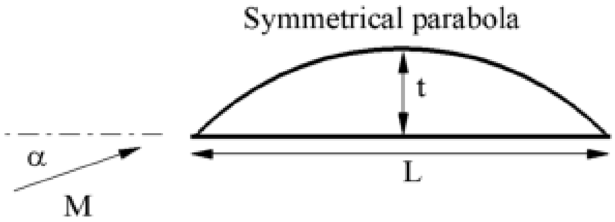
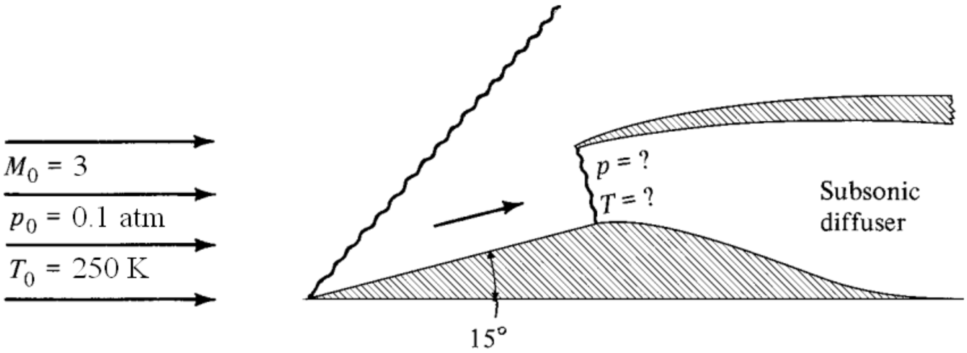
**In the Name of GOD**

**Supersonic Aerodynamics** **HW#1** **Deadline: 1391/1/16**

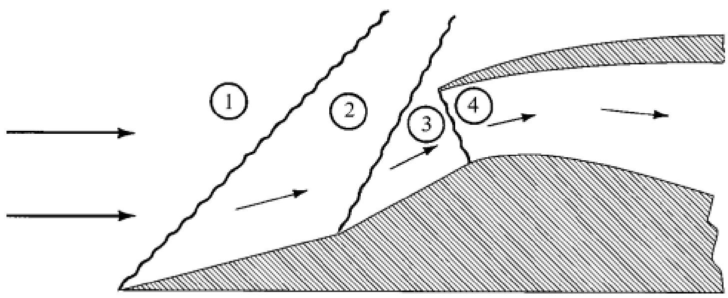
**(Q.1)** Using the linear theory, find $C_l$, $C_d$, and $C_{mLE}$ for the profile shown in terms of M, t/L, and α.




**(Q.2)** Consider air inlet to a jet aircraft.



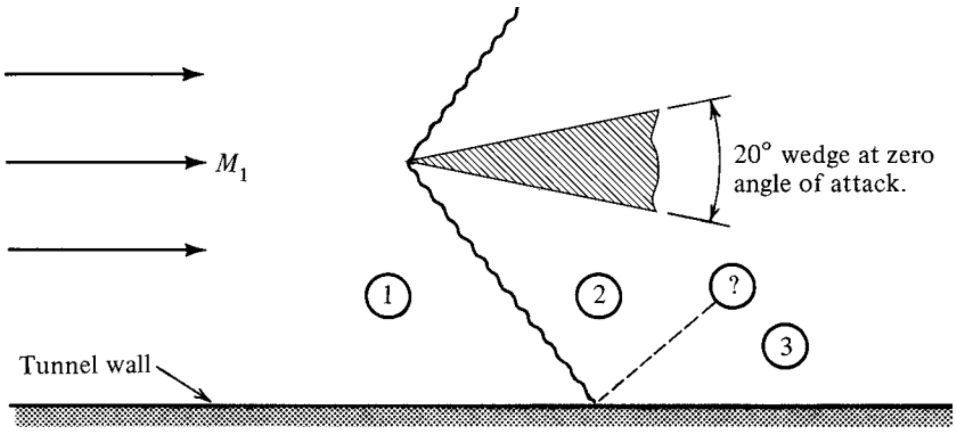

a) What are the conditions of the air (temperature, pressure, and entropy change) just after it passes through the normal shock?
b) Draw a reasonably detailed T –s diagram for the air inlet. Start the diagram at the free stream and end it at the subsonic diffuser entrance to the compressor.
c) If the single 15° wedge is replaced by a double wedge of 7° and 8° (below figure), determine the conditions of the air after it enters the diffuser (condition 4).



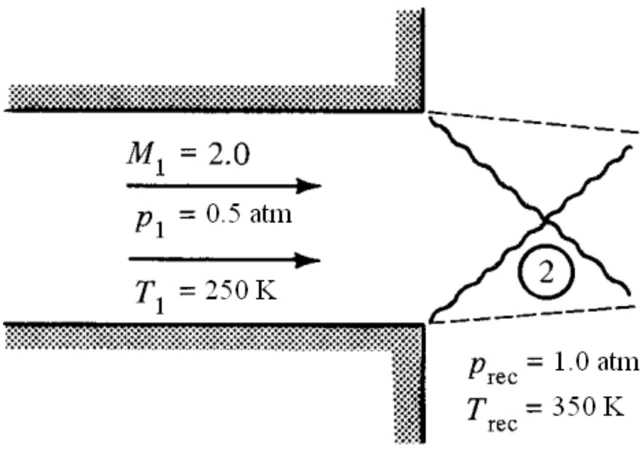

d) Compare the losses for parts (a) and (c).

**(Q.3)** For the flow situation shown in below figure, $M_1 = 1.8$, $T_1 = 300$ K, $p_1 = 1.0$ atm, and $\gamma = 1.4$.

a) Find conditions in region 2 assuming that they are supersonic.
b) What must occur along the dashed line?
c) Find the conditions in region 3.
d) Find the value of $T_2$, $p_2$, and $M_2$ if $p_{t2} = 4.5$ atm.
e) How would the problem change if the flow in region 2 were subsonic?



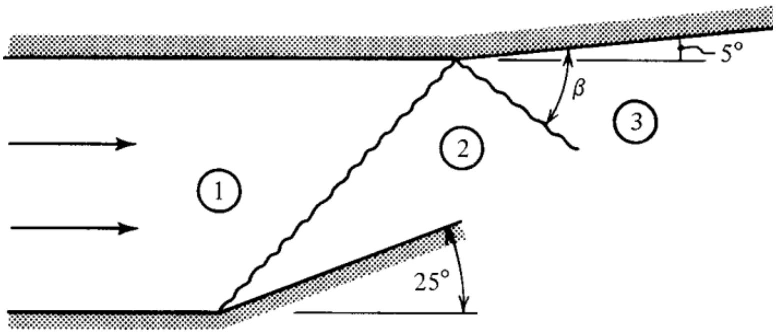

**(Q.4)** Oxygen traveling at M = 2.0 and leaves a duct as shown. According to the receiver conditions, it is desired to




a) At what angle will the fist shocks form? By how much is the flow deflected?

b) What are the temperature, pressure, and Mach number in region 2?

**(Q.5)** A uniform flow of air has a Mach number of 3.3. The bottom of the duct is bent upward at a 25° angle. Assume that the flow is supersonic throughout the system. Compute $M_3$, $p_3/p_1$, $T_3/T_1$, and β.




**(Q.6)** A 2D oblique shock diffuser operates in a supersonic stream of air at an angle of attack of 7°. $P_1$=1.0 atm and $M_1$=2.5. Find:

a) M, $P/P_1$, θ, and $M^*$ in zones 1, 2, 3, 4, and 5.
b) Make an accurate plot of the pressure deflection diagram.
c) Sketch the velocity hodograph and label points 1, 2, 3, 4, and 5.
d) Calculate flow direction α.