UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME   :   AIRCRAFT AERODYNAMICS

COURSE CODE   :   BDU 10703

PROGRAMME CODE   :   BDC/BDM

EXAMINATION DATE :   DECEMBER 2019/JANUARY 2020

DURATION   :   3 HOURS

INSTRUCTION   :   PART A: ANSWERS **ALL** QUESTIONS
PART B: ANSWERS **ONE (1)** QUESTION **ONLY**

THIS QUESTION PAPER CONSISTS OF **THREE (3)** PAGES

Q1   (a)   There are five important flow parameters need to be known in aerodynamics study. They are namely :

- Reynolds Number R_L
- Mach Number M
- Knudsen Number K_n
- Strouhal number S_{TR}
- Stanton Number S_{TN}

Select two of them. Write down their equations and explain their physical meanings for those selected flow parameters.

(10 marks)

(b)   Given a potential function of flow Φ defined as $\Phi(x,y) = K \ln\left(\sqrt{x^2 + y^2}\right)$, if $K = 10 \ m^2/sec.$,then:

(i)   Prove that the given flow $\Phi(x,y)$ is irrotional flow

(10 marks)

(ii)   Determine the velocity at the point $A(5,5)$

(10 marks)

Q2   An airfoil 5 digits Naca series 23012 immersed in the flow field with the incoming free stream makes 5^0 angle of attack with respect to the airfoil's chord line. The camber line of this airfoil is given as:

$$\frac{y_c}{c} = \begin{cases} 2.6596\left[\left(\frac{x}{c}\right)^3 - 0.6075\left(\frac{x}{c}\right)^2 + 0.1147\left(\frac{x}{c}\right)\right] & \text{for } 0 \le \left(\frac{x}{c}\right) \le 0.2025 \\ 0.02208\left[1 - \left(\frac{x}{c}\right)\right] & \text{for } 0.2025 \le \left(\frac{x}{c}\right) \le 1.0 \end{cases}$$

Using Thin airfoil theory, evaluate :

(a)   the thin airfoil coefficient A_0, A_1 and A_2 then determine:

(15 marks)

(b)   the lift coefficient C_l

(4 marks)

(c)   The pitching moment coefficient at the leading edge c_{mle}

(3 marks)

(d)   The center of pressure c_P

(3 marks)

Q3   (a)   Explain the reason why wing of incidence angle is required in the wing

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placement to the fuselage.

(5 marks)

(b)   Describe the purpose of wing twist angle.

(5 marks)

(c)   Give the reason why the most of glider airplanes are used a high aspect ratio wing

(5 marks)

(d)   what is the influence of swept angle to the aerodynamic characteristics?.

(5 mark)

Part B: Answer **One (1)** Question **Only**

Q4   An   uniform flow past through an object at speed $U_\infty = 30 \frac{m}{sec}$ with the angle of attack $\alpha = 5^0$. The cross section of the object is ellipse having form:
$$\frac{x^2}{16} + \frac{y^2}{9} = 1$$
If the flow behave as a two dimensional potential flow, then by using a   Joukowsky transformation, evaluate :

(a)   The complex potential function F(z) of the flow field

(10 marks)

(b)   The conjugate complex velocity w(z)

(10 marks)

(c)   The lift coefficient on the ellipse.

(5 marks)

Q5   A symmetrical airfoil NACA 0008 is immersed in the uniform flow of $U_\infty = 10 \frac{m}{sec}$ and the angle of attack $\alpha = 5^0$ .The free stream static pressure $p_\infty = 10^5 \frac{N}{m^2}$. The airfoil chord length   c = 0.1 m and   the maximum airfoil thickness $y_{tmax} = 0.008\ m$. By using Joukowsky transformation , evaluate:

(a)   The required formulation of Joukowsky transformation function.

(10 mark)

(b)   The complex potential function for the flow around this airfoil

(10 mark)

(c)   The lift coefficient C_L

(5 mark)

-END OF QUESTIONS –