King Fahd University of Petroleum & Minerals
Aerospace Engineering Department

AE 427 AEROSPACE SYSTEM DESIGN

Major Exam No. 1, Fall Semester 2007

Date: (13/10/1428H) 24/10/2007G **Time Allowed: 50 minutes**
Total Marks: 50 Marks **Closed Book Exam**

Student Name: _____

Student ID:_____

Total Marks: **(/ 40)**

Question No. 1: (6 Marks)

Select True or False. *Correct* the *false* statements:

1. The most efficient cruise velocity for a propeller aircraft occurs is the velocity that yields maximum *L*/*D*. **T( ) F ( )**

Correction:

2. The optimum taper ratio required to approximate elliptical lift distribution for an unswept wing is $\lambda = 1.0$. **T( ) F ( )**

Correction

3. When holding the wing area and the S_{wet}/S_{ref} constant, the maximum subsonic *L*/*D* of an aircraft decreases with aspect ratio due to the reduction in chord length. **T( ) F ( )**

Correction:

Question No. 2 (5 Marks)

Maximum range for a propeller aircraft is maximized when the parasite drag is equal to the induced drag

$$qSC_{D0} = qS\frac{C_L^2}{\pi Ae}$$

Find an expression for the wing loading required to satisfy this condition.

Question No. 3: (7 Marks)

If a clean propeller aircraft is designed to cruise at 15000 ft, where air density is 0.001496 sl/ft^3, at a velocity of 300 kt, what would be the value of the wing loading for maximum range? The aircraft has the following initial values:

Aaspect ratio = 10, W_{TO} = 40,000 lb , S = 250 ft^2 , b = 80 ft, $C_{L\ TO}$ = 1.5 , W_{cruise}/W_{TO} = 0.93.

Air density at sea level is 0.0023769 sl/ft^3

Question No. 4: (10 Marks)

For the aircraft of Question No. 3, what will be the wing loading for the aircraft to have a ceiling of 20000 ft, where the air density is 0.001267 sl/ft^3, and when the T/W at this condition is 0.12? Is this a reasonable value for the wing loading for this type of aircraft?

Hint: Wing loading for climb conditions is given by:

$$\frac{W}{S} = \frac{[(T/W) - G] \pm \sqrt{[(T/W) - G]^2 - (4C_{D0}/\pi Ae)}}{2/q\pi Ae}$$

Question No. 5: (12 Marks)

For the aircraft of Question No. 3, what is the T/W required to achieve a climb gradient of 0.1. Assume climb to occur at sea level conditions, and that C_L is the same as in take off.

Hint:

$$\left(\frac{T}{W}\right)_{climb} = \left(\frac{D}{W}\right)_{climb} + \frac{V_{vertical}}{V} \qquad , \qquad D = D_{parasite} + D_{induced}$$

Good Luck! *Dr. Wael Abdelrahman*