6.A normal shock shown in Figure 6,is observed in an air flow at Mach M_1,temperature T_1,pressure P_1,density ρ_1 ,and velocity V_1.

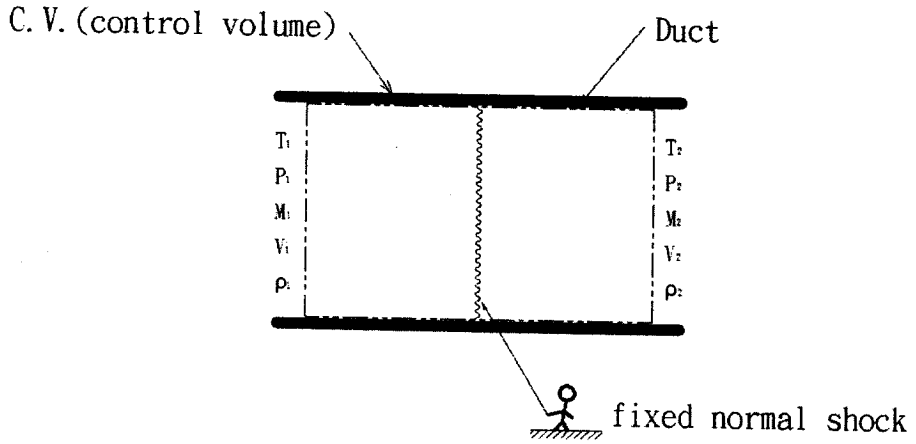

Figure 6 : A fixed normal shock in one-dimensional flow

Solve the following problem,

(a) To prove the equation (6a) where T_t is the stagnation temperature of air,T is the static temperature of air,M is the Mach number of air , and γ is the specific heat ratio of air, (5%)

$$\frac{T_t}{T} = 1 + \frac{\gamma - 1}{2} M^2 . \qquad (6a)$$

(b)Find the stagnation temperature of air at Mach 4 and at static temperature 200K. (5%)

(c)To prove the temperature ratio across the normal shock as

$$\frac{T_2}{T_1} = \frac{1 + \frac{\gamma - 1}{2} M_1^2}{1 + \frac{\gamma - 1}{2} M_2^2} \qquad (6b)$$

and list the assumptions used in the derivation of the above equation. (5%)

(d)Find the temperature after normal shock,T_2, giving ,

$$M_2 = \frac{M_1^2 + \frac{2}{\gamma - 1}}{\frac{2\gamma}{\gamma - 1} M_1^2 - 1} . \quad (5\%) \qquad (6c)$$

(e)How to prove equation (6c) and list the assumptions used in the derivation of the above equation. (5%)