PROPULSION GATE SOLUTION.

YEAR - 2007:

Q1 Which one of the following engines should be used by a subsonic passanger transport aircraft?

Sol^n:

Turbofan engine - For subsonic passanger aircraft we will use either turbofan or turbojet engine. TSFC is minimum for turbofans.

$$TSFC = \frac{f}{(1+f)u_c - u}$$

Typical value of TSFC modern engines are:

Ramjet (0.17 - 0.26) kg/hr, Turbojet (0.075 - 0.11 kg/hr)
Turbofan (0.03 - 0.05) kg/hr

Q2 Air enters through the eye of a centrifugal compressor with stagnation temperature 300K and exits the compressor with a stagnation temperature 424K. If the isentropic efficiency of the compressor is 0.81 and the ratio of specific heats of the flowing gas (assumed at constant) is 1.4, then the pressure ratio across the compressor is.

Soln:

$T_{01} = 300\ K$, $T_{02} = 424\ K$

$\eta_c = 0.81$, $\gamma = 1.4$, $P_c = \left[1 + \eta_c \left(\frac{\Delta T_{02}}{T_{01}}\right)\right]^{\gamma/(\gamma-1)}$

$P_c = \left[1 + 0.81\left(\frac{124}{300}\right)\right]^{\frac{1.4}{0.4}} = 2.747$

Q3 For an impulse turbine with identical stages, the hot gas exits from the stator blades at the mean blade height at an absolute inlet

blade angle with axis of the turbine at the mean blade height for the rotor blade is 37°, then absolute exit velocity angle with the axis of the turbine at the mean blade height of the rotor blade is.

For a turbine with identical stages,

$$R = \frac{C_a}{2U}(\tan\beta_3 - \tan\beta_2)$$

Here, every trim is at mean blade height.

For impulse turbine $R = 0$

$$\tan\beta_3 = \tan\beta_2$$

$$\beta_3 = \beta_2 \Rightarrow \boxed{\beta_3 = 37^\circ}$$

Q4 Which one of the following materials should be selected to design an axial flow turbine operating at high temperature.

Soln Temperature for such turbine can be upto 2000 K and we need to use titanium alloy design its part if temperature is not very high

→ Al-alloy will melt at this temperature, steel alloy will be too heavy.

→ Ni-alloy can be based at higher temperature, These alloys are used for high temperature application.

Q5 Which statement is true?

(a) Isentropic efficiency of a compressor is constant throughout the compressor.

(b) Flow separation problem are more critical for the AFC than for centrifugal compressor.

(c) The pressure ratio of centrifugal compressor

approaches zero as the compressor mass flow rate approaches zero.

(d) Centrifugal compressor are always designed with multiple stage.

Q6 The on-board rocket motor of a satellite of initial mass 2000 kg provides a specific impulse of 280, if this motor is fired to give a speed increment of 500 m/s along the direction of motion, the mass of propellant consumed,

$M_0 = 2000$ kg

$I_{sp} = 280$

$\Delta V = 200$ m/s

For rocket, $\Delta V = V_{eq} \ln\left(\frac{M_0}{M_i}\right)$

$I_{sp} = \frac{V_{eq}}{g_e}$