Q1: Givens: $AR = 4.3$

$\alpha = 5°$

$a_0 = \frac{dC_l}{d\alpha} = 0.1085\ /\text{deg}$ airfoil lift curve slope

elliptical lift distribution ($u=1$)

Want C_{Di}

$C_{Di} = \frac{C_L^2}{\pi AR}$ since elliptical lift distribution

Need C_L (3-D lift coefficient)

then convert 2D lift slope to 3D

Note $a_0 = 0.1085\ /\text{degree} = 6.216\ /\text{radians}$

$$a_{3D} = \frac{a_0}{(1 + a_0/\pi AR)} = \frac{6.216}{\left(1 + \frac{6.216}{\pi \cdot 4.3}\right)}$$

$= 4.26\ /\text{rad}$

$\alpha = 5$ degrees $= 0.087$ radians

$C_L = a_{3D} \cdot \alpha = 0.37$ & $C_{Di} = \frac{(0.37)^2}{\pi \cdot 4.3}$

$= \underline{0.0102}$

Q2

Givens: Altitude = 60,000 ft, standard day

$M_\infty = 1.61$

$D_{wave} = 5{,}295\ lb$

& $D_{wave,\ thickness} = \frac{1}{2} D_{wave}$

$S = 900\ ft^2$, double wedge

Desired: t/c

$$q = (\gamma/2)\, P_\infty \cdot M_\infty^2, \quad P_\infty = 151.03\ \frac{lb}{ft^2} \text{ @ } 60{,}000\ ft$$

$$= (1.4/2)(151.03\ lb/ft^2)(1.61)^2$$

$$= 274\ lb/ft^2$$

then $C_{D,wave} = D_{wave}/qS = \dfrac{0.0215}{(274\ lb/ft^2)(900\ ft^2)}$

$$= 0.0215$$

then $C_{D\,wave,\ thickness} = C_{D\,wave}/2 = \dfrac{0.0215}{2} = 0.0107$

then $C_{D,wave,\ thickness}$ double wedge $= \dfrac{4}{\sqrt{M_\infty^2 - 1}}\left(t/c\right)^2$

$$= \frac{4}{\sqrt{(1.61)^2 - 1}}\left(\frac{t}{c}\right)^2 = 0.0107$$

$t/c = 0.0580$

Q 3: Givens: $M_{cc,\Lambda=0} = 0.70$

M_{∞} Desired $\approx 0.85 - 0.90$

Assume $M_{cc\Lambda}$ doesn't depend on C_L ($m=1$)

Desired: Λ to acheive $M_{\infty, \text{Desired}}$

Since we want to cruise @ 0.85-0.90 Mach #, that is to say $M_{cc\Lambda}$ should be around or slightly higher than this

so $$M_{cc\Lambda} = \frac{M_{cc\Lambda=0}}{\cos\Lambda} \rightarrow$$

$$\cos^{-1}\left(\frac{M_{cc\Lambda=0}}{M_{cc\Lambda}}\right) = \Lambda$$

Midpoint value $\cos^{-1}\left(\frac{0.7}{0.87}\right) = 36.4°$

closest value given in multiple choice $\approx$ 38°

Q4.

from definition of M_{DIV}, M_{DIV} occurs when $\Delta C_{D,c} = 0.001$

from graph, @ $C_L = 0.3$, $C_{D\,incompressible} \approx 0.02$

then $C_D = 0.021$ @ $M_0 \approx \underline{0.85}$