1. (a) (10%) Sketch and explain the difference between a turbojet engine and a turbofan engine. (All major components of the engines must be shown.)
   (b) (10%) What is the meaning of an engine specific impulse Isp? Explain why the turbofan engine has a larger Isp?

2. (20%) Describe the basic subsystems required to keep a satellite orbiting around and communicating with the Earth?

3. (20%) Considering an airplane weighing W at take-off with constant climb speed V and climb angle θ and assume its engine produces the thrust having an installation angle ε with the flight speed. (1) Derive the force balance equation by constructing a figure showing all relevant forces acting on the airplane, (2) If the airplane turns to a level flight, what will the force balance equation become?

4. Given a velocity potential ϕ:

$$\phi = \frac{1}{3}x^3 + \frac{1}{2}x^2 - xy^2 - \frac{1}{2}y^2$$

(a) (7%) Show that this field represents a possible incompressible, irrotational flow.

(b) (8%) Calculate the circulation Γ about the square enclosed by $x=\pm 2$ and $y=\pm 1$, shown in Figure 1.

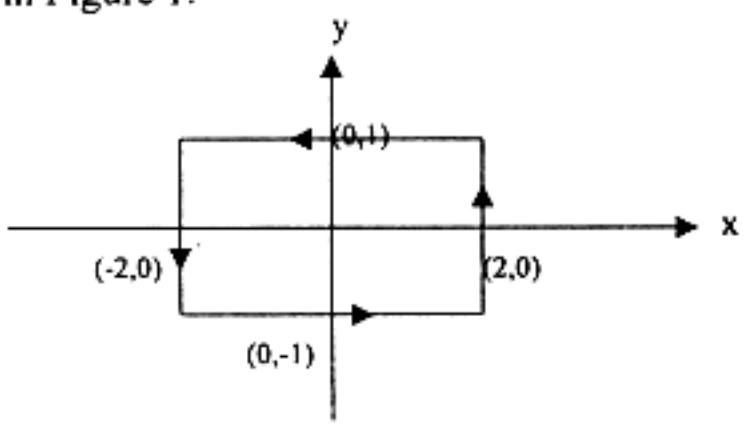

Figure 1

5. (15%) The lift curves for an infinite wing versus a finite elliptic wing with the same airfoil cross section are sketched in the Figure 2. The lift slopes of the infinite wing and the finite elliptic wing are a_0 and a respectively. Explain (7%) (1) why $a < a_0$; (8%) (2) prove that $a = \dfrac{a_0}{1 + \alpha_i / (\alpha - \alpha_i - \alpha_{L=0})}$, where α, α_i and $\alpha_{L=0}$ are geometric angle of attack, induced angle of attack and the zero lift angle of attack respectively.

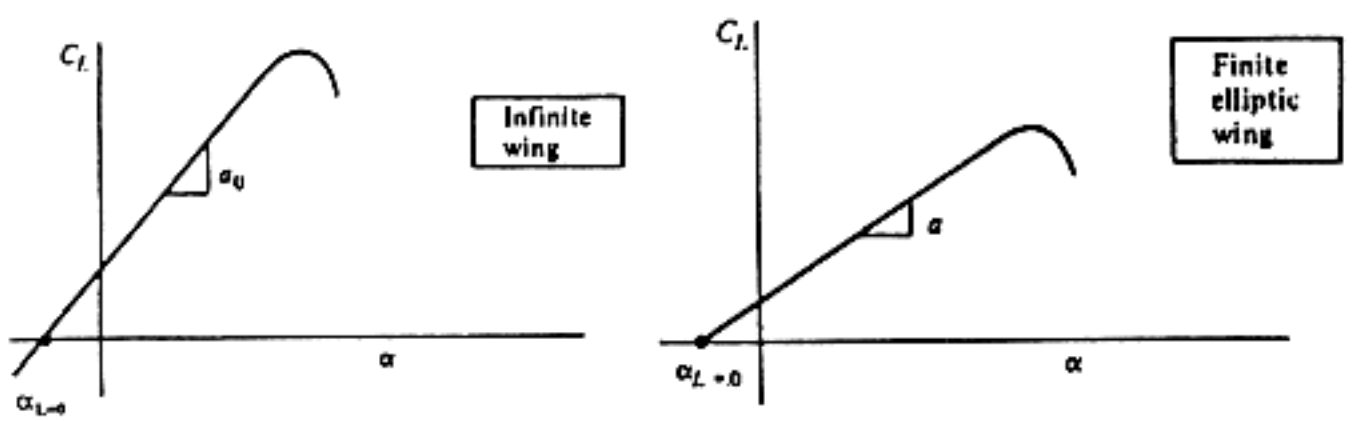

Figure 2

6. (10%) Write down at least four items of properties to explain the differences between the aeronautical and astronautical engineering.