INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**COMPUTATIONAL AERODYNAMICS**				
Course Code	AAE013				
Programme	B.Tech				
Semester	VI	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	3
Chief Coordinator	Ms. D Anitha, Assistant Professor				
Course Faculty	Ms. D Anitha, Assistant Professor Mr. G Satya Dileep, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Discuss the fundamental aspects of numerical discretization and the major theories, approaches and methodologies used in computational aerodynamics.
II	Analyze to build up the skills in the actual implementation of computational aerodynamics methods boundary conditions, turbulence modeling etc by using commercial CFD codes.
III	Demonstrate the applications of CFD for classic fluid dynamics problems and basic thoughts and philosophy associated with CFD.
IV	Understand the various grids used in practice, including some recommendations related to grid quality and choose appropriate data structure to solve problems in real world.

COURSE OUTCOMES (COs):

CO 1	Understand the applications of CFD in various engineering fields and to generate governing equations in conservative and non-conservative form.
CO 2	Understand the mathematical behavior of partial differential equations and classify into hyperbolic, parabolic and elliptical natures.
CO 3	Acquire the concepts of finite difference method through discretization and grid generation techniques.
CO 4	Identify different CFD techniques available for different partial differential equations.
CO 5	Explore the concepts of finite volume methods, and its difference from finite difference method.

COURSE LEARNING OUTCOMES (CLOs):

AAE013.01	Understand the necessity of CFD tool as both research and design areas in modern computational world
AAE013.02	Explain the applications of computational fluid dynamics tool in various engineering branches other than aerospace engineering.
AAE013.03	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its meta centre height.
AAE013.04	Recognize the selection of type of flow from the finite control volume and infinitesimal small fluid element depending upon the requirements.
AAE013.05	Develop the governing equations required for computational aerodynamics in both conservation and non-conservation forms.
AAE013.06	Explain the need of classification of quasi linear partial differential equations by Cramer's rule and Eigen Value Method.
AAE013.07	Understand the concepts of range of influence and domain of dependence for a flow field.
AAE013.08	Explain the general behaviour of the partial differential equations which falls in hyperbolic, parabolic and elliptic equations.
AAE013.09	Demonstrate the CFD aspects of the hyperbolic, parabolic and elliptic equations in aerodynamic problems and physical problems.
AAE013.10	Distinguish between explicit and implicit approaches that are needed for solving different finite differential equations.
AAE013.11	Explain the Consistency analysis and von Neumann stability analysis of finite difference methods and physical significance of CFL condition.

AAE013.12	Discuss the different types of grids available for different flow fields available in computational fluid dynamics.
AAE013.13	Understand the need for generating grids for solving the finite differential equations in analyzing a flow field.
AAE013.14	Describe the various CFD techniques available for solving the finite differential equations for a flow field.
AAE013.15	Discuss the aspects of numerical dissipation and numerical dispersion and explain the applications of each in CFD techniques.
AAE013.16	Explain the technique of pressure correction method with the need of staggered grid and its philosophy.
AAE013.17	Explain the numerical procedures for analysis like SIMPLE, SIMPLER SIMPLEC and PISO algorithms and differentiate with regular CFD techniques.
AAE013.18	Discuss the concepts of finite volume method and explain the difference from finite difference method for solving different flow field.
AAE013.19	Demonstrate the need of finite volume discretization and its general formulation of a numerical scheme in finite volume method.
AAE013.20	Understand the principle of two dimensional finite volume methods in solving flow fields with finite control volume.

TUTORIAL QUESTION BANK

UNIT – I				
INTRODUCTION TO COMPUTATIONAL AERODYNAMICS				
Part - A(Short Answer Questions)				
S.NO	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes**
1	Define substantial derivative with example.	Understand	CO 1	AAE013.04
2	State the detachment distance in blunt nosed body	Understand	CO 1	AAE013.04
3	State any two applications of CFD in engineering.	Remember	CO 1	AAE013.02
4	Define divergence of velocity in aerodynamics.	Understand	CO 1	AAE013.04
5	State the local derivative with the suitable example.	Understand	CO 1	AAE013.04
6	List the forces in Newton's second law in diagrammatic form.	Understand	CO 1	AAE013.04
7	Distinguish conservative and non-conservative form of the governing equation for control volume.	Remember	CO 1	AAE013.04
8	State the proper physical boundary condition for a viscous flow	Understand	CO 1	AAE013.04
9	Mention the applications of CFD in industrial manufacturing.	Remember	CO 1	AAE013.04
10	Distinguish the Newtonian and Non-Newtonian fluids.	Understand	CO 1	AAE013.03
Part - B (Long Answer Questions)				
1	Which three disciplines is CFD derived from? Discuss some of the advantages of using CFD?	Understand	CO 1	AAE013.01
2	How CFD is helpful as a research tool, a design tool, and an educational tool in analyzing fluid dynamical problems.	Understand	CO 1	AAE013.01
3	What is substantial derivative? Derive the expression for time rate of change of fluid element. Define local derivative, convective derivative.	Remember	CO 1	AAE013.04
4	Illustrate the use of conservation form of the equations so important for the shock-capturing method by considering the flow across a normal shock wave.	Understand	CO 1	AAE013.02
5	Develop the entire system of governing equations in conservation form for computer programming convenience.	Remember	CO 1	AAE013.02
6	Explain the computer architectures and list the types of computer architectures. Compare and contrast the viscous flow and inviscid flow.	Understand	CO 1	AAE013.02
7	Explain the physical meaning of Divergence of Velocity that frequently appears in the equations of fluid dynamics. Define substantial Derivative and explain its physical meaning.	Remember	CO 1	AAE013.04
8	Discuss some of the applications of CFD and explain why it is so important in the modern study of fluid mechanics?	Understand	CO 1	AAE013.02

9	Discuss how Computational Fluid Dynamics is vital in the following fields. a) Automobile engineering b) Industrial manufacturing.	Remember	CO 1	AAE013.02
10	Describe the steps involved in Computational Fluid Dynamics (CFD) process.	Understand	CO 1	AAE013.03
Part - C (Analytical Questions)				
1	List out the models of flow for a continuum fluid. Differentiate the control volume and infinitesimal fluid element fixed in space with the fluid moving through it with the help of neat sketch.	Remember	CO 1	AAE013.04
2	Explain how the continuity equation derived from these flow models can be converted from conservative to non-conservative form.	Remember	CO 1	AAE013.04
3	Derive momentum equation in conservation form using infinitesimal small fluid element moving with the flow.	Understand	CO 1	AAE013.04
4	Derive energy equation in conservation form using infinitesimal small fluid element fixed in space for compressible in viscid flow.	Remember	CO 1	AAE013.04
5	Write short notes on non-conservative form of governing equations. Derive continuity equation in non-conservation form using infinitesimal small fluid element moving in space.	Remember	CO 1	AAE013.04
6	Explain and Differentiate shock fitting and shock capturing methods with the suitable diagram.	Understand	CO 1	AAE013.04
7	Derive the generic form of a partial differential equation used in CFD and explain the significance of each term.	Remember	CO 1	AAE013.04
8	Derive energy equation in conservation form using infinitesimal small fluid element moving in space for compressible viscous flow.	Understand	CO 1	AAE013.04
9	Derive energy equation in conservation form using infinitesimal small fluid element fixed in space in terms of internal energy for compressible flow.	Remember	CO 1	AAE013.04
10	Derive continuity equation in conservation form using infinitesimal small fluid element moving with the flow.	Remember	CO 1	AAE013.04
UNIT II				
MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS				
Part – A (Short Answer Questions)				
1	Define quasi linear partial differential equations.	Understand	CO 2	AAE013.05
2	Define characteristic curve and its uses.	Understand	CO 2	AAE013.06
3	Classify the quasi linear partial differential equations by determining value of Determinant.	Understand	CO 2	AAE013.07

4	Define compatibility equation for method of characteristics.	Remember	CO 2	AAE013.07
5	State the boundary layer equations.	Understand	CO 2	AAE013.06
6	List the types of flow are governed by the elliptic equations.	Remember	CO 2	AAE013.08
7	List the types of fluid dynamic flow fields are governed by parabolic equations.	Remember	CO 2	AAE013.06
8	List the advantage of the compatibility equation	Remember	CO 2	AAE013.06
9	Explain well-posed problems with example for numerical analysis.	Understand	CO 2	AAE013.07
10	When an equation is called Parabolized Navier-Stokes equation.	Remember	CO 2	AAE013.08
Part - B (Long Answer Questions)				
1	Classify the system of equation form the general equation for a conic section from analytical geometry and derive the expression.	Understand	CO 2	AAE013.05
2	Illustrate the characteristic curve with the suitable diagram. Differentiate the left running and right running characteristics with the suitable example.	Understand	CO 2	AAE013.05
3	Explain the mathematical and physical nature of flows governed by parabolic Equations with an illustration of a steady boundary layer flow.	Understand	CO 2	AAE013.05
4	Explore the boundary layer flow for the parabolic equation by considering the nose region with the neat sketch.	Remember	CO 2	AAE013.06
5	Illustrate the typical transient temperature distributions in a constant property fluid, starting from an impulsive increase in Tw2 from T1 to T2 at time zero.	Understand	CO 2	AAE013.07
6	Explicit the general behavior of the different classes of partial differential equation – impact on physical and computational fluid dynamics with suitable example for each.	Remember	CO 2	AAE013.06
7	Elucidate the domain and boundaries for the solution of hyperbolic equations for the three dimensional steady flow.	Remember	CO 2	AAE013.06
8	Discuss the domain and boundaries for the solution of hyperbolic equations for the one and two dimensional unsteady flow with the suitable diagram.	Remember	CO 2	AAE013.08
9	How will be the mathematical behaviour of various types of partial differential Equations?	Understand	CO 2	AAE013.08
10	Discuss the domain and boundaries for the solution of elliptic equations for the two dimensions with the suitable diagram	Understand	CO 2	AAE013.08
Part - C (Analytical Questions)				
1	Classify the following set of equations for irrotational, two-dimensional, inviscid, steady flow of a compressible flow using Eigen value method: $(1 - M_{\infty}^2)$ [illegible] + [illegible] $= 0$ [illegible] − [illegible] $= 0$	Understand	CO 2	AAE013.05

	Where u', v' are small perturbation velocities measured relative to the free Stream velocity.			
2	Explain the classification of the following quasi-linear partial differential equations using Cramer's rule: $a_1(\partial u/\partial x)+ b_1(\partial u/\partial y)+ c_1(\partial v/\partial x)+ d_1(\partial v/\partial y)=f_1$ $a_2(\partial u/\partial x)+ b_2(\partial u/\partial y)+ c_2(\partial v/\partial x)+ d_2(\partial v/\partial y)=f_2$ Where u and v are dependent variables, continuous functions of x and y and a_1, a_2, b_1, b_2, c_1, c_2, d_1, d_2, f_1, f_2 can be functions of x, y, u and v.	Understand	CO 2	AAE013.05
3	Discuss the physical behaviour of flows governed by hyperbolic equations with an example of steady, inviscid supersonic flow over a two dimensional circular arc airfoil.	Remember	CO 2	AAE013.07
4	Discuss the physical behaviour of flows governed by parabolic equations with an example of steady boundary layer flows. Explain PNS model for high speed flows and explain its merits.	Understand	CO 2	AAE013.07
5	Classify the following partial differential equations according to their nature as elliptic, parabolic, hyperbolic (a)Unsteady Thermal Conduction Equation (b)Laplace's Equation (c)Second-order wave equation (d)First-order wave equation	Remember	CO 2	AAE013.07
6	Write short notes on the following: (a)Parabolized Navier-Stokes equations (b) Well-posed problems.	Understand	CO 2	AAE013.08
7	Discuss the mathematical and physical behaviour of flows governed by Parabolic equations with an example of unsteady thermal conduction in two and three dimensions.	Understand	CO 2	AAE013.08
8	Discuss the mathematical and physical nature of flows governed by elliptic equations with an illustration of incompressible, inviscid flow. Explain Neumann and Dirichlet boundary conditions.	Remember	CO 2	AAE013.08
9	What are characteristic lines? Explain the philosophy of the Method of characteristics. Consider the full velocity potential equation for the steady, two dimensional supersonic flows and determine the equation for characteristic curves in the physical xy space and classify the nature of velocity potential equation based on Mach number.	Understand	CO 2	AAE013.07

UNIT –III				
BASIC ASPECTS OF DISCRETIZATION				
Part – A (Short Answer Questions)				
1	What are the errors that influence numerical solutions the PDE?	Understand	CO 3	AAE013.09
2	Define Courant number. What is the important stability criterion for hyperbolic equation?	Understand	CO 3	AAE013.09
3	Define discretization error in numerical approach.	Remember	CO 3	AAE013.10
4	Define Round-off error and its effects.	Understand	CO 3	AAE013.10
5	Write disadvantages of the implicit approach.	Understand	CO 3	AAE013.10
6	Define the need of grid point in discretization.	Remember	CO 3	AAE013.11
7	State CFD technique and list the approaches.	Understand	CO 3	AAE013.09
8	List out the types of errors and state them.	Remember	CO 3	AAE013.09
9	Discuss about truncation error in numerical approach.	Understand	CO 3	AAE013.10
10	Define first order forward difference with example.	Remember	CO 3	AAE013.13
11	State reflection boundary condition.	Understand	CO 3	AAE013.11
12	List the pros and cons of higher – order accuracy.	Understand	CO 3	AAE013.09
13	Illustrate the discrete gird points.	Understand	CO 3	AAE013.09
14	Define finite- difference modules.	Understand	CO 3	AAE013.09
25	Write two differences between structured and unstructured grids?	Understand	CO 3	AAE013.11
26	Draw triangular and Tetrahedral cells.	Understand	CO 3	AAE013.12
27	Sketch the structured curvilinear body-fitted grid of the C-type.	Remember	CO 3	AAE013.12
28	List out the methods for the curved solid bodies – non uniform Cartesian grids	Understand	CO 3	AAE013.11
29	Sketch the structured curvilinear body-fitted grid of the O-type.	Remember	CO 3	AAE013.12
30	Sketch the structured curvilinear body-fitted grid of the H-type.	Understand	CO 3	AAE013.12
31	Sketch the Cartesian grid with non-uniform cell sizes for a cavity.	Understand	CO 3	AAE013.12
32	Write the advantages of adaptive grid?	Remember	CO 3	AAE013.11
33	Distinguish Cartesian grid and non-uniform Cartesian grids	Understand	CO 3	AAE013.12
34	List out the types of Body fitted structured grids.	Understand	CO 3	AAE013.12
35	Sketch the structured curvilinear body-fitted grid of the I-type for turbo machinery blades.	Understand	CO 3	AAE013.12
Part – B (Long Answer Questions)				
1	Obtain the expression for first - order forward difference and first - order rearward difference by using the Taylor series.	Remember	CO 3	AAE013.09
2	Explain Lax method for one dimensional wave equation and explain the stability criterion for hyperbolic equations	Understand	CO 3	AAE013.11

3	Explain the explicit formulation by using one dimensional heat conduction equation as an example with its relative merits and demerits	Understand	CO 3	AAE013.10
4	Construct the implicit finite difference module using seven point spatial grid by considering one-dimensional heat conduction equation which is parabolic partial differential solution.	Understand	CO 3	AAE013.10
5	Elucidate the von Neumann stability method which is used to study the stability properties of linear difference equations.	Understand	CO 3	AAE013.10
6	Construct a finite difference quotient by using the polynomial approach by assuming the boundary and obtain a expression for one sided finite difference.	Remember	CO 3	AAE013.09
7	List out the advantages and disadvantages of implicit approach and explicit approach.	Understand	CO 3	AAE013.11
8	Illustrate the maximum and minimum wavelengths for the Fourier components of the round-off error.	Understand	CO 3	AAE013.10
9	Justify stability criterion depends on the form of the difference equation by considering the first order wave equation which is a hyperbolic behavior.	Understand	CO 3	AAE013.10
10	Define Courant number and Courant-Friedrichs-Lewy(CFL) condition. Interpret the physical behavior of CFL condition.	Understand	CO 3	AAE013.10
1	Discuss and sketch the structured multi-block body-fitted grid of the H-O-H type.	Remember	CO 3	AAE013.11
2	Discuss and sketch the structured curvilinear body-fitted of the C-H type.	Understand	CO 3	AAE013.12
3	Illustrate the matching and non-matching block boundary interfaces of a multi-block-structured grid with a channel connecting two circular ducts.	Understand	CO 3	AAE013.12
4	Discuss the structured multi-block body-fitted grid of the 'butterfly' type for internal flows.	Remember	CO 3	AAE013.12
5	Sketch the Cartesian mesh around a solid boundary with immersed boundary method and Sketch cut-cell configuration.	Understand	CO 3	AAE013.12
6	Discuss chimera technique for the flexible block-structured grid generation with suitable diagram.	Understand	CO 3	AAE013.12
Part - C (Analytical Questions)				
1	Write short notes on the following properties of numerical solutions of fluid flows: i) Stability ii) Consistency iii) Accuracy iv) Convergence.	Remember	CO 3	AAE013.11
2	Illustrate the time marching solution for constructing the explicit finite difference module by considering one-dimensional heat conduction equation which is parabolic partial differential solution.	Understand	CO 3	AAE013.10

3	Obtain the difference equation by considering unsteady, one-dimensional heat conduction equation with constant thermal diffusivity with the neat sketch.	Remember	CO 3	AAE013.11
4	Write down the expressions for the first order forward difference and first - order rearward difference with respect to x and y. Sketch the appropriate finite- difference modules for each by using the discrete grid points.	Understand	CO 3	AAE013.09
5	Sketch the finite- difference modules for second - order central second difference with respect to x, y and second - order central mixed difference with respect to x and y by justifying the expression.	Remember	CO 3	AAE013.10
6	Write down the expressions for the second order central second difference with respect to x and y. Sketch the appropriate finite-difference modules for each by using the discrete grid points.	Understand	CO 3	AAE013.11
7	Illustrate a stable case by comparing the numerical domain includeall the analytical domain and does not include all the analytical domain with the neat sketch.	Understand	CO 3	AAE013.10
8	Sketch the variation of round-off error as a function of x. Sketch and the sine function with the wave length L and L/2. From Fourier series what is the wave number?	Understand	CO 3	AAE013.10
1	Explain the importance of grid generation in CFD process and discuss the difference between structured grid and unstructured grid.	Understand	CO 3	AAE013.11
2	Elucidate the unstructured hybrid grid showing the regular quadrilateral or hexahedra cells type structure near the solid walls.	Understand	CO 3	AAE013.12
3	Define structured and unstructured grids. Discuss various configurations of Body-fitted structured grids and multi-block grids with the help of sketches.	Remember	CO 3	AAE013.11
4	Summarize the hybrid grids of a turbine blade with film cool configuration for generation of unstructured grid with the suitable example.	Understand	CO 3	AAE013.12
5	Elucidate the triangle or tetrahedral cells for generation of unstructured grid with the suitable example.	Understand	CO 3	AAE013.12
6	Sketch the quad tree grid with hanging nodes, nodes around an airfoil with staircase boundary approximation	Understand	CO 3	AAE013.12
UNIT -IV				
CFD TECHNIQUES				
Part – A (Short Answer Questions)				
1	State point iterative method.	Understand	CO 4	AAE013.14

2	To what extent does the addition of artificial viscosity effect the accuracy of the problem.	Remember	CO 4	AAE013.14
3	What is Relaxation technique?	Understand	CO 4	AAE013.14
4	Sketch the effect of numerical dispersion when initial wave at time t=0 and t>0.	Understand	CO 4	AAE013.15
5	Define approximate factorization.	Remember	CO 4	AAE013.14
6	Write down the expression for relaxation factor.	Understand	CO 4	AAE013.14
7	What is Pressure correction technique?	Understand	CO 4	AAE013.16
8	Differentiate successive over relaxation and under relaxation.	Remember	CO 4	AAE013.16
9	What is the need for staggered grid?	Understand	CO 4	AAE013.14
10	Sketch the effect of numerical dissipation when initial wave at time t=0 and t>0.	Remember	CO 4	AAE013.14
Part – B (Long Answer Questions)				
1	Obtain an expression for second order accuracy in both space and time by using the Lax Wendroff method explicitly.	Understand	CO 4	AAE013.14
2	Obtain an expression for second order accuracy in both space and time by using the Maccormack method explicitly.	Understand	CO 4	AAE013.14
3	What is a Crank Nicholson technique? Explain its advantages in field of CFD techniques.	Remember	CO 4	AAE013.14
4	Obtain an expression for finite difference method, relaxation technique for the solution of elliptic partial differential equation. Explain its applications.	Remember	CO 4	AAE013.14
5	Elucidate the simple form of artificial viscosity by considering unsteady two dimensional flows.	Remember	CO 4	AAE013.15
6	Obtain an expression of computational module for x momentum equation for an incompressible viscous flow for the pressure correction formula.	Understand	CO 4	AAE013.14
7	List out the sequence of operation in a Computational fluid dynamics procedure which employs the SIMPLE algorithm with the flow chart.	Remember	CO 4	AAE013.16
8	Discuss the sequence of operation in a Computational fluid dynamics procedure which employs the SIMPLEC algorithm with the flow chart.	Understand	CO 4	AAE013.16
9	Elucidate the first step in the alternating direction implicit (ADI) technique by sweeping in the x direction to obtain T at time $t+\Delta t/2$.	Understand	CO 4	AAE013.14
10	What is the need for staggered grid and sketch? List out the advantages of staggered grid.	Understand	CO 4	AAE013.14
Part - C (Analytical Questions)				
1	Explain explicit MacCormack Technique for a steady, two-dimensional, supersonic, inviscid flow field in(x, y) space using the following generic	Understand	CO 4	AAE013.14

	conservation form without source terms: ∂F/∂x=-∂G/∂y where F and G represent flux vectors formed from the governing equations.			
2	List out the sequence of operation in a Computational fluid dynamics procedure which employs the SIMPLER algorithm with the flow chart.	Remember	CO 4	AAE013.14
3	List out the sequence of operation in a Computational fluid dynamics procedure which employs the PISO algorithm with the flow chart.	Understand	CO 4	AAE013.14
4	Discuss the boundary condition for the pressure correction method with schematic of staggered grid by incompressible viscous flow.	Remember	CO 4	AAE013.14
5	Elucidate the relaxation technique for the inviscid, incompressible, two dimensional, irrotational flow under explicit approach.	Understand	CO 4	AAE013.14
6	Obtain an expression of computational module for y momentum equation for an incompressible viscous flow for the pressure correction formula.	Remember	CO 4	AAE013.14
7	Elucidate the second step in the alternating direction implicit (ADI) technique by sweeping in the y direction to obtain T at time t+Δt.	Remember	CO 4	AAE013.14
8	Discuss numerical dissipation and numerical dispersion in the context of Numerical solution to fluid dynamical problems	Understand	CO 4	AAE013.15
9	Explain checker-board behaviour of velocity and pressure fields in central Discretization schemes using sketches and explain how such behaviour can be avoided.	Remember	CO 4	AAE013.16
10	State pressure correction technique. List out the process for the philosophy of the pressure correction method.	Remember	CO 4	AAE013.17
UNIT – V				
FINITE VOLUME METHODS				
Part - A (Short Answer Questions)				
1	Define Finite volume method and list the advantages and disadvantages	Remember	CO 5	AAE013.18
2	State control volume for the Finite volume method?	Understand	CO 5	AAE013.18
3	What is the basis of Finite Volume Method?	Remember	CO 5	AAE013.18
4	Discuss and sketch the incorrect finite volume decomposition.	Understand	CO 5	AAE013.18
5	Sketch the cell-centered and cell-vertex cells for structured grid.	Understand	CO 5	AAE013.18
6	Sketch the cell-centered and cell-vertex cells for structured grid.	Remember	CO 5	AAE013.18
7	Define residual in finite volume method.	Understand	CO 5	AAE013.18
8	Discuss the alternative formulation of the conservation condition.	Remember	CO 5	AAE013.19
9	Write down the expression used for the estimation of the area of an arbitrary cell.	Understand	CO 5	AAE013.19
10	Define one condition for finite volume selection.	Remember	CO 5	AAE013.19

Part - B (Long Answer Questions)				
1	Illustrate the conservative discretization on a one-dimensional form of conservation law by subdivision of a one dimensional space into mesh cells with the flux vector in x-component.	Understand	CO 5	AAE013.18
2	What do you understand by conservative discretization and explain the importance of it in FVM.	Understand	CO 5	AAE013.18
3	Obtain the formal expression of a conservative discretization by stating the theorem for the discretized equation.	Understand	CO 5	AAE013.18
4	Discuss the cell-centered approach for the structured finite volume mesh and unstructured finite volume mesh with the help of neat sketch.	Understand	CO 5	AAE013.18
5	Illustrate the non-conservative discretization on a one-dimensional form of conservation law.	Understand	CO 5	AAE013.18
6	Evaluate the fluxes for the upwind schemes and cell-vertex finite volumes methods, upwind schemes determine the cell face fluxes according to the propagation direction of the convection velocity.	Remember	CO 5	AAE013.18
7	Distinguish the non-uniform finite volume mesh and orthogonal non-uniform finite volume mesh with the suitable diagram.	Understand	CO 5	AAE013.19
8	Construct the standard finite difference discretization on the mesh by considering the two-dimensional diffusion equation and Cartesian grid.	Remember	CO 5	AAE013.18
9	Derive a finite volume estimation of gradients by considering control cell and applying trapezoidal integration formulas.	Understand	CO 5	AAE013.18
Part - C (Analytical Questions)				
1	Explain cell-centered and cell-vertex discretization methodologies used in Finite volume approach with the help of sketches. What are the constraints to be satisfied on the choice of discretized control volumes for a consistent finite volume method?	Understand	CO 5	AAE013.18
2	Evaluate the fluxes for the upwind schemes and cell-centered finite volumes methods, upwind schemes determine the cell face fluxes according to the propagation direction of the convection velocity.	Remember	CO 5	AAE013.19
3	Distinguish the cell-centered approach and cell-vertex approach for the unstructured finite volume mesh with the help of neat sketch.	Understand	CO 5	AAE013.19
4	Illustrate the cell-vertex finite volume method with the example of two-dimensional control surfaces by selecting hexagonal control volume and trapezoidal control surface.	Remember	CO 5	AAE013.19
5	Distinguish the interpretation of finite volume methods from the finite difference and finite element approaches.	Understand	CO 5	AAE013.19

6	Obtain the general formulation of a numerical scheme. The formulation is to be valid for all possible cases such as structured gird or unstructured grids either cell-centered or cell-vertex defines variables.	Remember	CO 5	AAE013.18
7	Determine the basic formulation for the two-dimensional finite volume method by using the area of an arbitrary plane quadrilateral.	Remember	CO 5	AAE013.18
8	Derive a finite volume estimation of gradients for an arbitrary quadrilateral by noticing differences Δy grouped for opposite nodes with the suitable diagram.	Understand	CO 5	AAE013.20
9	Discuss the upwind scheme on Cartesian mesh by considering the discretization of the Two-dimensional linear convection equation and the fluxes are f=aU and g=bU.	Remember	CO 5	AAE013.20
10	Derive a finite volume estimation of gradients by application of the Gauss divergence theorem for two dimensional control cells.	Remember	CO 5	AAE013.19

Prepared by:

Ms. D. Anitha Assistant Professor **HOD, AE**