INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	**:**	**ADVANCED COMPUTATIONAL AERODYNAMICS**
Course Code	**:**	**JNTUH R15 - A72116**
Class	**:**	**IV B Tech I Semester**
Branch	**:**	**AERONAUTICAL ENGINEERING**
Year	**:**	**2018 – 2019**
Course Coordinator	**:**	**Ms. D. Anitha, Assistant Professor, Department of AE**
Course Faculty	**:**	**Ms. D. Anitha, Assistant Professor, Department of AE**

OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner‟s learning process.

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes
	UNIT - I **PANEL METHODS**		
Part - A (Short Answer Questions)			
1	Define Neumann boundary condition in numerical solutions.	Remember	1
2	Explain Drichlet boundary condition in numerical solutions.	Understand	1
3	Mention the need of general physical considerations in numerical solutions.	Understand	1
4	Describe the additional physical considerations in numerical solutions.	Remember	1
5	Mention different singularity elements used in numerical solutions.	Understand	2
6	Calculate the expression for velocity potential of two-dimensional constant strength source distribution.	Remember	1
7	List out the preliminary considerations prior establishing numerical solutions.	Remember	1
8	Describe the six basic steps in solving the numerical solution using panel techniques.	Understand	1
9	Define influence coefficients?	Understand	1
10	Explain what you mean by discretization in computational fluid dynamics.	Remember	2
Part - B (Long Answer Questions)			
1	Describe the effect of compressibility and viscosity that to be accounted for thin airfoil theory.	Remember	1
2	Solve thin airfoil theory with lumped vortex element.	Understand	1
3	Explain in brief the steps required in constructing a numerical solution	Understand	1
4	Differentiate between the Neumann boundary condition and Drichlet boundary condition.	Remember	2
5	Explain different boundary conditions in detail with possible conditions?	Understand	1
6	Contrast Neumann boundary condition and Drichlet boundary condition	Remember	1

7	Examine various aerodynamic loads available for an irrotational, incompressible flow.	Remember	2
8	Construct the steps for reducing a problem into set of linear algebraic equation.	Understand	1
9	Solve two dimensional doublet distribution of constant strength using Neumann conditions.	Understand	1
10	Explain briefly about the steps toward constructing a numerical solution for the panel methods?	Remember	1
Part - C (Problem Solving and Critical Thinking Questions)			
1	Derive the velocity components at different cases for two dimensional constant strength source distributions.	Remember	2
2	Calculate the velocity components at different cases for two dimensional constant strength doublet distributions.	Understand	1
3	Explain the preliminary considerations prior to establishing the numerical solution?	Understand	1
4	Explain the concept of reduction of a problem to a set of linear algebraic equations?	Remember	2
5	Briefly explain about the secondary computation or about aerodynamics loads and how are they calculated?	Understand	1
6	Calculate the velocity components at different cases for two dimensional constant strength vortex distributions.	Remember	1
7	Compare the velocity components at different cases for two dimensional constant strength for vortex distributions and doublet distributions	Understand	2
8	List out the steps in detail for solving the two dimensional doublet distribution of constant strength using Neumann conditions.	Understand	1
9	Compare the velocity components at different cases for two dimensional constant strength for source distributions and doublet distributions	Remember	1
10	Explain about the effects of flow compressibility and viscosity in the computational fluid dynamics.	Understand	1
UNIT - II **METHOD OF CHARACTERISTICS , BOUNDARY CONDITIONS**			
Part - A (Short Answer Questions)			
1	Define compatibility equation.	Remember	3
2	Explain characteristic lines in method of characteristics.	Understand	4
3	Explain minimum length nozzles and its application.	Understand	3
4	List the process in supersonic nozzles.	Remember	2
5	Define initial data line in method of characteristics.	Understand	3
6	Mention the importance of solid wall in inviscid flows	Remember	2
7	Explain domain of dependence and range of influence	Understand	4
8	Mention the importance of symmetry plane.	Understand	2
9	Define the concept of periodic boundaries.	Remember	3
10	Describe viscous flow and its importance.	Understand	3
Part - B (Long Answer Questions)			
1	Derive the characteristic line for two dimensional irrotational flows.	Remember	3
2	Explain the importance of characteristic lines and its effect in fluid dynamics.	Understand	4
3	Summarize the philosophy of method of characteristics	Understand	3
4	Derive the compatibility equations for two dimensional irrotational flows.	Remember	2
5	Produce the method of unit process for the conditions at wall, internal flow, shock wave.	Understand	3
6	Design the supersonic wind tunnel nozzle using method of characteristics.	Understand	2
7	Discuss the boundary conditions at interface between grid blocks.	Remember	4
8	Explain in brief about the concept of dummy cell.	Understand	3
9	List out the modifications for lifting bodies to be done in farfield.	Remember	4
10	Discuss the concept of characteristic variable in farfield for the method of characteristics.	Understand	3

Part - C (Problem Solving and Critical Thinking Questions)			
1	Discuss the concept of input and output boundary and list its differences.	Remember	3
2	List out the differences in injection boundary and periodic boundary.	Understand	2
3	Explain interface between grids and the concept of far-field.	Understand	2
4	Explain various flow gradients at boundaries.	Remember	2
5	Describe about characteristic variables in viscous flows.	Understand	3
6	Explain in brief about the importance of finite element method and its comparison with method of characteristics.	Remember	2
7	Explain in brief about injection boundary and compare it with input/output boundary.	Remember	2
8	Discuss the flow gradients at boundaries of unstructured grids.	Understand	2
9	Explain in brief about Symmetry plane and coordinate cut.	Remember	2
10	Discuss solid wall in viscid flow and compare it with viscous flow.	Understand	2
UNIT-III **NUMERICAL SOLUTION OF TRANSONIC SMALL DISTURBANCE**			
Part - A (Short Answer Questions)			
1	Define transonic flow and its importance.	Remember	4
2	Differentiate between Critical Mach number and Drag-divergence Mach number.	Understand	5
3	Explain area-rule method for airfoils.	Understand	4
4	Define adverse pressure gradient?	Remember	5
5	Discuss the physical aspects of transonic flows.	Understand	5
6	Explain drag-divergence Mach number in detail.	Remember	4
7	Define slotted-throat wind tunnels and usage of it.	Understand	5
8	Define drag-divergence Mach number?	Understand	5
9	Explain Critical Mach number?	Remember	5
10	Which method is used to illustrate the effect of increasing free-stream Mach number and increasing airfoil thickness on the transonic flow over airfoils?	Understand	5
11	Define free stream Mach number?	Remember	4
12	Discuss the theoretical aspects of transonic flows.	Understand	4
13	Explain the separated flow associated with the shock wave/boundary layer interaction in transonic flow.	Understand	5
14	Define bow shock?	Remember	5
15	Which gradients are present in transonic flows due to the presence of the shock waves?	Understand	5
16	Differentiate between the local Mach number and Critical Mach number.	Remember	4
17	What is the transonic small- perturbation equation?	Understand	5
18	Define transonic similarity parameter?	Understand	4
19	Illustrate the effect of pressure coefficient in transonic flow?	Remember	5
20	Define perturbation velocity potential?	Understand	4
21	Explain the importance of transonic flow for engineering applications with example.	Remember	4
22	Define the flow regimes varying with Mach number and explain in detail about transonic flow?	Understand	5
23	Explain the importance of supercritical airfoil	Understand	4
24	Define transonic similarity equation?	Remember	4
1	Write down the transonic small disturbance equation?	Understand	4
2	Explain the transonic regime?	Understand	5
3	By using which equation we can reduce the transonic small disturbance equation?	Understand	5

4	What is the transonic similarity parameter?	Remember	4
5	Write down the transonic small disturbance equation in non dimensional form?	Understand	4
6	How can we use Prandtl-Glauert equation for subsonic or supersonic flow?	Remember	4
7	What are the boundary conditions?	Understand	4
8	Explain the Upwind differences in transonic small disturbance equation?	Remember	4
9	Explain Murman-cole switching in supersonic flow regions?	Understand	4
10	Explain Murman-cole upwinding in supersonic flow regions?	Understand	4
11	When will be the small perturbation solutions can be obtained?	Understand	4
12	What are the types of boundary conditions?	Remember	6
13	Briefly explain the flow regimes?	Understand	4
14	Write down the Murman cole equation for a non lifting transonic airfoil using line relaxation methods?	Remember	5
15	What are the small disturbance assumptions?	Understand	4
16	Differentiate between Murman-cole switching and Murman-cole upwinding in supersonic flow regions.	Understand	4
17	Explain mathematical characteristics of the TSD equation?	Remember	6
18	What are the echelons of transonic flow numerical solutions?	Understand	5
19	Explain small disturbance approximation of surface pressure coefficient?	Remember	4
20	Elaborate TSD Equation and explain it?	Understand	5
21	Define upwind scheme?	Remember	6
22	List out the relaxation methods for the finite difference method in discretization.	Understand	4
23	Illustrate the internal boundary conditions?	Understand	5
24	List out the mathematical characteristics of the TSD equation?	Remember	4
Part - B (Long Answer Questions)			
1	List out the physical aspects of transonic flows.	Remember	5
2	Explain briefly about super-critical airfoil with numerical calculations?	Understand	4
3	Discuss the boundary conditions used in upwinding schemes in supersonic flows with numerical calculations?	Understand	5
4	Derive the equation for transonic small disturbance equations.	Remember	4
5	List out the transonic parameters which involved in the small disturbance equations.	Remember	6
6	Briefly explain the Mach number and list the types of flows with respect to Mach number	Understand	5
7	Mention the types of shocks occur due to the flow regimes.	Understand	5
8	Briefly explain about perturbation velocity potential?	Remember	4
1	Discuss Murman-Cole upwinding schemes in supersonic flow regions.	Remember	6
2	Compare the physical and theoretical aspects of transonic flows	Understand	5
3	Describe Murman-Cole switching schemes in supersonic flow regions.	Understand	4
4	Explain the finite difference formulation in Transonic small disturbance equation.	Remember	5
5	Compare the numerical solutions between Murman-cole switching and Murman-cole unwinding in supersonic flow regimes	Remember	6
6	Explain interactive solution methods for discretized Transonic small disturbance equation.	Understand	4
7	Explain boundary conditions and its importance for transonic equations.	Understand	5

Part - C (Problem Solving and Critical Thinking Questions)			
1	Discuss the boundary conditions used in upwinding schemes in supersonic flows.	Remember	4
2	Explain the importance of discretized Transonic small disturbance equation and also the iterative solution methods for discretized Transonic small disturbance equation.	Understand	5
3	Explain area-rule method for airfoils using the numerical calculations.	Understand	5
4	Explain Murman-cole switching /unwinding in supersonic flow regimes?	Remember	4
5	Describe the separated flow associated with the boundary layer in transonic flow	Understand	4
1	Explain the steps for interactive solution methods for discretized Transonic small disturbance equation.	Remember	6
2	Compare the physical and theoretical aspects of supersonic flows and transonic flows.	Understand	5
3	Explain in detail critical mach number and its importance.	Understand	6
4	Briefly explain in detail about supercritical airfoil with neat sketch.	Remember	5
5	Explain in detail drag-divergence mach number how it varies with mach number.	Understand	5
6	Briefly explain Prandtl-Glauert equation for supersonic flow?	Understand	6
UNIT-IV **NUMERICAL SOLUTION OF EULER EQUATIONS, BOUNDARY LAYER EQUATIONS**			
Part - A (Short Answer Questions)			
1	Define boundary layer edge.	Understand	7
2	Describe the importance of flux approach and Euler equations	Remember	8
3	Explain the concept of flux vector splitting and Mention different types of vector split methods	Understand	9
4	Explain what the need of upwind reconstruction is.	Understand	8
5	Briefly explain about Keller-box scheme.	Remember	8
6	Explain the process involved in Lax-Wendroff method	Remember	7
7	Describe the concept of near wall shear stress.	Understand	8
8	Explain upwind schemes and Mention the importance of first order upwind scheme.	Understand	9
9	Describe the importance of boundary layer equations.	Remember	7
10	Differentiate between boundary layer and boundary layer edge.	Understand	6
Part - B (Long Answer Questions)			
1	Examine in detail about Lax-Wendroff method.	Understand	8
2	Discuss the basic principle of upwind schemes and the numerical solution	Remember	8
3	Explain in detail about flux approach and flux vector splitting.	Understand	7
4	Discuss Steger-Warming flux and Van Leer flux vector splitting method	Understand	8
5	List the difference between flux approach and vector splitting methods.	Remember	9
6	Differentiate Godunov's first order upwind method and Roe's first order upwind method.	Understand	8
7	Explain the concept of upwind reconstruction in brief.	Remember	8
8	Discuss in brief about flux approach and list out the steps for setting up boundary layer equations.	Understand	7
9	Evaluate the solution of flat boundary layer equations.	Understand	8
10	Discuss the need and requirement for boundary layer transformation.	Remember	9

Part - C (Problem Solving and Critical Thinking Questions)			
1	Differentiate between Steger-Warming flux vector splitting method and Van Leer flux vector splitting method	Understand	8
2	Examine the different process in discretization of boundary.	Remember	8
3	Explain Explicit discretization of the boundary and Implicit discretization of the boundary.	Understand	8
4	Discuss the need and requirement for boundary layer transformation.	Understand	7
5	Explain the effect of boundary layer edge and wall shear stress and how it effects the numerical calculations in computational fluid dynamics	Remember	8
6	Discuss the concept of integration of continuity equation with the numerical calculations	Understand	9
7	Solve the implicit difference equations of boundary layer and explicit difference equations of boundary layer	Remember	8
8	Explain the need of boundary layer transformation in boundary layer theory with the simple steps.	Understand	8
9	Mention the approach of Keller- Box scheme with the numerical steps to solve the equation.	Understand	7
10	Explain boundary layer thickness and the importance of boundary layer equations.	Remember	8
UNIT-V **TIME DEPENDENT METHODS**			
Part - A (Short Answer Questions)			
1	Explain the need of stability of solution.	Understand	9
2	List out the various explicit methods.	Remember	10
3	Explain the importance of forward-time forward space method.	Understand	11
4	Summarize the use of predictor-corrector method.	Understand	12
5	Explain the importance of forward-time backward space method.	Remember	11
6	Mention different time split methods.	Understand	10
7	Explain the importance of Crank-Nicolson method	Remember	12
8	List difference between forward-time central space method and forward-time backward space method.	Understand	11
9	Explain the criteria required to establish Crank Nicolson method.	Understand	12
10	Explain the approach of Lax-Wendroff scheme.	Remember	11
Part - B (Long Answer Questions)			
1	Mention the various explicit methods in time marching solutions.	Understand	10
2	Discuss the forward-time forward space method, forward-time central space method and forward-time backward space method.	Remember	12
3	Compare the forward-time forward space method and forward-time central space method.	Understand	11
4	Discuss the forward-time backward space method.	Understand	12
5	Explain the leap-frog method in detail with example.	Understand	11
6	Briefly explain the criteria and requirement for stability of solution.	Remember	10
7	List out the various explicit methods that can be used in CFD tools.	Understand	12
8	Discuss Cranck-Nikolson method as implicit approach by the numerical calculation.	Understand	11
9	Discuss Euler's forward-time central space method and its importance.	Remember	12
10	List out various implicit methods and their importance in CFD tools.	Understand	11
Part - C (Problem Solving and Critical Thinking Questions)			
1	Explain in brief the necessity and requirement of time split methods.	Remember	10
2	Explain the necessity and requirement of McCormack method.	Understand	12
3	Discuss approximate factorization schemes.	Understand	11

4	Explain the necessity and importance of approximate factorization.	Understand	12
5	Discuss the description of Lax-Wendroff scheme.	Remember	10
6	Explain McCormack two step Predictor-corrector method.	Understand	12
7	List the difference between corrector method and predictor method.	Understand	11
8	Discuss various time split methods.	Remember	12
9	Differentiate the forward-time forward space method and forward-time central space method	Understand	11
10	List the difference between time split methods and approximate factorization.	Remember	10

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