KUMARAGURU
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M.TECH DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Second Semester

DEFENCE TECHNOLOGY

P18DTE0025: Computational Aerodynamics

COURSE OUTCOMES

CO1: Understand the CFD analysis, fluid mechanics, heat transfer analysis, numerical modelling of fluids.

CO2: Generate numerical model related to fluid dynamics

CO3: To do the pre and post-processing of CFD analysis.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1.   1. Solver   CO1 $[K_1]$

     2. Geometry

     3. Post processor

     4. Boundary condition

     Sequence the above CFD process in the incremental order

     a)   2-4-1-3   b)   1-3-2-4

     c)   3-4-2-1   d)   4-1-3-2

2.   FVM is having one of the main advantages of FEM, which is_____   CO2 $[K_1]$

     a)   Domain Flexibility   b)   Geometric flexibility

     c)   Volume flexibility   d)   Structure flexibility

3.   The fluid flow equations that we directly obtain by applying the fundamental physical principles to an infinitesimal fluid element are in _____ form   CO1 $[K_1]$

     a)   ODE   b)   PDE

     c)   Integral   d)   Matrix

4. Matching type item with multiple choice code   CO1 [K$_2$]

List I	List II
A. Discretization error	i. $|\varepsilon^{n+1}i /\varepsilon^{n}i| >1$
B. Round of error	ii. $|\varepsilon^{n+1}i /\varepsilon^{n}i| \leq 1$
C. Stable Solution	iii. A-D
D. Unstable Solution	iv. N-D

a) A-iii B-iv C-ii D-i   b) A-ii B-iv C-iii D-i

c) A-iii B-iv C-i D-ii   d) A-iv B-ii C-iii D-i

5. _____ is the base law for Energy equation   CO1 [K$_1$]

a) Newton's 1st law   b) 1st law of Thermodynamics

c) 2nd law of Thermodynamics   d) Newton's 2nd law

6. Fluid governing equation system contains ____ equations in terms of six unknown   CO2 [K$_2$]
flow-field variables

a) 2   b) 3

c) 4   d) 5

7. Assertion (A): The physical plane is transformed into rectangular computational plane.   CO2 [K$_3$]
Reason (R): In physical plane the grids are not uniformly spaced.

a) Both A and R are Individually true and   b) Both A and R are Individually true but
R is the correct explanation of A   R is not the correct explanation of A

c) A is true but R is false   d) A is false but R is true

8. The origin of FD method is _____   CO1 [K$_1$]

a) Exponential series   b) Taylor series

c) Finite series   d) Logarithmic series

9. Pick the correct statements   CO2 [K$_2$]
1. CFD enables engineers to perform numerical experiments in a 'virtual flow
laboratory'

2. Simulations will estimate Quantitative description of flow phenomena using CFD
code

3. Experiments will estimate Quantitative prediction of flow phenomena using
measurements

4.Very difficult in CFD is capturing the turbulence of the flow

a) 2,3   b) 1,3

c) 1,4   d) 2,4

10. The objective of turbulence modeling is to develop equations that will predict the ____ CO3 [K_2]
averaged fluid properties

   a) Space   b) Velocity

   c) Stability   d) Time

PART B (10 x 2 = 20 Marks)

11.	What is the significance of Jacobian in transformation	CO1	[K_1]
12.	Mention the principle of mass conservation with governing equation.	CO1	[K_2]
13.	Brief about the heat transfer mechanisms available.	CO1	[K_2]
14.	Why boundary condition is important in computational aerodynamics?	CO2	[K_1]
15.	Mention the significance of the domain in CFD.	CO1	[K_1]
16.	What is CFL condition, mention its equation.	CO1	[K_1]
17.	Differentiate the difference between the physical domain and computational domain	CO2	[K_2]
18.	Brief about the spectral methods application in CFD.	CO1	[K_2]
19.	How PDE's are classified? Mention its equation	CO2	[K_1]
20.	Differentiate between FDM and FVM approaches.	CO3	[K_1]

PART C (6 x 5 = 30 Marks)

21.	Compare the aerodynamic experiments and numerical simulations	5	CO1	[K_2]
22.	Write in detail about Lagrangian & Eulerian fluid flow field modeling approaches with suitable examples and equations.	5	CO2	[K_2]
23.	What is grid transformation? Detail its significance in the CFD process	5	CO1	[K_3]
24.	Derive the mixed derivative algebraic equation used in FDM	5	CO2	[K_2]
25.	List down some of the basic needs of grids in CFD. Mention some 2D and 3D structured, and unstructured meshes.	5	CO2	[K_3]
26.	Brief about the influence of data analysis and uncertainties in computational aerodynamics	5	CO3	[K_3]

Answer any FOUR Questions
PART D (4 x 10 = 40 Marks)

27. Derive Newton's 2nd law equation using the Lagrangian approach in 'X'   10   CO1   [K₂]
    coordinates with a suitable force diagram.

28. Explain the step-by-step procedure of a fluid flow analysis process using an   10   CO2   [K₂]
    internal or external flow analysis case study.

29. Describe in detail the Lax-Wendroff technique for evaluating the density at time   10   CO2   [K₂]
    step (t +Δt) for a gas-dynamic problem.

30. Explain about the three commonly used grid transformation techniques.   10   CO1   [K₃]

31. Mention about the significance of turbulence models in CFD. Explain in detail   10   CO3   [K₃]
    about various RANS turbulence models available in CFD codes

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