Benha University **Faculty of Engineering-Shoubra**
Mechanical Engineering Department **3rd year (Mechanical Power)**
Second term (2014-2015) **Sheet No (2)** **Hydraulic Machines**

1- A centrifugal pump impeller has an external diameter of 300 mm and discharge area of 0.11m^2. The blades are bent backwards so that the direction of the relative velocity at the discharge surface makes an angle of 145^o with the tangent to this surface drawn in the direction of impeller rotation. The diameters of the suction and delivery pipes are 300 mm and 225 mm respectively. Gauges at points on the suction and delivery pipes close to the pump and each 1.5 m above the level in the supply sump shoe head of 3.6 m below and 18.6 m above the atmospheric pressure when the pump was delivering 0.21 m^3/s of water at 1200 rpm. It required 71 kW to drive the pump find:

   a- The overall efficiency **(67%)**

   b- The manometric efficiency, assuming that water enter the impeller without whirl**(75%)**

   c- The loss of head in suction pipe.**(1.64m)**

2- A centrifugal pump with a backward curved impeller at an angle of 135^o to the forward tangent at exit is 23cm in diameter and 2.5 cm wide at outlet, 5% of the flow area is taken up by the thickness of the blades. The suction and delivery pipes are 15 and 12.5 cm in diameter respectively. The pressure gauges are installed close to the pump. When the pump rotate at 1760 rpm and discharge 37.5 lit/s , the vacuum gauge on the suction pipe line and pressure gauge on the discharge pipe line show 0.546 kg_f/cm^2 and 1.65 kg_f/cm^2 respectively. Assuming the actual outlet whirl velocity to be 0.65 of the ideal whirl velocity and overall efficiency to be 70%. Find the power required to drive the pump and the manometric efficiency.**(15.87HP&83%)**

3- A centrifugal pump delivers water at a rate of 0.022m^3/s when running at 1470 rpm. The gauge reading of suction and delivery pressure heads, taken at the same level were -3 m and 12 m respectively and the power supplied to the pump was 4.8 kW. The cross section area of the suction pipe is 14.2 *10^{-3} m^2 and the area of the delivery pipe is 10.3*10^{-3} m^2, the pump has 23 cm diameter impeller , which is 19 mm wide at outlet has blades leaning backward and making an angle of 60^o with the radius at blade outlet. Assuming that there is no whirl at impeller inlet and that due to interblade the loss of head in the pump and its overall efficiency.**(5.08m & 68%)**

4- A centrifugal pump when running at 1500 rpm is to drive 0.09 m^3/s against a head of 24 m. the flow at entry is radial, and the radial velocity of flow is to be constant through the impeller at 3.6m/s. the diffuser vanes may be assumed to convert 50% of the kinetic head at exit from the impeller into pressure head. The outer diameter is to be twice the inner and width of the impeller at exit is to be 12% of the diameter. Neglecting the impeller losses and the influence of the blade thickness, determine the diameter and width at inlet and outlet and the impeller and guide vanes angles.

(D2=0.2575m b2=0.031m D1= 0.1287m β1=19.6 β2 = 29.55 α2=14.55)

5- A centrifugal pump which runs at 1200 rpm is mounted so that its center is 2.4 above the water level in the suction sump. It delivers water to a point 19 m above its center. The friction loss in suction pipe is $68Q^2$ m and that in delivery pipe is 650 Q^2 where Q (m^3/s) is the rate of flow. The impeller of the pump is 350mm diameter and width of the blade passages at outlet is 18mm. the blade occupy 6% of the circumference and are backward facing at 35^o to the tangent. At inlet the flow is radial and the radial component of the flow remains unchanged through the impeller. Assuming that 50% of the velocity head of the water leaving the impeller is converted to pressure head in volute, and that the friction and shock losses in the pump, the velocity head in the suction and delivery pipes are all negligible. Calculate the manometric and the rate of flow.(Q= 0.096 &85.2%)

6- A centrifugal pump is used to raise water against a static head of 20 m. the suction and delivery pipes both 0.15m diameters, the total frictional head losses amounting to 9.5 times the pipe velocity head. The impeller which rotates at 1450 rpm is 0.3m diameter. The impeller radius ratio is 0.45; the exit blade angle being 30^o, the axial width of the impeller is designed so as to give constant radial velocity at all radii is 20mm at impeller exit. Assuming that the hydraulic efficiency is 0.82 and the overall efficiency is 0.72. Determine the rate of flow, the blade angle at inlet and the power required to drive the pump. Assume that the actual whirl velocity is 0.7 of the theoretical.

(Q= 0.05 power 22.5HP β1= 14.5)

7- The inlet and outlet diameter of a centrifugal fan rotating at 1450 rpm are 475mm and 700 mm respectively. The corresponding impeller widths are 190mm and 145mm. the performance of the fan is controlled by a series of inlet vanes which are set to produce a whirl component in the direction of rotation such the relative velocity of the air at inlet is 31m/s making an angle of 15^o with the tangent to the blade inlet circle and causing a shock loss of 0.6 $v_1^2/2g$, where v1 is the absolute velocity of air at inlet. The impeller blades are backward inclined and the inlet and outlet angles are 12^o and 23^o respectively. Assuming that due to slip the actual whirl component at outlet is 0.8 of the theoretical and that the impeller loss is 0.4 of the velocity head at impeller outlet, calculate the total head developed by the impeller and the air flow rate through the fan

(H=113.7m&Q=2.27)