Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	COMPUTATIONAL FLUID DYNAMICS
COURSE CODE	:	BDE 40403
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	1. PART A : ANSWER **TWO** (2) FROM **THREE** (3) QUESTIONS. 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 the significance of each of the following in regards to an iterative CFD solution;

(i) Transport equation;
(ii) Initial value;
(iii) Residual;
(iv) Iteration; and
(v) Post-processing.

(10 marks)

(b) A CFD code is used to simulate flow over a two dimensional airfoil at an angle of attack. A portion of the computational domain near the airfoil is outlined in Figure Q1 (b) (the computational domain extends well beyond the region outlined by the dashed line). Sketch a coarse structured grid using four-sided cells and sketch a coarse unstructured grid using three-sided cells in the region shown. Be sure to cluster the cells where appropriate and discuss the advantages and disadvantages of each grid type.

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

(i) Computational domain;
(ii) Grid independent.

(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 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 numerical technique below and explain why it is used in CFD codes and what are the advantages of using them.

(i) The first order upwind scheme

(ii) The QUICK scheme

(10 marks)

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

(10 marks)

Q5 (a) The most popular solution algorithms for pressure and velocity calculations with the finite volume method are SIMPLE, SIMPLER and PISO. Describe each methods used in CFD.

(10 marks)

(b) Write the SIMPLE algorithm to solve the incompressible flow calculations.

(10 marks)

Q6 (a) Describe the development of Reynolds equations (Reynolds-Average Navier-Stokes Equation) and list down the Reynolds stresses.

(10 marks)

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

(10 marks)

END OF QUESTION

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2018/2019 PROGRAMME : BDD
COURSE NAME : COMPUTATIONAL FLUID DYNAMICS COURSE CODE: BDE 40403

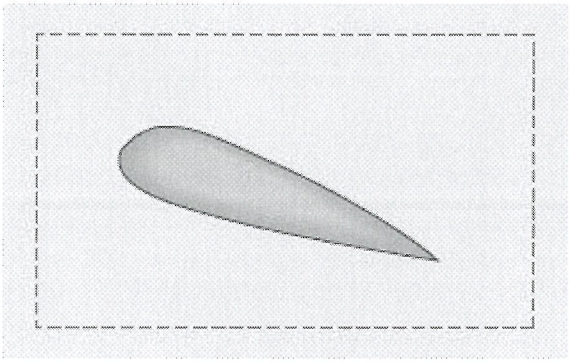

FIGURE Q1(b)