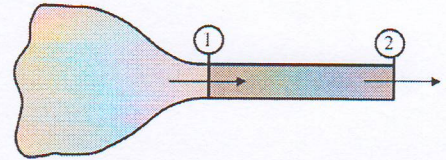


#### QUESTION 4 [10 Marks]

A constant-area duct, 25 cm in length by 1.3 cm in diameter, is connected to an air reservoir through a converging nozzle, as shown in Figure. For a constant reservoir pressure of 1 MPa and constant reservoir temperature of 600 K, determine the flow rate through the duct for a back pressure of 101 kPa. Assume adiabatic flow in the tube with  $f = 0.023$ .

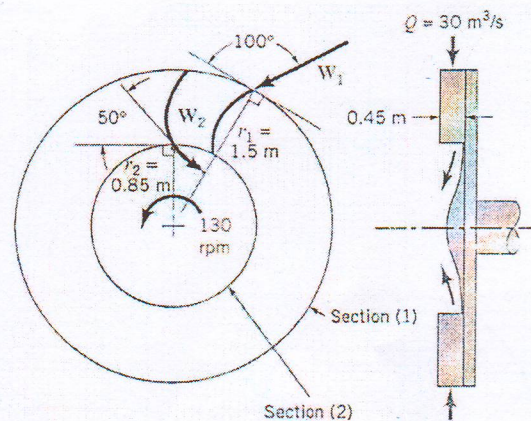


#### QUESTION 5 [10 Marks]

A centrifugal pump having an impeller diameter of 0.5 m operates at 900 rpm. The water enters the pump parallel to the pump shaft. If the blade exit angle is 25 deg. Determine shaft power required to turn the impeller when the flow through the pump is  $0.16 \text{ m}^3/\text{s}$ . The uniform blade height is 50 mm (Sketch the velocities diagram).

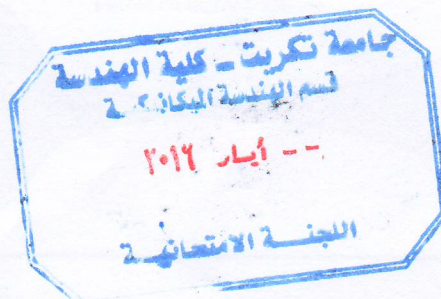
#### QUESTION 6 [10 Marks]

A simplified sketch of a hydraulic turbine runner is shown in figure. Relative to rotating runner, water enters at section (1) "cylindrical cross section area  $A_1$  at  $r_1 = 1.5 \text{ m}$ " at an angle of 100 deg. from the tangential direction and leaves at section (2) "cylindrical cross-section area  $A_2$  at  $r_2 = 0.85 \text{ m}$ " at the angle of 50 deg. from the tangential direction. The blade height at section (1) and (2) is 0.45 m and the volume flow rate through the turbine is  $30 \text{ m}^3/\text{s}$ . The runner speed is 130 rpm in the direction shown. Determine the shaft power developed (Sketch the velocities diagram).



End of Examination paper

GOOD LUCK



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