

## Exercise Problem # 1

- The design mass flow rate of a centrifugal compressor is  $7.5 \text{ kg/s}$  with inlet stagnation temperature of  $300 \text{ K}$  and pressure of  $100 \text{ kPa}$ . The compressor has straight radial blades at the outlet. The blade angle at the inducer inlet tip is  $50^\circ$  and the inlet hub-tip ratio is  $0.5$ . The impeller is designed to have a relative Mach number of  $0.9$  at the inducer inlet tip. If the tip speed is  $450 \text{ m/s}$ , determine (a) the air density at inducer inlet, (b) the inducer inlet diameter, (c) the rotor rpm (d) the impeller outlet diameter.
- Ans:  $0.988 \text{ kg/m}^3$ ,  $0.258 \text{ m}$ ,  $17100 \text{ rpm}$ ,  $0.502 \text{ m}$

## Exercise Problem # 2

- A centrifugal compressor runs at 10000 rpm and delivers 600 m<sup>3</sup>/min of air at a pressure of 4:1. The isentropic efficiency of the compressor is 0.82. The outer radius of the impeller is twice the inner radius. The axial velocity is 60m/s. If the ambient conditions are 1 bar and 293 K, determine (a) the impeller diameter at inlet and outlet (b) the power input (c) the impeller and diffuser angles at inlet.
- Ans: 0.92, 0.461, 2044 kW, 13.9°, 7.1°

## Exercise Problem # 3

- 30 kg of air per second is compressed in a centrifugal compressor at a rotational speed of 15000 rpm. The air enters the compressor axially. The compressor has a tip radius of 30 cm. The air leaves the tip with a relative velocity of 100 m/s at an angle of 80°. Assuming an inlet stagnation pressure and temperature of 1 bar and 300 K, respectively, find (a) the torque required to drive the compressor, (b) the power required (c) the compressor delivery pressure
- Ans: 4085 Nm, 6.417 MW, 6.531 bar

## Exercise Problem # 4

A centrifugal compressor has an impeller tip speed of  $366 \text{ m/s}$ . Determine the absolute Mach number of the flow leaving the radial vanes of the impeller when the radial component of velocity at impeller exit is  $30.5 \text{ m/s}$  and the slip factor is  $0.90$ . Given that the flow area at impeller exit is  $0.1 \text{ m}^2$  and the total-to-total efficiency of the impeller is  $90\%$ , determine the mass flow rate.

Ans:  $0.875, 5.61 \text{ kg/s}$