbooks, Reference books, etc

Reference Books

1. Gerald, C.F. and Wheatley, P.O., Applied Numerical Analysis, Addison Wesley, 2010.
2. Jain, M.K., Iyengar, S.R. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, Wiley Eastern, 2010.
3. Desai, C.S. and Abel, J. F., Introduction to Finite Element Method; a numerical method

for engineering analysis, Van Nostrand Reinhold Co., 1991.
4. Elsegolts, L., Differential Equations and the Calculus of Variations, Mir Publishers, 1977.
5. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 2017.
6. Veerarajan, T., Numerical Methods, Volume III, Tata McGraw Hill Edition, New Delhi, 2009.
7. Reddy, J.N., Introduction to Finite Element Method, Mcgraw Hill, 2016.

COURSE OBJECTIVES

1. To make the students mathematically strong for solving engineering and scientific problems.
2. To familiarize the students with Euler-Lagrange's equation and fundamental concepts in calculus of variations.
3. To enable the students to understand various numerical computational techniques and its applications to engineering problems.
4. To train students with mathematical aspects so as to comprehend, analyze, design and create novel products and solution for the real-life problems.

MAPPING OF COs with POs

Course Outcomes	Programme Outcomes (PO)
1. Classify partial differential equations and able to solve mathematical models for physical processes such as one-dimensional and two-dimensional heat transfer problems.	**PO4, PO8 & PO11**
2. Formulate and solve variational problems in parametric form, Ostrogradsky equation and isoperimetric problems.	**PO4 & PO11**
3. Compute numerical solution of ordinary differential equations using various methods and estimate the various errors & approximations associated with numerical techniques.	**PO4, PO8 & PO11**
4. Discretize and solving the partial differential equations associated with thermal, fluid and general engineering problems using finite difference scheme.	**PO4, PO8 & PO11**
5. Apply advanced numerical method such as finite element method to solve heat transfer problems.	**PO4, PO8 & PO11**

COURSE PLAN – PART II

COURSE OVERVIEW

The course will

- Provide a structured approach to solve partial differential equations in various physical phenomena such as heat transfer / general engineering problems by analytical and computational methods.
- Introduce the fundamental concepts of calculus of variations with several types of functional and their applications.
- Explore various numerical methods to solve ordinary differential equations and partial differential equations.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	**Week-1**	Review of Basic concepts in PDE - Classifications of PDE - One dimensional heat flow equation - Solution of one-dimensional heat flow equation by the method of separation of variables.	**Chalk and Talk / PPT**
2	**Week-2**	Some problems in one-dimensional heat flow equation - Analytic solution of Two-dimensional heat flow equation in steady flow in Cartesian coordinates - problems.	**Chalk and Talk**
3	**Week-3**	Analytic solution of Two-dimensional heat flow equation in steady flow in Polar coordinates. Introduction to Calculus of variation and its applications - Variational notations and first variation.	**Chalk and Talk**
4	**Week-4**	Euler's equation derivation - Variational problems involving several unknown dependent functions - Derivation of Euler Poisson Equation and Problems - Variational problems in parametric form.	**Chalk and Talk**
5	**Week-5**	Derivation of Ostrogradsky equation - Derivation of Natural boundary conditions - Problems on Natural boundary conditions.	**Chalk and Talk**

6	**Week-6**	Conditional Extremum - Isoperimetric Problems. Introduction to numerical solution of ODE - Euler's method - Taylor's series method - problems.	**Chalk and Talk**
7	**Week-7**	Runge-Kutta method of the fourth order for simultaneous ordinary differential equations and second order ODEs - problems.	**Chalk and Talk**
8	**Week-8**	Introduction to multistep methods and their advantages - Derivation of Milne's predictor-corrector formula - error term - Adam's predictor-corrector method - problems.	**Chalk and Talk**
9	**Week-9**	Introduction to Finite difference method - Derivation of finite difference formulas and the errors involved in these formulas and computing numerical solutions of Laplace equation by Liebmann's procedure.	**Chalk and Talk**
10	**Week-10**	Numerical solution of Poisson equation by Liebmann's technique - Derivation of explicit formula - Bender-Schmidt recurrence formula for solving one-dimensional heat flow equation and computing numerical solutions.	**Chalk and Talk**
11	**Week-11**	Derivation of explicit scheme to compute numerical solution of one-dimensional wave equation and some problems. Introduction to Finite Element Method and its applications.	**Chalk and Talk**
12	**Week-12**	The basic steps involved in Finite Element Method (FEM) - Rules for forming Interpolation Function and Shape Function for one and two dimensional problems.	**Chalk and Talk**
13	**Week-13**	Global function for one dimensional problems - Application of FEM to one-dimensional Heat Transfer problems.	**Chalk and Talk**
14	**Week-14**	Application of FEM to two dimensional problems.	**Chalk and Talk**

COURSE ASSESSMENT METHODS (shall range from 4 to 6**)**

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Assessment - 1	7th Week	1 hour	15%
2	Assessment - 2	12th Week	1 hour	15%
3	Assessment - 3 (Assignments / Quizzes)	-	Throughout the semester	20%
CPA	Compensation Assessment*	16th Week	1 hour	15%
4	Final Assessment *	18th Week	3 hours	50%

***mandatory; refer to guidelines on page 4**

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1. Feedback from students during class committee meetings.
2. Anonymous feedback through a questionnaire (as followed previously by the Institute).
3. Students can approach the faculty (with a prior appointment) at any stage in the course duration in case he/she finds difficulty in understanding the concept.
4. Student knowledge about the topic covered in this course will be judged through marks obtained in the examination.

COURSE POLICY (including compensation assessment to be specified**)**

1. Examination:
   a) Students who have missed either assessment 1 or assessment 2 or both can register for compensation assessment which shall be conducted soon after the completion of the assessment 2 (cycle test-2) and before the regular semester examination (Final Assessment). Other students were strictly NOT allowed to register for compensation assessment.

   b) The compensation assessment shall be conducted for 15% marks comprising the syllabus of both assessment 1 and assessment 2.

   c) Students should submit the assignments (if any) before the last date of submission. In case, any student fails to submit their assignments within the last date of submission, he/she will get zero mark for that assignment.

2. The institute follows relative grading with flexibility given to teachers to decide the mark ranges for grades.

3. If a student fails to appear semester examination due to genuine/medical reason, can

register for special end semester examination after approval from course instructor & head of department of mathematics. 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.

4. There will be one reassessment 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 name with course instructor to appear for reassessment within three days from reopening of institute for next semester. If students satisfy, the criteria fixed by the faculty to promote E grade will be given E grade and others given "F" grade.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- At least 75% attendance in each course is mandatory.
- A maximum of 10% shall be allowed under On Duty (OD) category.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
- The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION, IF ANY

Students can contact the course faculty for discussion after the class hours by fixing appointment through e-mail (anandasrinivasans@gmail.com) / phone (+91 9791748528) during the office hours (8.30 am to 5.30 pm).

FOR APPROVAL

R. Gowthami

Course Faculty 01/09/2023
(Anandasrinivasan S)
(Dr. R. Gowthami)

CC- Chairperson 4/9/23
(Dr. D. Nagarajan)

HOD 4/09/2023
(Dr. S. Muthukumaran)

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