(20%) 1. Explain the following terms:

(a) Aerodynamic Center

(b) Pressure Center

(c) Mean Aerodynamic Chord

(d) Coanda Effect

(e) Kutta Condition

(20%) 2. If the drag coefficient is shown in the polar form

$$C_D = C_{D_0} + KC_L^2$$

where C_{D_0} and K are constant

Find (a) the lift coefficient for maximum lift/drag ratio,

(b) the maximum lift/drag ratio

in terms of C_{D_0} and K.

(20%) 3. Consider a two-dimensional thin and symmetric airfoil with a trailing-edge flap hinged at the 0.8 chord length point. The flow is inviscid and incompressible. The classical thin airfoil theory is valid.

(a) When the flap deflection is zero, draw a typical $\alpha - C_l$ diagram where C_l is the lift coefficient and α is the angle of attack. Indicate on your figure the zero-lift angle of attack $\alpha_{L=0}$, the stall angle α_{stall} and the maximum lift coefficient $C_{l,max}$. What are the value of the slope of the lift curve $\frac{\partial C_l}{\partial \alpha}$ and the value of the zero-lift angle of attack $\alpha_{L=0}$ in this symmetric case?

(b) When the flap deflection is positive (downward), say $10°$, draw a typical $\alpha - C_l$ curve on the same figure as in (a), showing the effects of the flap deflection. Comparing with the case of zero flap deflection, will the coefficients $C_{l,max}$, $\frac{\partial C_l}{\partial \alpha}$, $\alpha_{L=0}$ and α_{stall} increase or decrease? Discuss each term separately.

(c) When the flap deflection is negative (upward), say $-10°$, draw a typical $\alpha - C_l$ curve on the same figure as in (a) and (b), showing the effects of the flap deflection. Comparing with the case of zero flap deflection, will the coefficients $C_{l,max}$, $\frac{\partial C_l}{\partial \alpha}$, $\alpha_{L=0}$ and α_{stall} increase or decrease? Discuss each term separately.

(背面仍有題目,請繼續作答)

(20%) 4. A triangular-shaped airfoil when placed in a supersonic flow can be approximated using the linearized potential flow equation

$$(M_\infty^2 - 1)\phi_{xx} - \phi_{zz} = 0$$

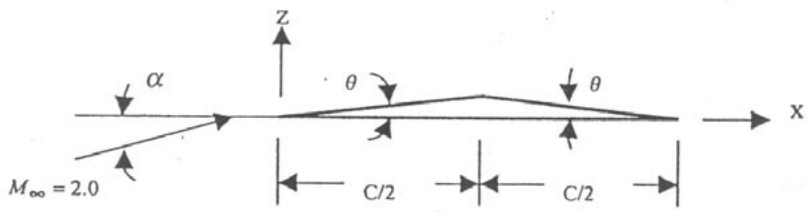
and the general solution to this governing equation can be found to be

$$\phi(x,z) = f(x + Bz) + g(x - Bz), \qquad B = \sqrt{M_\infty^2 - 1}$$

a) Determine the functions $f(x)$ and $g(x)$.

b) Calculate the pressure coefficient C_p along the two sides of the airfoil.

c) Obtain the lift coefficient C_L.



Note：1)You are asked to derive the C_P and C_L.
Directly employing formulas will get no credits.

2) $C_P = -\dfrac{2}{U_\infty}\dfrac{\partial\phi}{\partial x}$

Aerodynamics

(20%) 5. Describe the different types of drags experienced by a finite wing in a subsonic, high subsonic and supersonic flow. In each case state the relevant flow properties of the wing that has the greatest effect on the magnitude of the drag.