Minoufiya University
Faculty of Engineering
Mechanical Power Eng. Dept.
Second Semester Examination
Academic Year: *2012-2013*

Subject/Code: *Hydraulic Machines/ MPE 321*
Academic level: *3th Mech Power.*
Date: 7/06 /2014
Time allowed: *3 hours*
Total degree: 90 *marks*

This Exam measures ILOS no. (A5, A14, A16, B2, B4,B5, B6, B13, B16, C5,C12, C15, C17, and C18).

Answer all the following questions

Question-1 *[20marks]*

a) Define, the specific speed and deduce a relation for the calculation of its value in respect to Q, n and H.

b) What do you understand by cavitation? What are its causes and how it can be prevented in the centrifugal pump?

c) A centrifugal pump lifts water against a static head of (40 m) of which (4 m) is suction lift. The suction and delivery pipes are both (15 cm) in diameter. The head lost in the suction pipe (2 m) and in the delivery pipe (7.5 m). The impeller is (40 cm) diameter and (2.5 cm) wide at the exit and run at (1200 RPM). The blade angle at exit is 30°. If hydraulic efficiency of the pump is (85%) and the overall efficiency is (75%). Determine the following:

i-The power required to drive the pump. ii-The discharge in (m3/hr)

iii-The lowest speed to start pumping if the impeller is (20 cm) diameter at the inlet.

Question-2 *[30 marks]*

a) Explain the effect of change of speed and diameter of a pump impeller on the characteristic curves of the centrifugal pumps.

b) What is meant by separation? Discuss its kinds in axial flow pumps.

c) A centrifugal pump running at (1000 rpm) gave the following relation between head and discharge:

Q (m^3/min)	0.0	4.5	9.0	13.5	18.5	22.5
H (m)	22.5	22.2	21.6	19.5	14.1	0.0

The pump is connected to a (30cm) suction and delivery pipes diameter. The total length of which is (69 m) and discharge to atmosphere at (15 m) above suction level. The secondary loss is equivalent to an additional (6 m) of pipe and the coefficient of friction is 0.024. Calculate the discharge and find the operating point for two pumps connected in parallel. If it is required to adjust the flow rate by regulating the pump speed, estimate the speed to reduce the flow rate to its half value in the case of the single pump.

Question-3 *[25 marks]*

a) Sketch the discharge versus crank angle diagram for single – acting triplex cylinders pump indicating the angles at which the discharge overlap

b) Prove that the ratio between the maximum discharge and the average discharge is (1.5708) for double – acting simplex piston pump.

c) A double- acting simplex pump (single cylinder) is used to raise water at a rate of (0.006 m^3/s) to a height (delivery head) of (42 m) through a delivery pipe of (100 mm) diameter and (81 m) length. The pump stroke is (250 mm), the piston diameter is (115 mm) and the piston rod diameter is (11 mm). The length of the suction pipe is (4 m) and suction pipe diameter (100mm). The average linear velocity of piston is(0.6 m/s). The pump servicing a pumping system characterized by the equation $H_{system}=H_{static}+KQ^2$ ($K=2x10^5$; Q is discharge in m^3/s). The total head rise by the pump (Hpump) is (52.2 m). An air vessel is fitted in the delivery pipe at (6 m) from the cylinder measured along the pipe. The friction coefficient in suction and delivery pipes is (0.032). Cavitation takes place at (0.7 kg_f/cm^2) below atmospheric pressure. Determine: (i) the speed of the pump in RPM, (ii)The suction head in m, (iii) percentage slip and volumetric efficiency if valve loss is 2% and the stuffing box loss is negligible, (iv) The total pressure head in the cylinder at the beginning of both suction and delivery stroke, (v) Power required to drive the pump ($\eta_{pump}=0.80$), (vi) is cavitation occur?, (vii) the discharge into or from the air vessel at $\theta=50^o$ with the inner dead centre, and (viii) Maximum volume for the air vessels and the pressure of compressed air if the head between the free surface of water in vessel and the pump axis is (0.6 m).

Quetsion-3 *[15marks]*

a) Drive an expression for the hydraulic efficiency of the pelton wheel as function of u/V, discuss this expression?

b) How can be controlled the power in pelton wheel, Francis and Kaplan turbines?

c) A Pelton wheel (1.22m.) in diameter is supplied from a reservoir giving an effective head of (305m) at the nozzle. The coefficient of velocity for the nozzle is (0.98) and the jet is deflected through an angle of (170 degree). If there are two jets, each (10.4 cm) in diameter and the buckets move at (0.465) the jet velocity. If the mechanical efficiency is (90%) and the gross head is (340m). Assume, Find: i) The hydraulic efficiency, ii) The water power, and iii) The overall efficiency. Assume relative velocity at exit equal (0.9) times the relative velocity at inlet.