Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	COMPUTATIONAL FLUID DYNAMICS
COURSE CODE	:	BDE 40403
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	1. PART A : ANSWER **TWO** (2) FROM **THREE** (3) QUESTIONS ONLY. 2. PART B : ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

PART A : ANSWER **TWO** (2) FROM **THREE** (3) QUESTIONS

Q1 (a) Describe about the significance of each of the following in regards to an iterative CFD solution;

(i) Initial conditions;
(ii) Residual;
(iii) Iteration;
(iv) Post-processing.

(12 marks)

(b) Sketch a simple structured grid using four sided cells and sketch a simple unstructured grid using three sided cell for two dimensional computational domain in **Figure Q1 (b)**. How many cells are in each domain?

(8 marks)

Q2 (a) Define and describe with an example of each of the following;

(i) Computational domain; and
(ii) Mesh.

(4 marks)

(b) Derive the continuity equation for a finite control volume that is fixed in space.

(6 marks)

(c) Show that the continuity equation can be changed from non-conservation form to a conservation form for a control volume.

(10 marks)

Q3 (a) What are the conceptual differences between the finite difference and the finite volume method?

(5 marks)

(b) The Laplace equation is given by:

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0$$

Show that this is an elliptic equation using Cramer's rule technique.

(15 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q4 (a) Describe the properties for the discretization scheme, and explain if the following scheme obeys the properties that you have described earlier;

(i) the second order upwind scheme;

(ii) the QUICK scheme; and

(iii) the central differencing scheme

(10 marks)

(b) Discretize the one-dimensional heat conduction (diffusion) equation below, with negligible source term. You may use your own grid generation. State the assumptions.

$$\frac{d}{dx}\left(k\frac{dT}{dx}\right) = 0$$

(10 marks)

Q5 (a) The most popular solution algorithms for pressure and velocity calculations with the finite volume method is SIMPLE. Explain in detail, why are the staggered grids are used for velocities instead of checkerboard grids?

(5 marks)

(b) Write the SIMPLE algorithm to solve the incompressible flow, and explain each step briefly.

(15 marks)

Q6 (a) Explain in detail the turbulence model that you think is best to simulate the following cases:

(i) flow in a long pipe; and

(ii) flow past an airfoil

(5 marks)

(b) Give **TWO** advantages and **TWO** disadvantages of Reynolds Averaged Navier-Stokes (RANS) turbulence model, and compare this model with Large Eddy Simulation (LES) turbulence model and Direct Numerical Simulation (DNS).

(15 marks)

END OF QUESTION

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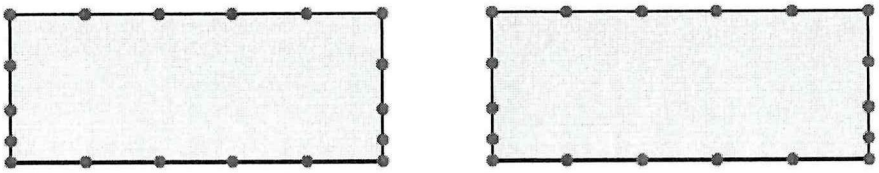

(i) (ii)

FIGURE Q1(b)