Paper id: 250641

Roll No: | | | | | | | | | | | 1 | | |

BTECH
(SEM VI) THEORY EXAMINATION 2024-25
COMPUTATIONAL FLUID DYNAMICS

TIME: 3 HRS   **M.MARKS: 70**

Note: Attempt all Sections. In case of any missing data; choose suitably.

SECTION A

1.   Attempt *all* questions in brief.   **02 x 7 = 14**

Q no.	Question	CO	Level
a.	Can CFD be used as a research tool? Justify your answer with examples.	2	K2
b.	Define conservation of mass and momentum in the context of fluid flow.	1	K2
c.	What is the difference between the explicit and implicit approach?	3	K2
d.	Define grid transformation. Why is it required?	4	K2
e.	State the key difference between finite element and finite volume methods.	4	K2
f.	State Newton's second law and its application in fluid mechanics.	1	K2
g.	Define compressed grid.	4	K2

SECTION B

2.   Attempt any *three* of the following: **07 x 3 = 21**

a.	Derive the Navier–Stokes equations for incompressible flow.	1	K2
b.	Derive an expression for 1-D unsteady state heat conduction equation by using explicitand implicit approach.	3	K3
c.	What is grid clustering and why is it used?Differentiate between structured and unstructured grids.	2	K2
d.	What are the typical errors encountered in FEM and how can they be minimized?	3	K2
e.	Discuss the challenges in applying FVM to complex geometries.Compare the applicability of FVM to structured and unstructured meshes.	4	K2

SECTION C

3.   Attempt any *one* part of the following: **07 x 1 = 07**

a.	Describe the physical significance of boundary layer equations in CFD.Discuss initial and boundary conditions used in CFD simulations with illustrations.	2	K2
b.	Explain the principle of conservation of energy and its application to fluid dynamics.Classify second-order partial differential equations with examples from fluid mechanics.	2	K2

4.   Attempt any *one* part of the following: **07 x 1 = 07**

a.	Solve the 1D steady-state heat conduction problem $d^2T/dx^2 = 0$ over a rod of length 1 m, with boundary conditions $T(0) = 100°C$ and $T(1) = 200°C$ using finite difference with 5 nodes.	3	K4
b.	Define discretization in the context of CFD.Discuss the role of Taylor series expansion in deriving finite difference approximations.	2	K2

5.   Attempt any *one* part of the following: **07 x 1 = 07**

a.	Explain the need of grid transformation in CFD. Explain compressed grids and their applications in resolving boundary layers.	3	K2
b.	Discuss the procedure for generating elliptic grids with governing equations.	3	K2

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6.	**Attempt any *one* part of the following:**	**07 x 1 = 07**	
a.	A one-dimensional steady-state heat conduction in a wall of length L = 1 m has a thermal conductivity of k = 100 W/m·K. The wall is discretized into 5 equal control volumes (Δx = 0.2 m). The left boundary (x = 0) is maintained at 100 °C and the right boundary (x = 1 m) is at 0 °C. Using the finite difference method, calculate the temperature distribution at the interior nodes assuming no internal heat generation. Given: k = 100 W/m·K L = 1 m, Δx = 0.2 m T(0) = 100 °C, T(1) = 0 °C Use the central difference scheme and assume steady-state conditions.	4	K4
b.	What are isoparametric elements? Explain with a diagram.Compare FEM and FDM in terms of geometry handling and accuracy.	3	K2
7.	**Attempt any *one* part of the following:**	**07 x 1 = 07**	
a.	Define flux in the context of finite volume method.Explain the finite volume method (FVM) and how it differs from FDM and FEM.	3	K2
b.	Describe the process of discretization using central differencing in FVM.What are flux limiters? Discuss their role in higher-order schemes.	3	K2