INSTITUTE OF AERONAUTICAL ENGINEERING

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AERONAUTICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**COMPUTATIONAL AERODYNAMICS**
Course Code	:	**AAE013**
Program	:	**B.Tech**
Semester	:	**VI**
Branch	:	**Aeronautical Engineering**
Section	:	**A & B**
Course Faculty	:	**Ms. D. Anitha, Assistant Professor** **Mr. G. Satya Dileep, Assistant Professor**

OBJECTIVES:

I	To help students to consider in depth the terminology and nomenclature used in the syllabus.
II	To focus on the meaning of new words / terminology/nomenclature

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CLO	CO	CLO Code
UNIT-I INTRODUCTION TO COMPUTATIONAL AERODYNAMICS						
1	Define Density.	Density is defined as mass per unit volume. Mass is a property and the SI unit for density is [kg/m^3].	Remember	CLO1	CO1	AAE013.01
2	Define Continuity Equation.	The continuity equation would be derived based on the law of conservation of mass in a controlled volume 'V.	Remember	CLO4	CO1	AAE013.04
3	Define body force.	Forces distributed over the entire mass or volume of the element. It is usually expressed per unit mass of the element or medium upon which the forces act. Example: Gravitational Force, Electromagnetic force fields etc.	Understand	CLO4	CO1	AAE013.04
4	Define surface force.	Forces exerted on the fluid element by its surroundings through direct contact at the surface.	Remember	CLO2	CO1	AAE013.02
5	Define Uniform Flow.	The flow is defined as uniform flow when in the flow field the velocity and other hydrodynamic parameters do not change from point to point at any instant of time.	Remember	CLO4	CO1	AAE013.04
6	Define Non Uniform Flow.	Non-Uniform Flow When the velocity and other hydrodynamic parameters changes from one point to another the flow is defined as non-uniform.	Remember	CLO4	CO1	AAE013.04

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7	What are Newtonian fluids?	Shear stress τ in a fluid is proportional to the time-rate-of-strain, i.e. velocity gradients. Such fluids are called Newtonian fluids.	Remember	CLO4	CO1	AAE013.04
8	What are non-Newtonian fluids?	Fluids in which shear stress τ is not proportional to the velocity gradients are non-Newtonian fluids; blood flow is one example.	Remember	CLO2	CO1	AAE013.02
9	What is substantial derivative?	$D\rho/Dt$ is a symbol for the instantaneous time rate of change of density of the fluid element as it moves through point 1. By definition, this symbol is called the substantial derivative, D/Dt.	Remember	CLO2	CO1	AAE013.02
10	What is local derivative?	D/Dt is the substantial derivative, which is physically the time rate of change following a moving fluid element; $\partial/\partial t$ is called the local derivative, which is physically the time rate of change at a fixed point.	Remember	CLO4	CO1	AAE013.04
11	What is convective derivative?	$V \cdot \Delta$ is called the convective derivative, which is physically the time rate of change due to the movement of the fluid element from one location to another in the flow field where the flow properties are spatially different.	Remember	CLO2	CO1	AAE013.02
12	Define no-slip condition.	For a viscous fluid, the boundary condition on a surface assumes no relative velocity between the surface and the gas immediately at the surface. This is called the no-slip condition. If the surface is stationary, with the flow moving past it, then $u = v = w = 0$ at the surface (for a viscous flow).	Remember	CLO2	CO1	AAE013.02
13	What are shock capturing methods?	Many computations of flows with shocks are designed to have the shock waves appear naturally within the computational space as a direct result of the overall flowfield solution, i.e. as a direct result of the general algorithm, without any special treatment to take care of the shocks themselves.	Remember	CLO2	CO1	AAE013.02
14	What are shock fitting methods?	Shock waves are explicitly introduced into the flow-field solution, the exact Rankine–Hugoniot relations for changes across a shock are used to relate the flow immediately ahead of and behind the shock, and the governing flow equations are used to calculate the remainder of the flow field.	Remember	CLO4	CO1	AAE013.04
15	Define total energy.	The total energy of a moving fluid per unit mass is the sum of its internal energy per unit mass, e, and its kinetic energy per unit mass, $V^2/2$.	Remember	CLO2	CO1	AAE013.02

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16	What are Normal Shocks?	Shock waves are highly localized irreversibilities in the flow. Within the distance of a mean free path, the flow passes from a supersonic to a subsonic state, the velocity decreases suddenly and the pressure rises sharply.	Remember	CLO2	CO1	AAE013.02
UNIT - II MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS						
1	What is Ordinary differential equation?	Ordinary differential equation (ODE) is a differential equation containing one or more functions of one independent variable and the derivatives of those functions.	Remember	CLO5	CO2	AAE013.05
2	What is partial differential equation?	An equation which involves more than one independent variables denoted by x,y,z,t… a dependent variable (dependent function) u of these (independent) variables, and the partial derivatives of u with respect to the independent variables such as $F(x,y,t,\ldots,u_x,u_y,u_t,.\ u_{xx},u_{yy})$ is called a partial differential equation.	Remember	CLO6	CO2	AAE013.06
3	Define Order.	The order of a partial differential equation is the order of the highest order partial derivative occurring in the equation.	Remember	CLO7	CO2	AAE013.07
4	Define quasi linear system.	HIGHER order derivate multiplied by the coefficients which are functions of the dependent variables themselves. Such a system of equations is called a quasi linear system.	Remember	CLO7	CO2	AAE013.07
5	What are characteristic lines?	The lines in the XY space along which the derivate of u an v are indeterminant are called the characteristic lines.	Remember	CLO6	CO2	AAE013.06
6	Define Hyperbolic.	D>0 two real and distinct characteristics exist through each point in the xy plane the quasi linear system is called hyperbolic.	Remember	CLO8	CO2	AAE013.08
7	Define parabolic.	D=0 two real and equal characteristics exist through each point in the xy plane the quasi linear system is called parabolic	Understand	CLO6	CO2	AAE013.06
8	Define elliptic.	D>0 the characteristics lines are imaginary , the quasi linear system is called elliptic	Remember	CLO6	CO2	AAE013.06
9	Define Compatibility equation.	The equation involving dependent variables which holds only along the characteristic line. The advantage of this compatibility equation is that it is in one less dimension than the original partial differential equations.	Remember	CLO5	CO2	AAE013.05
10	Define the method of characteristic.	Solution technique for the original system of equations where in the characteristic lines are constructed in the xy space and the simpler compatibility equations are solved along these characteristics. This technique is called method of characteristics.	Remember	CLO5	CO2	AAE013.05

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11	Define boundary layer equations.	The boundary layer is thin and the Reynolds number based on body length L is large the Navier-Stokes equations reduce to an approximate set of equations called the boundary layer equations.	Remember	CLO6	CO2	AAE013.06
12	Define boundary layer.	The thin viscous layer adjacent to a surface is called a boundary layer.	Remember	CLO7	CO2	AAE013.07
13	What is Dirichlet condition?	A specification of the dependent variables u and v along the boundary. This type of boundary condition is called Dirichlet condition.	Remember	CLO6	CO2	AAE013.05
14	What is Neumann condition?	A specification of the derivates of the dependent variables, such a du/dx along the boundary. This type of boundary condition is called Neumann condition.	Remember	CLO6	CO2	AAE013.06
15	What is Parabolized Navier-Stokes equation?	The viscous terms in Navier-Stokes equation that involve derivates in the stream wise direction are assumed to be small and can be neglected and if the glow is assumed to be steady then the resulting equations are called the parabolized Navier-Stokes (PNS)equations.	Remember	CLO7	CO2	AAE013.07
UNIT-III BASIC ASPECTS OF DISCRETIZATION						
1	Define Grid points.	Numerical solutions can give answers at only discrete points in the domain called grid points.	Remember	CLO9	CO3	AAE013.09
2	Define Discretization .	Discretization is the process by which a closed form of mathematical expression, such as a function or a differential or integral equation involving functions, all of which are viewed as having an infinite continuum of values throughout some domain, is approximated by analogous (but different) expressions which prescribe values at only a finite number of discrete points or volumes in the domain.	Remember	CLO9	CO3	AAE013.09
3	What are Methods of finite differences?	The original partial differential equations are replaced by a system of algebraic equation which can be solved for the values of the flow field variables at the discrete points only this method of discretization is called the methods of finite differences.	Remember	CLO10	CO3	AAE013.10
4	Define difference equation.	When all the partial derivates in a given partial differential equation are replaced by finite different quotients the resulting algebraic equation is called a difference equation.	Understand	CLO10	CO3	AAE013.10
5	What is Discretization error?	The difference between the exact analytical solution of the partial differential equation and the exact solution of the corresponding difference equation.	Remember	CLO10	CO3	AAE013.10
6	What is Round off error?	The numerical error introduced after a repetitive number of calculations in which the computer is constantly rounding the numbers to some significant figure.	Remember	CLO11	CO3	AAE013.11

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7	What is Wave number?	The wavenumber is the spatial frequency of a wave, measured in cycles per unit distance or radians per unit distance. Whereas temporal frequency can be thought of as the number of waves per unit time, wavenumber is the number of waves per unit distance.	Remember	CLO9	CO3	AAE013.09
8	What is Courant number?	Courant number depends on velocity, cell-size and time step and is typically calculated for each cell. The Courant number will accordingly change a bit with velocity when you have a static mesh and a constant time step.	Remember	CLO9	CO3	AAE013.09
9	What is Courant–Friedrichs–Lewy (CFL) condition?	The Courant–Friedrichs–Lewy (CFL) condition is a necessary condition for convergence while solving certain partial differential equations (usually hyperbolic PDEs) numerically. It arises in the numerical analysis of explicit time integration schemes.	Understand	CLO13	CO3	AAE013.13
10	Define Grid.	The arrangement of these discrete points throughout the flow field is simply called a grid.	Remember	CLO11	CO3	AAE013.11
11	Define adaptive grid.	AN adaptive grid is a grid network that automatically clusters grid points in regions of high flow field gradients it uses the solution of the flow field properties to locate the grid points in the physical plane.	Remember	CLO9	CO3	AAE013.09
12	What is Flow field visualization method?	Flow field visualization method that helps to identify the location of waves, shear layers and other gradient in the flow.	Remember	CLO13	CO3	AAE013.13
13	What are Zonal grids?	The different blocks cover different zones of the flow field and hence such grids are frequently called zonal grids.	Remember	CLO11	CO3	AAE013.11
14	Define structured grids.	A family of coordinate lines does not intersect i.e lines of ξ do not cross, lines of constant η. Hence there is a certain structure to all these grids such grids are called structured grids.	Remember	CLO9	CO3	AAE013.09
15	What is Von Neumann stability analysis?	In numerical analysis, von Neumann stability analysis (also known as Fourier stability analysis) is a procedure used to check the stability of finite difference schemes as applied to linear partial differential equations.	Remember	CLO11	CO3	AAE013.11
UNIT-IV CFD TECHNIQUES						
1	What is LAX wendroff technique?	LAX wendroff technique is an explicit finite difference method particularly suited to marching solutions.	Remember	CLO14	CO4	AAE013.14
2	What is Maccormacks technique?	Maccormacks technique is also an explicit finite difference technique which is a second order accurate in both space and time.	Remember	CLO14	CO4	AAE013.14
3	What is Relaxation technique?	Relaxation technique is a finite difference method particularly suited for solution of elliptic partial differential equations.	Remember	CLO14	CO4	AAE013.14

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4	What is Jacobi method?	In numerical linear algebra, the Jacobi method is an iterative algorithm for determining the solutions of a diagonally dominant system of linear equations. Each diagonal element is solved for, and an approximate value is plugged in.	Remember	CLO15	CO4	AAE013.15
5	What is Gauss–Seidel method?	In numerical linear algebra, the Gauss–Seidel method, also known as the Liebmann method or the method of successive displacement, is an iterative method used to solve a linear system of equations.	Remember	CLO14	CO4	AAE013.14
6	Define successive over-relaxation.	In numerical linear algebra, the method of successive over-relaxation (SOR) is a variant of the Gauss–Seidel method for solving a linear system of equations, resulting in faster convergence.	Remember	CLO14	CO4	AAE013.14
7	Define Under-Relaxation.	Under-Relaxation reduces solution oscillations and helps to keep the computation stable.	Remember	CLO16	CO4	AAE013.16
8	Define numerical dissipation.	Numerical dissipation is the direct result of the even order derivatives on the right hand side of modified equation.	Remember	CLO16	CO4	AAE013.16
9	Define numerical dispersive.	numerical dispersive is the direct result of the odd order derivatives on the right hand side of modified equation.	Remember	CLO14	CO4	AAE013.14
10	Define Artificial viscosity.	Artificial viscosity is a numerical concept pertaining to CFD. It's addition in the numerical scheme is used for obtaining stable and smooth solutions across the mathematical discontinuities like Shock.	Remember	CLO14	CO4	AAE013.14
11	What is Adi technique?	In numerical linear algebra, the Alternating Direction Implicit (ADI) method is an iterative method used to solve Sylvester matrix equations. It is a popular method for solving the large matrix equations that arise in systems theory and control and can be formulated to construct solutions in a memory-efficient, factored form method.	Remember	CLO15	CO4	AAE013.15
12	What is Crank Nicolson scheme?	In numerical analysis, the Crank–Nicolson method is a finite difference method used for numerically solving the heat equation and similar partial differential equations	Remember	CLO14	CO4	AAE013.14
13	What is Pressure correction technique?	Pressure-correction method is a class of methods used in computational fluid dynamics for numerically solving the Navier-Stokes equations normally for incompressible flows.	Remember	CLO16	CO4	AAE013.16
14	Define SIMPLE algorithm.	In computational fluid dynamics (CFD), the SIMPLE algorithm is a widely used numerical procedure to solve the Navier-Stokes equations. SIMPLE is an acronym for Semi-Implicit Method for Pressure Linked Equations	Remember	CLO16	CO4	AAE013.16
15	What is flux corrected transport method?	The Calculations were made using a finite volume scheme called flux corrected transport(FCT) method.	Remember	CLO14	CO4	AAE013.14

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16	Define Schlieren photography.	Schlieren photography is a visual process that is used to photograph the flow of fluids of varying density. Invented by the German physicist August Toepler in 1864 to study supersonic motion, it is widely used in aeronautical engineering to photograph the flow of air around objects.	Remember	CLO16	CO4	AAE013.16
17	Define staggered grid.	A staggered grid is a setting for the spatial discretization, in which the variables are not defined at the same position as in case of the collocated grid.	Remember	CLO14	CO4	AAE013.14
UNIT-V FINITE VOLUME METHODS						
1	What is finite volume method?	The finite volume method (FVM) is a method for representing and evaluating partial differential equations in the form of algebraic equations.	Remember	CLO18	CO5	AAE013.18
2	What are High-resolution schemes?	High-resolution schemes are used in the numerical solution of partial differential equations where high accuracy is required in the presence of shocks or discontinuities.	Remember	CLO18	CO5	AAE013.18
3	What is total variation diminishing?	In numerical methods, total variation diminishing is a property of certain discretization schemes used to solve hyperbolic partial differential equations. The most notable application of this method is in computational fluid dynamics.	Remember	CLO19	CO5	AAE013.19
4	What is Cell Centered Approach?	Control volumes are defined by a suitable grid and computational nodes are assigned at the control volume centre.	Remember	CLO19	CO5	AAE013.19
5	What is Vertex Centered Approach?	In this approach, for any one-dimensional domain (interval)vertices are identified first and then the edges of the nonoverlapping volumes which cover the entire region are placed midway between the vertices.	Remember	CLO19	CO5	AAE013.19
6	What is Face centered approach?	Nodal locations are defined first and control volumes are then structured around them so that control volume faces lie midway between nodes. It can be used only with structured grids.	Remember	CLO18	CO5	AAE013.18
7	What is convection–diffusion equation?	The convection–diffusion equation is a combination of the diffusion and convection (advection) equations, and describes physical phenomena where particles, energy, or other physical quantities are transferred inside a physical system due to two processes: diffusion and convection.	Remember	CLO18	CO5	AAE013.18
8	Define control volume.	Control volume is a volume in space of special interest for particular analysis.	Remember	CLO20	CO5	AAE013.20
9	Define Control surface .	The surface of the control volume is referred as a control surface and is a closed surface.	Remember	CLO19	CO5	AAE013.19
10	What is Time-	Time-dependent density functional theory (TDDFT) is a quantum	Remember	CLO18	CO5	AAE013.18

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	dependent density functional theory?	mechanical theory used in physics and chemistry to investigate the properties and dynamics of many-body systems in the presence of time-dependent potentials, such as electric or magnetic fields.				
11	Define Explicit methods?	Explicit methods calculate the state of a system at a later time from the state of the system at the current time.	Remember	CLO18	CO5	AAE013.18
12	Define implicit methods?	implicit methods find a solution by solving an equation involving both the current state of the system and the later one.	Remember	CLO20	CO5	AAE013.20
13	What is Implicit-Explicit Method?	For usual applications the implicit term is chosen to be linear while the explicit term can be nonlinear. This combination of the former method is called Implicit-Explicit Method.	Remember	CLO19	CO5	AAE013.19
14	What is backward Euler method?	It is one of the most basic numerical methods for the solution of ordinary differential equations. It is similar to the (standard) Euler method, but differs in that it is an implicit method. The backward Euler method has order one in time.	Remember	CLO18	CO5	AAE013.18
15	What is Euler method?	The Euler method is a first-order method, which means that the local error (error per step) is proportional to the square of the step size, and the global error (error at a given time) is proportional to the step size. The Euler method often serves as the basis to construct more complex methods, e.g., predictor–corrector method.	Remember	CLO18	CO5	AAE013.18

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