NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

This course outline template acts as a guide for writing your course outline. As every course is different, please feel free to amend the template/ format to suit your requirements.

COURSE OUTLINE TEMPLATE			
Course Title	**Mathematical Methods**		
Course Code	**MA609**	**No. of Credits**	**3**
Department	**Mathematics**	**Faculty**	**Dr. R. Ponalagusamy**
Pre-requisites Course Code	**UG Mathematics**		
Course Coordinator(s) (if, applicable)	**NIL**		
Other Course Teacher(s)/Tutor(s) E-mail	**NIL**	**Telephone No.**	**7402448889**
Course Type	**Core course**		

COURSE OVERVIEW

- **To have general awareness and understanding of**
  (1) Variations of several types of functional and their applications.
  (2) Several Direct methods to solve engineering problems involving functionals.
- **To understand various mathematical methods to solve integral equations.**
- **To obtain analytical Solutions for elliptic, parabolic and hyperbolic PDEs.**
- **To understand and compute numerical solutions of PDEs by using Finite Difference and Finite Volume Techniques.**

COURSE OBJECTIVES

1. **To solve variational problems in parametric form with the calculus of variation and Eulers equation.**
2. **To apply Euler's finite difference technique, Rayleigh - Ritz method, Galerkin's method, Kantorovich's method.**
3. **Describe Formulation of Integral Equations by using Green's Function, various types of integral equations and Method of successive approximations.**
4. **To develop understanding about analytical solutions for engineering problems.**
5. **Discuss finite difference scheme and finite volume method for elliptic, parabolic, and hyperbolic PDEs.**

COURSE OUTCOMES (CO)

Course Outcomes	Aligned Programme Outcomes (PO)
On completion of the course, the students will be able to: 1. Discuss calculus of variations and Euler's equation and to solve variational problems in parametric form, Ostrogradsky equation and isoparimetric problems. 2. Use Euler's FDM- Rayleigh - Ritz method- Galerkin's method- Kantorovich's method. 3. Convert BVP to integral equations by using Green's function; solve Fredholm integral equations by separable kernels and to discuss about method of successive approximations. 4. Obtain analytical solutions of elliptic, parabolic and hyperbolic Partial Differential Equations and their engineering applications. **5.** Understand usage of numerical methods such as finite element method and finite volume method to solve fluid flow and heat transfer problems.	**The engineering post graduates will apply their knowledge of Mathematical Methods and logic in solving engineering advanced problems.**

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week	Topic	Mode of Delivery
1.	**Week-1**	**1. Introduction to Calculus of variation and its applications, Variatioal notations and first variation, Euler's equation derivation and problems and Variational problems involving several unknown dependent functions.**	**Chalk and Talk**
	Week-2	**2. Derivation of Euler Poisson Equation and problems, Variational problems in parametric form, Derivation of Ostrogradsky equation and Derivation of Natural boundary conditions.**	
	Week-3	**3. Problems on Natural boundary conditions, Conditional Extremum - Isoperimetric**	

2.		problems, and Explanation of Rayleigh-Ritz method.	Chalk and Talk
	Week-4	4. Problems on Rayleigh-Ritz method, Explation of Galerkin's method and some problems.	
	Week-5	5. Explanation of Kantorovich's method with Mathematical derivation, Solving problems and Derivation of Euler's finite difference scheme.	
	Week-6	6. Problems using Euler's finite difference method, Introduction to various types of integral equations, Method of converting initial value problem into Volterra Integral Equation and some problems.	
	Week-7	7. Analysis on Conversion of Boundary Value Problems to integral equations using Green's Function, Some problems, Solution of Fredholm equation with separable kernels and some problems.	
	Week-8	8. Mathematical Derivation on Solutions of Volterra integral and Fredholm integral equations by the method of Successive approximations, and problems on those two integral equations.	
	Week-9	9. Introduction to analytic solution for PDEs, Derivation of analytic solution of elliptic Equation and several problems with various types of boundary conditions.	
	Week-10	10. Derivation of analytic solution of parabolic equation. Solving useful engineering problems related to parabolic equation.	
	Week-11	11. Procedure for obtaining analytic solution of hyperbolic equation. Some problems. Computing numerical solutions of elliptic equation (PDE) by Liebmann's procedure.	

3.	**Week-12** **Week-13** **Week-14**	**12. Problems on elliptic equation, Derivation of Explicit formula, Bender- Schmidt Recurrence formula and Crank-Nicolson implicit formula for solving parabolic equation (PDE) and computing numerical solutions.** **13. Derivation of explicit scheme to compute numerical solution of hyperbolic equation (PDE) and some problems. Finite volume method for solving elliptic and parabolic equations.** **14. Description of method of finite volume to solve hyperbolic equation.**	**Chalk and Talk**

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1.	**Cycle Test – I**	**Week- 8**	**1 Hour**	**20%**
2.	**Cycle Test – II**	**Week-13**	**1 Hour**	**20%**
3.	**Retest**	**Week-14**	**1 Hour**	
4.	**Seminar**			**10%**
5.	**End Semester Examination**		**3 Hours**	**50%** **Total : 100 Marks**

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

REFERENCES:

1. **ELSGOLTS, L., Differential Equations and the Calculus of Variations, Mir Publishers, 1977.**

2. **HILDEBRAND, F.B., Methods of Applied Mathematics, Prentice Hall, 1992.**

3. **GREWAL, B.S., Higher Engineering Mathematics, Khanna Publishers, 2001.**

4. **VENKATARAMAN, M.K., Higher Mathematics for Engineering and Science, National Publishing Company, 2010.**

5. **DAVID BLEECKER and GEORGE CSORDAS, Basic Differential Equations, International Press, 2003.**

6. **CAUSON, D.M., MINGHAM, C.G. and QIAN, L., Introductory Finite Volume Methods for PDEs, The Ebook company(bookboon.com), 2011.**

7. **MAZUMDER, S., Numerical Methods for Partial Differential Equations, 1st Edition Finite Difference and Finite Volume Methods, Academic Press, 2015.**

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. Test-I and Test-II will be conducted in regular class. 2. 75% attendance is compulsory for writing the end semester examination.
ADDITIONAL COURSE INFORMATION
Faculty is available for discussion after the class hours at the Department on the first floor of Lyceum, Room No. 222. Faculty can also be contacted over phone: 7402448889
FOR SENATE'S CONSIDERATION
15/9/2016 Course Faculty _____ CC-Chairperson _____ HOD 15/9/16

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