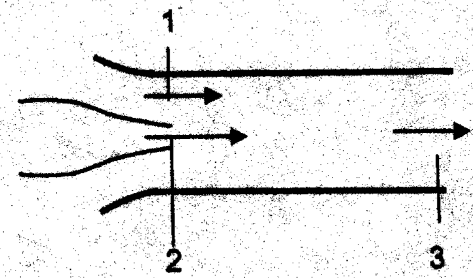
Quiz #1

AE-422: Flight Propulsion I — 22/02/1428 (12/3/2007)

Duration: 15 minutes — *10 points*

Student Name: Solution — Student ID #: ____________

Two streams of air mix in a constant-area mixing conduit. The first stream enters the mixing tube at station 1 with a Mach number of 0.1 and a temperature of 600 °C and the second stream enters the mixing tube at station 2 with a Mach number of 0.25 and a temperature of 10 °C. The flow at station 1 and 2 can be assumed one-dimensional. If the pressure at station 1 is 0.2 MPa and the ratio of the first to the second stream areas is 2, find $\dot{m}/A_3$. Assume $\gamma = 1.4$ and $c_p = 1.0$ kJ/(kg · K).



$$\dot{m}_3 = \dot{m}_1 + \dot{m}_2$$

$$\frac{\dot{m}_3}{A_3} = \frac{\rho_1 u_1 A_1}{A_3} + \frac{\rho_2 u_2 A_2}{A_3}$$

$$\rho_1 = \frac{P_1}{RT_1} = \frac{0.2\times10^6}{285.7 * 873} = 0.802 \text{ kg/m}^3$$

$$\rho_2 = \frac{P_2}{RT_2} = \frac{0.2\times10^6}{285.7 * 283} = 2.474 \text{ kg/m}^3$$

$$u_1 = M_1\sqrt{\gamma R T_1} = 0.1\sqrt{1.4 * 285.7 * 873} = 59.1 \text{ m/s}$$

$$u_2 = M_2\sqrt{\gamma R T_2} = 84.1 \text{ m/s}$$

$$A_1 + A_2 = A_3 \Rightarrow \frac{A_1}{A_2} + 1 = \frac{A_3}{A_2} \Rightarrow \frac{A_3}{A_2} = 3\ ; \quad \frac{A_1}{A_3} = \frac{1}{3}$$

$$\Rightarrow \frac{A_2}{A_3} = 2/3$$

$$\boxed{\frac{\dot{m}_3}{A_3} = \rho_3 u_3 = 100.95 \text{ kg/s·m}^2}$$