20% 1) An airplane with a wing area of 450ft^2, a span of 60ft and a mean aerodynamic chord (m.a.c) of 8ft is flying at a pressure altitude of 6000ft (density=0.001909 slug/ft^3) at a speed of 300 mph. The ambient temperature is 517 ° R. The wing has a geometric angle of attack of 4 degrees above the angle of zero lift. Assume that the two-dimensional lift curve slope is 95% of the theoretical value. Determine:

a) The lift in pounds.

b) The induced drag in pounds, assuming that the drag differs from that for the ideal elliptic distribution only by the correction factor u. Assume that u =0.98.

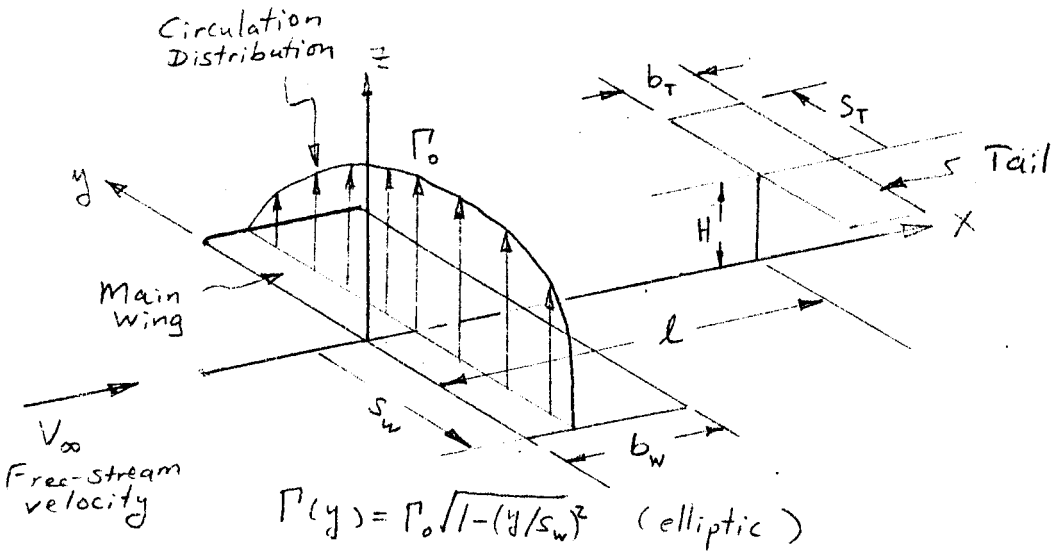
Hint: $$C_L = \frac{a_0 \alpha_0}{1 + a_0 / \pi \cdot AR}$$

$$C_{D_i} = \frac{C_L^2}{\pi \cdot AR \cdot u}$$

AR = aspect ratio

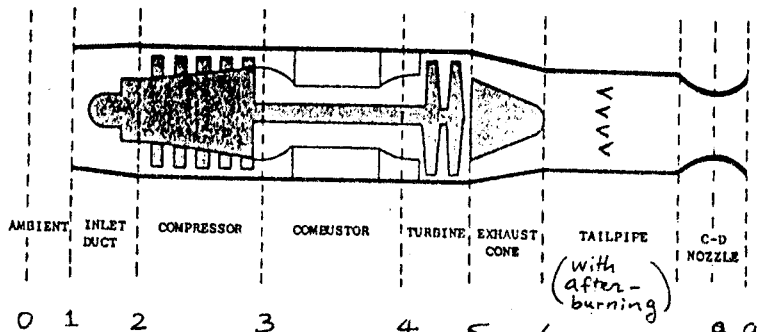
α_0 =geometric angle of attack

15% 2) A wing-tail system is shown below with geometrical relationship indicated. Assume that an elliptic distribution of circulation is produced on the wing. What will be the wake effect on the angle of attack of the stream approaching the tail? State your physical reasoning and give your derivation of the formula using the coordinate system illustrated.



15% 3) A turbojet engine comprises several modules sketched below. Draw T-S (temperature-entropy) diagrams to show the thermodynamic relations of each constituent module under the following situations:

a) Assure all the processes involved are isentropic.
b) Compare the T-S diagram of a real situation to the ideal case of a).
c) What would be the result of using a better film cooling device for the turbine module?
d) What would be the effect on the overall performance suppose the engine is operated on a hot day?



(station numbers 0~9 to be used on your T-S diagrams)

15% 4) Supposed an airplane having weight 38,000 N, wing area 30 m^2 and aspect ratio 8.5, is flying at 350 km/hr in level straight flight at the altitude of 5,000 m, where the density is 0.73643 kg/m^3. Calculate the load factor and the lift coefficient at this flight condition. If this airplane is intended to make a level turn of radius 500 m, then what will the load factor and the lift coefficient be?

15% 5) Describe what are the conditions for the longitudinal static stability of a symmetric aircraft. If considering this airplane in dynamic flight, what are the conditions that this aircraft should satisfy in order to be dynamically stable? In terms of the changes of center of gravity (cg) and the elevator deflection, respectively, how do they affect the trimmed angle and the stability characteristics? You may explain all questions by illustrations.

20% 6) Explain what are the three laws proposed by Kepler in 1600s. Supposed you are going to launch a geostationary (GEO) satellite, weigh 2,000kg, which is easy to be seen from TAINAN area (Longitude = 120.2° and Latitude = 23°), what are the position (in terms of Latitude and Longitude) and the altitude where this GEO satellite have to be deployed (i.e. placed)? Write down these values after the calculations, if needed. Assume the university constant is 6.67×10^{-11} $m^3/kg\,s^2$ and the Earth's mass is 5.98×10^{24} kg.