Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	COMPUTATIONAL FLUID DYNAMICS
COURSE CODE	:	BDE 40403
PROGRAMME	:	BDD
EXAMINATION DATE	:	JUNE 2017
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) Explain in detail, **EIGHT (8)** steps involved in a typical CFD analysis of a steady, laminar flow field.

(8 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 1** (a) and (b). State the number of cells in each domain.

(12 marks)

Q2 (a) Define and describe each of the following items;

(i) Control volume;
(ii) Control surface;
(iii) Substantial derivative;
(iv) Local derivative

(8 marks)

(b) Write the conservation form of the energy equation, written in terms of the total energy.

(12 marks)

Q3 (a) Compose and explain the differences between structured and unstructure numerical grid

(5 marks)

(b) The velocity of a fluid element along the tapered channel centerline as shown in **Figure 3** is given by $\vec{v} = \vec{v}\left(1 + \frac{2x}{L}\right)\hat{\imath}$. Calculate:

(i) the cceleration of any particle along the centerline (as a function of x) and;

(ii) the position of a particle (as a function of time) that is located at x = 0 at time zero.

(15 marks)

PART B : ANSWER **ALL** QUESTIONS.

Q4 (a) Describe the CFD numerical techniques below and explain their advantages:

(i) The second order upwind scheme

(ii) The QUICK scheme

(10 marks)

(b) Derive the algorithm for formulation of two-dimensional steady state diffusion equation.

(15 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 terms below;

(i) Boussinesq hypothesis;

(ii) zero-, one-, two-equation models.

(5 marks)

(b) Explain the k-ε model for turbulent modeling. Give **TWO** advantages and **TWO (2)** disadvantages of this model, and compare this model with Large Eddy Simulation (LES) turbulence model.

(15 marks)

-END OF QUESTION-

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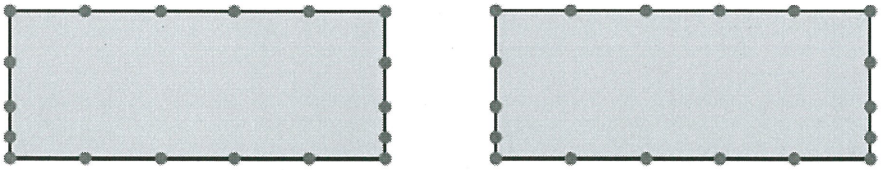

(a) (b)

FIGURE Q1(b)

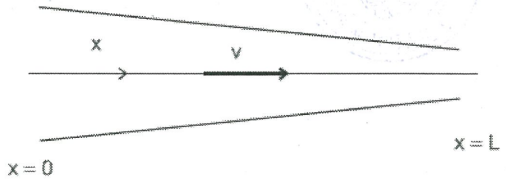

FIGURE Q3(b)