NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI
DEPARTMENT OF MECHANICAL ENGINNERING

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COURSE PLAN – PART I			
Name of the programme and specialization	**M.Tech Thermal Power Engineering**		
Course Title	**Computational Fluid Dynamics**		
Course Code	**ME 606**	**No. of Credits**	**03**
Course Code of Prerequisite subject(s)	-	-	-
Session	**January 2021**	**Section (if, applicable)**	-
Name of Faculty	**P Kaushik**	**Department**	**Mechanical Engineering**
Official Email	**pkaushik@nitt.edu**	**Telephone No.**	**+91 9632253573**
Name of Course Coordinator(s) (if, applicable)	-		
Official E-mail	-	**Telephone No.**	-
Course Type (please tick appropriately)	✓ **Core course**	☐ **Elective course**	

Syllabus (approved in BoS)

Computational Fluid Dynamics: What, When, and Why?, CFD Advantages and Applications, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation. Approximate Solutions of Differential Equations: Error Minimization Principles, Functional involving higher order derivatives, Essential and natural boundary conditions, Discretization methods - Finite Element Method and Finite difference methods: Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples and Some Conceptual Basics and Implementation of boundary conditions. Discretization of Unsteady State Problems: 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consistency, Stability, Convergence, Grid independent and time independent study, Stability analysis of parabolic and hyperbolic equations. Finite Volume Discretization of 2-D unsteady State Diffusion type Problems: FVM for 2-D unsteady state diffusion problems

Solution of Systems of Linear Algebraic Equations: Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search methods with examples. Norm of a vector, Norm of a matrix, some important properties of matrix norm, Error analysis of elimination methods.

Finite volume discretization of Convection-Diffusion Equations: Schemes. The concept of false diffusion, QUICK scheme. Discretization of Navier Stokes Equations: Discretization of the

Momentum Equation, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm. What is there in implementing a CFD code: The basic structure of a CFD code: Pre-processor, Solver and Postprocessor, User-defined subroutines.

Essential Readings

1. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor & Francis, 1997.

2. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.

3. Anderson J.D., Computational Fluid Dynamics - The basics with Applications, Mc Graw-Hill, 1995.

4. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics - The finite volume method, Longman Scientific & Technical, 1995.

5. Patankar, S.V., Numerical Heat Transfer & Fluid Flow, Hemisphere, 1980.

6. Date A.W., Introduction to Computational Fluid Dynamics, Cambridge University Press, 2005.

COURSE OBJECTIVES

1. To introduce numerical modeling and its role in the field of heat transfer and fluid flow.
2. To enable the students to understand the various discretization methods and solving methodologies.
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers.

MAPPING OF COs with POs

Course Outcomes	**Programme Outcomes (PO)** (Enter Numbers only)
1. Express numerical modeling and its role in the field of fluid flow and heat transfer.	PO1, PO2, PO3
2. Estimate the various errors and approximations associated with numerical techniques.	PO3, PO5
3. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems.	PO2, PO5
4. Interpret the knowledge, capability of analyzing and solving any concept or problem associated with heat energy dynamics and utilization.	PO1, PO3
5. Illustrate the working concepts of thermal engineering devices.	PO4

COURSE PLAN – PART II

COURSE OVERVIEW

The course provides a stuctured approach on the method of approaching to solve a problem in heat transfer and/or fluid flow by computational method. The design of the course includes understanding of the governing equations of fluid flow and heat transfer. The course further goes on to describe the types of these governing equations and strategies which are important to solve them. The course further describes the numerical schemes used to convert these equations and their corresponding boundary conditions into a system of ordinary equations. The numerical strategies used to solve

these ordinary equations are further dilineated in the course. Solution of some special cases of fluid flow and heat transfer problems are illustrated.

COURSE TEACHING AND LEARNING ACTIVITIES **(** Add more rows)

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	1st week	Introduction – Basic Governing equations	PPT, Problem Solving
2	2nd week	Basic governing equations - General scalar transport equation	Problem Solving, Chalk & Talk
3	3rd week	Classification of equations	Problem Solving, Chalk & Talk
4	4th week	Approximate Solutions	Problem Solving, Chalk & Talk
5	5th week	Discretization methods	Problem Solving, Chalk & Talk
6	6th week	Finite volume method	Problem Solving, Chalk & Talk
7	7th week	Time Dependent Diffusion Type Problems	Problem Solving, Chalk & Talk
8	8th week	Solution of Systems of Linear Algebraic Equations	Problem Solving, Chalk & Talk
9	9th week	Elimination, Iteration and Gradient Search methods with examples	Problem Solving, Chalk & Talk
10	10th week	Error analysis of elimination methods	Chalk & Talk, Coding
11	11th week	Finite volume discretization of Convection-Diffusion Equations	Problem Solving, Chalk & Talk
12	12th week	Discretization of Navier Stokes Equations	Problem Solving, Chalk & Talk

13	13th week	SIMPLE Algorithm - SIMPLER Algorithm	PPT, Problem Solving
14	14th week	The basic structure of a CFD code	Problem Solving, Chalk & Talk

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

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Assignment	-	Over the semester	30%
2	Cycle Test - I	February 2021	1 hour	20%
3	Cycle Test - II	April 2021	1 hour	20%
CPA	Compensation Assessment*	May 2021	1 hour	20%
4	Final Assessment *	As per institute norms	As per institute norms	30%

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

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

1. Students feedback through class committee meetings
2. Feedback questionnaire from students – at the end of the semester
3. Feedback from students on the course outcomes shall be obtained at the end of the course

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

Mode of Correspondence

1. The Faculty is available for consultation during the time intimated to the students then and there.

2. The students will be communicated through the email id: pkaushik@nitt.edu for any academic related issues (including sharing of study materials) with respect to this course.

Compensation Assessment

1. Attending all the assessments (2, 3, 4, 5) are mandatory for every student. Flexibility is given to the students to fix the date for each mode of evaluation convenient to majority of the students.

2. If any student fails to attend the cycle test 1 and 2 due to genuine reason like medical emergency, the student may be permitted to appear the compensation assessment (CPA) on submission of appropriate documents as proof and permission of the head of the department. (Not valid for students having attendance lag).

3. Under no circumstance, the compensation assessment (CPA) will be considered as an improvement test.

4. The minimum marks for passing this course and grading pattern will adhere to the regulations of the institute.

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

FOR APPROVAL

Course Faculty _____ **CC- Chairperson** _____ **HOD** _____

Guidelines

a) The number of assessments for any theory course shall range from 4 to 6.

b) Every theory course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in				**P.G.**
2018	**2017**	**2016**	**2015**	
35% or (Class average/2) whichever is greater.		(Peak/3) or (Class Average/2) whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.