Model Template for Scheme of Course Work

to be submitted by the Faculty of B.Tech/M.Tech/MCA I semester on or before 11.10.2013 to bhanucvk@gvpce.ac.in and yadavalliraghu@yahoo.com

SCHEME OF COURSE WORK

Course Details:

Course Title	**: Computational Fluid Dynamics**		
Course Code	**: 13ME2311**	**L P C**	**: 4 0 3**
Program:	**: M.Tech. in Mechanical Engineering**		
Specialization:	**: Thermal Engineering**		
Semester	**: II**		
Prerequisites	**: Fluid Mechanics, Heat Transfer and Basic Numerical Methods**		
Courses to which it is a prerequisite	**:Simulation lab**		

Course Outcomes (COs):

At the end of the course the student will be able to

1	Explain basic approaches and numerical methodsto solve fluid dynamics problems
2	Explain finite volume method for diffusion and convection-diffusion problems using diferent interpolation schemes
3	Solve lenear algebraic equations and transient one and two dimensional heat conduction equations
4	Explain stream function-vorticity method, and to solve the pressure equation
5	Discuss pressure correction method to solve incompressible and compressible flows and explain turbulent flow models

Program Outcomes (POs):

PO1:Exhibit in-depth knowledge in thermal engineering specialization

PO2: Think critically and analyze complex engineering problems to make creative advances in theory and practice

PO3: Solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment

PO4: Use research methodologies, techniques and tools, and contribute to the development of technological knowledge

PO5: Apply appropriate techniques, modern engineering and software tools to perform modeling of complex engineering problems knowing the limitations

PO6: Understand group dynamics, contribute to collaborative multidisciplinary scientific research

PO7: Demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors

PO8: Communicate complex engineering problems with the engineering community and society, write and present technical reports effectively.

PO9: Engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously

PO10: Exhibit professional and intellectual integrity, ethics of research and scholarship and will realize his/her responsibility towards the community

PO11: Examine critically the outcomes of his/her actions and make corrective measures without depending on external feedback

Course Outcome Versus**Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	S											
CO-2	M	S										
CO-3		S						M				

S - Strongly correlated, *M - Moderately* correlated, *Blank - No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

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Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	Principles of conservation of mass and momentum – dimensionless form of equations	CO-1	Explain the principles of conservation of mass and momentum – dimensionless form of equations	Lecture Derivations	Assignment (Week 2 - 4)
2	simplified mathematical models for incompressible, inviscid, potential and creeping flows, Boussinesq and boundary layer approximations	CO-1	Derive simplified mathematical models for incompressible, inviscid, potential and creeping flows, Explain boussinesq and boundary layer approximations	Lecture / Discussion Problem solving	Mid-Test 1 (Week 9)
3	mathematical classification as hyperbolic, parabolic and elliptic flows.	CO-1	Explain the mathematical classification as hyperbolic, parabolic and elliptic flows.	Lecture Problem solving	Quiz (Week 2 - 4)
4	Approaches to fluid dynamical problems – possibilities and limitations of numerical methods. components of numerical solution method: mathematical model	CO-1	Explain the approaches to fluid dynamical problems – possibilities and limitations of numerical methods. components of numerical solution method	Lecture Derivations and analysis	
5	discretization method,		Explain convergence	Lecture	

	coordinate and basis vector systems, numerical grid, finite approximations. solution method, convergence criteria, consistency, stability, convergence	CO-2	criteria. Explain consistency, stability, convergence	Problem solving	
6	discretization approaches: finite difference method, finite volume method. discretization approaches: finite element method	CO-2	Explain discretization approaches in finite difference method, finite volume method. Explain discretization approaches in finite element method	Lecture Problem solving	
7	Finite difference methods: approximation of first, second and mixed derivatives, uniform and non-uniform derivatives, implementation of boundary conditions, discretization errors.	CO-2	Explain Finite difference methods using approximation of first, second and mixed derivatives, uniform and non-uniform derivatives, implementation of boundary conditions.	Lecture Problem solving	
8	Finite volume methods: approximation of surface and volume integrals. – interpolation schemes: upwind differencing, central difference scheme. quadratic upwind interpolation (QUICK) scheme	CO-2	Explain finite difference methods using approximation of first, second and mixed derivatives, uniform and non-uniform derivatives, implementation of boundary conditions,	Lecture Problem solving	

9	implementation of boundary conditions – algebraic equation system	CO-2	Explain the implementation of boundary conditions.	Lecture Problem solving	
10	Solution of linear algebraic equations: Gauss elimination method. Thomas algorithm for tri-diagonal system of equations.	CO-2	Explain Gauss elimination method.Explain Thomas algorithm for tri-diagonal system of equations.	Lecture Discussion Problem solving	Mid-Test 2 (Week 18)
11	Solution of transient one-dimensional differential equation: explicit method. Crank-Nicolson implicit scheme	CO-3	Derive solution of transient one-dimensional differential equation using explicit method. Crank-Nicolson implicit scheme	Lecture Problem solving	Case Study (Week 10 - 14)
12	Solution of unsteady two-dimensional differential equation: Alternating Direction Implicit method	CO-3	Derive the solution of unsteady two-dimensional differential equation using Alternating Direction Implicit method	Lecture Problem solving	
13	Solution of Navier-Stokes equations-I: Discretization of derivative terms: convective and viscous terms	**CO-3**	Derive solution of Navier-Stokes equations-I	Lecture Problem solving	
14	pressure and body force terms – conservation properties. Variable grid: Collocated arrangement, staggered arrangement	CO-3	Explain briefly Collocated arrangement, staggered arrangement of grids.	Lecture Problem solving	
15	The pressure equation and its solution: A simple explicit time advance scheme. A	CO-4	Derive simple explicit time advance scheme	Lecture Problem	Seminar (Week

	simple implicit time advance scheme. Stream function-vorticity method			solving	15)
16	Solution of Navier-Stokes equations-II: Implicit pressure correction methods: SIMPLE algorithm.SIMPLER algorithm. Turbulent flows: Large eddy simulation (LES)	CO-4	Derive SIMPLE algorithm. Derive SIMPLER algorithm.	Lecture Problem solving	
17	Reynolds averaged Navier-Stokes equations – Simple turbulence models. Reynolds averaged Navier-Stokes equations – Simple turbulence model	CO-4	Derive Reynolds averaged Navier-Stokes equations using Simple turbulence models	Lecture Demonstration Problem solving	
18	Reynolds stress model. Compressible flow: Pressure correction method. pressure-velocity-density coupling, boundary conditions	CO-4	Explain Reynolds stress model. Compressible flow	Lecture Problem solving	
19/20	**END EXAM**				

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