Register Number:……..

KUMARAGURU college of technology
character is life

B.E DEGREE EXAMINATIONS : MAY 2018

(Regulation 2015)

Fourth Semester

MECHANICAL ENGINEERING

U15MEPE28: Computational Fluid Dynamics

COURSE OUTCOMES

CO1: Understand the governing equations of fluid dynamics and boundary conditions
CO2: Apply the knowledge of finite element discretization methods for solving explicit and implicit schemes for two-dimensional conduction problems
CO3: Understand various grid generation methods.
CO4: Apply finite volume techniques for different schemes for solving one dimensional heat conduction equation.
CO5: Understand SIMPLE algorithm
CO6: Understand the impact and applications of CFD in Engineering

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

Answer all the Questions:-
PART A (10 x 1 = 10 Marks)

1. When a direct computation of dependent variables can be made in terms of known quantities, computation is said to be — CO2 [K_2]
   a) Implicit b) Explicit
   c) Unique d) Dependent
2. Meshes which only requires element size on lines and surfaces that define geometry as input. — CO3 [K_3]
   a) Structured mesh b) unstructured mesh
   c) Dirichlet mesh d) Hex mesh
3. Ratio between longest side and shortest side of mesh is called — CO3 [K_2]
   a) mesh orthogonality b) mesh skewness
   c) mesh aspect ratio d) mesh smoothness
4. If scalar flux across boundary is zero, values of properties just adjacent to solution domain are taken as — CO5 [K_2]
   a) maximum b) values of nearest node
   c) zero d) Minimum
5. The following item consists of two statements, one labeled as the “Assertion (A)” and the other as “Reason (R). You are to examine those two statements carefully and select the answers to these items using the codes given below: — CO6 [K_1]

   Assertion (A): At Mach number Ma > 1, pressure disturbances travel.

   Reason (R) : Lower than flow velocity

.

Codes:

a. both A and R are individually true and R is the correct explanation of A
b. both A and R are individually true but R is not the correct explanation of A
c. A is true but R is false
d. A is false but R is true.

a) a b) c
c) b d) d

6. Ratio of flow velocity to speed of sound in that medium is called CO1 [K_3]

a) Reynolds number b) Mach number
c) Euler number d) Froude number

7. Mesh requires blocking as input called CO3 [K_2]

a) Structured mesh b) unstructured mesh
c) Dirichlet mesh d) Tet Mesh

8. A process in which flow in boundary layer can no longer stay attached to surface & separates from surface is called CO1 [K_3]

a) Force separation b) boundary separation
c) flow separation d) surface separation

9. Match list I with list II and select the correct answer. CO4 [K_3]

List I	List II
A.When fluid properties does not change with time, flow iscalled	1. control volume
B. A space of interest where mass can cross boundary is	2.Steady state
C. Boundary of control volume is called	3. Unsteady state
D. When fluid properties change with time, flow iscalled	4. control surface

a) A-4, B-3,C-1,D-2 b) A-4, B-1, C-2, D-3
c) A-2, B-1,C4,D-3 d) A-3, B-1,C-2,D-4

10. Match list I with list II and select the correct answer. CO6 [K_3]

List I	**List II**
A. Ratio of momentum diffusivity and thermal diffusivity is called	1. faster than flow velocity
B. When mach number is in between 1.2 - 5, flow is in	2. Prandel number
C. At Mach number Ma < 1, pressure disturbances travel	3. super sonic regime
D. Dividing line between subsonic and super sonic regime is called	4. sonic line

a) A-2 B-3,C-1,D-4 b) A-4,B-1,C-3,D-2
c) A-2,B-4,C-3,D-1 d) A-3,B-1,C-2,D-4

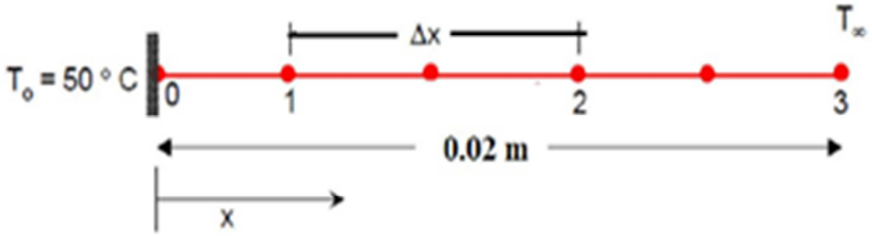
PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11	What are the different applications of CFD now days in various industries?	CO6	[K_1]
12	Write the Momentum equations for viscous flow in conservation and Non-conservation form.	CO1	[K_1]
13.	Why forward and backward difference expressions are not more accurate then central difference expressions.	CO2	[K_2]
14	Define shock-capturing approach.	CO3	[K_2]
15	Define Courant number.	CO1	[K_1]
16.	Define Dirichlet tessellatipn or Voronoj diagram.	CO3	[K_2]
17.	Write the advantage of implicit approach.	CO2	[K_2]
18.	Define cell-centres, cell-vertices.	CO4	[K_2]
19.	What is Lax-Wendroff time-stepping?	CO5	[K_2]
20	What are Kolmogorov scale ratio's?	CO5	[K_2]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

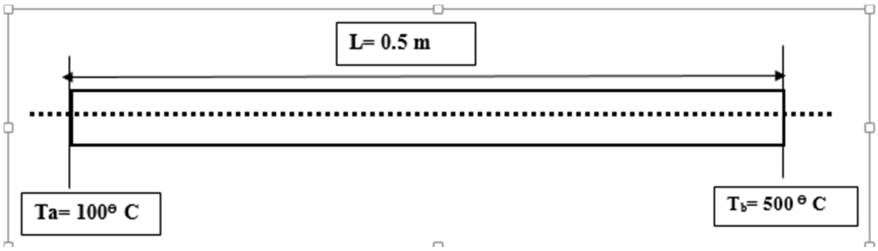
21. Consider the steady state heat conduction in a slab of thickness L, in which energy is generated at a constant rate of S W/m^3. The boundary surface at x = 0 is maintained at a constant temperature T_0, while the boundary surface at x = L dissipates heat by convection with a heat transfer coefficient h into an ambient at temperature T_∞ . Compute the temperature inside the slab for h = 200 W/(m^2 .°C), k = 18 W/(m.°C), L = 0.02 m, T_∞ = 100 °C, T_0 = 50 °C, and S = 7.2 x 10^7 W/m^3 using FDM (Discretize with 3 Grid Points as Shown in figure) — CO2 [K_2]



22 (a)Derive the momentum equation used in computational fluid dynamics. (7)

(b) Write a short note on Physical boundary conditions for viscid and inviscid fluid flow. (7) — CO1 [K_1]

23	(a)	Explain various types of grid. Also explain structured and unstructured grid with their advantages and disadvantages.	(7)	CO3 [K_1]
	(b)	Write Short note on Adaptive mesh and Numerical error in CFD modelling	(7)	
24		Using FVM, Discretize the 1D steady state convection - diffusion (no heat generation) equation as per the below form for interior and exterior control volume $a_p\phi_p = a_w\phi_w + a_E\phi_E + S_u$		CO4 [K_3]
25.		Consider the problem of source free heat conduction in an insulated rod whose The temperature on the left hand side boundary is taken to be 100°C and the right hand side boundary is insulated so the heat flux across it is zero.Heat is lost to the surroundings by convective heat transfer. The one dimensional sketched in Figure is governed by d/dx (k dT/ dx) = 0.Calculate the steady state temperature distribution in the rod Using FVM, (Divide the length of the rod into 3 control volumes) Thermal conductivity k= 1000 W/m K, Cross sectional area A= 10* 10^{-3} m^2		CO4 [K_3]



26	(a)	Discuss in detail about the role of SIMPLE and it variants in numerical analysis	(7)	CO5 [K1]
	(b)	Brief about PISO Algorithm.	(7)	
27		How the pressure gradient term is eliminated from the momentum equations using Vorticity – Stream Function method? State the disadvantages of this method in determination flow field. Explain in detail.		CO5 [K1]

****