



**UNIVERSITI TUN HUSSEIN ONN  
MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2016/2017**

**TERBUKA**

COURSE NAME : COMPUTATIONAL FLUID DYNAMICS

COURSE CODE : BDE 40403

PROGRAMME : BDD

EXAMINATION DATE : DECEMBER 2016/JANUARY 2017

DURATION : 3 HOURS

INSTRUCTION : 1. PART A : ANSWER **TWO** (2) QUESTIONS ONLY.  
2. PART B : ANSWER **ALL** QUESTIONS.

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

PART A : ANSWER **TWO** (2) QUESTIONS ONLY

**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 of **Figure Q1(b)**. How many cell are in each?

(8 marks)

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

- (i) Computational domain;
- (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)

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- Q3** (a) What are the conceptual differences between the finite difference and 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 source term is negligible. 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 the best to simulate the following cases;

- (i) flow in a long pipe; and
- (ii) flow past an airfoil

(5 marks)

(b) Give two (2) advantages and two (2) disadvantages of 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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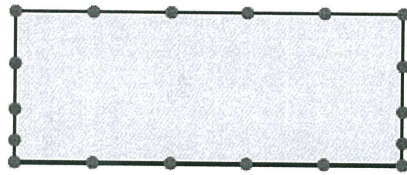
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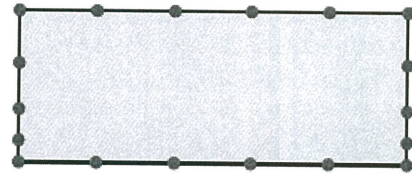
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(i)



(ii)

**Figure Q1(b)**

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