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: 8/6/2013* 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 *[20 marks]*

a) a) What conditions must be satisfied for similarity in hydraulic machines.

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

c) A centrifugal pump delivers (75 lit. / sec.) of water against a total head of (30 m) and runs at (1350 rpm). The external diameter of its impeller is (30 cm), the blade height at exit is (5 cm), the hydraulic efficiency is (85%) and the overall efficiency is (75%). If the vapor pressure is (0.15 Kg_f / cm^2) , the atmospheric pressure is (1.013 Kg_f / cm^2) and the cavitation factor is (0.1). Find the following:

i) The maximum allowable manometric suction head.
ii) The exit blade angle.
iii) The power required to drive the pump.
iv) The specific speed.

Question-2 *[30 marks]*

a) Explain why the actual energy transferred to the liquid by a centrifugal pump is smaller than that predicted by Eueler's equation.

b) Discuss the kinds of separation which occurs in axial flow pumps and show its reasons and methods control.

c) A centrifugal pump has the following performance at (1300 rpm.) :

Q (lit./sec.)	0.0	10	20	30	40	50	60
H (m)	44	43.5	42	40	36	30.5	23
(%)η	0.0	38	62	74	78	65	25

The pump is interposed in a water pipe line (300 m.) long and (15 cm.) diameter. The static lift is (20 m.) and the pipe has a coefficient of friction is (0.03) , two bends (C_b = 0.4) and a foot valve (C_v = 0.6). Calculate the input power, the pump speed, the power lost in valve and the system efficiency, when the discharge is decrease to one half of its maximum value in the following cases:

i) Using throttle valve.
ii) Reducing the pump speed and the valve is fully open.

To next page

Question-3 *[25 marks]*

a) Find the percentage of power saved against friction due to fitting of air vessel for a single-acting pump.

b) A double-acting single cylinder positive displacement pump of 190 mm diameter by 380 mm stroke draws liquid (ρ=1000 kg/m^3) from a source 3.65 m below pump axis and delivers to a height 30.5 m above pump axis. Both suction and delivery pipes are 100mm diameter and their respective lengths are 9 m and 61 m. The friction coefficient for the pipe is 0.032. Air vessels are fitted on both suction and delivery sides of the pump. The air vessel in the suction side is 3 m away from the cylinder, while that on the delivery side is 6 m away from the cylinder. The cavitation takes place at 0.7 kg$_f$/cm^2 below atmospheric pressure. The free surface of water in both vessels is 0.6 m from the pump axis. The pump efficiency is 80%. The pump piston makes 36 double strokes per min. Determine:

i- The pressure difference between the two sides of the piston at the beginning of stroke,

ii- Maximum volume for the air vessels and the pressure of air in the vessels,

iii-The rate of flow into or from the air vessel, when the crank makes 40o with the inner dead center,

iv- The horse power (HP) required to derive the pum,

v- is cavitation occur? Draw the indicator diagram.

Quetsion-3 *[15marks]*

a) Prove that the maximum efficiency of Pelton Wheel turbine is

$$\eta_{max} = \frac{1}{2}(1 - k\cos\vartheta)$$

b) Explain with aid sketch the difference between theory of operation of Francis and Kaplen turbines.

b) A Pelton wheel running at 480 rev/min and operating under on effective head of 420 m is required to develop 4800 kW. There are two equal jets and the bucket deflection angle is 165o. The overall efficiency is 85 % when the water is discharged from the wheel in a direction parallel to the axis of rotation. The coefficient of velocity of nozzle=0.97 and speed ratio =0.46. The relative velocity of water at exit from the bucket is 0.86 times the relative velocity at inlet. *Calculate:*

i- Cross-sectional area of each jet,

ii- Bucket diameter, and

iii- Hydraulic efficiency of the turbine.

Good Luck

Prof. Sobieh Selim, Prof. Ahmed Rafat, and Dr. Ahsraf Amin