

Minoufiya University  
 Faculty of Engineering  
 Mechanical Power Eng. Dept.  
 Second Semester Examination  
 Academic Year: 2014-2015



Subject/Code: *Hydraulic Machines/ MPE 227B*  
 Academic level: *2<sup>th</sup> Electrical*  
 Date: *27 /05 /2015*  
 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: Specific speed, attack angle, lag angle, operating point.
- b) What do you understand by cavitation? What are its causes and how it can be prevented in the centrifugal pump?
- c) The impeller of a centrifugal pump having external and internal diameters 500 mm and 250 mm respectively width at outlet 50 mm and running at 1200 RPM works against a head of 48 m. The velocity of flow through the impeller is constant and equal to 3.0 m/s. The vanes are set back at an angle of 40° at outlet. Determine:
  - i) - Inlet vane angle. ii)-Work done by the impeller on water per second, and
  - iii) - Manometric efficiency.

Question-2 [30 marks]

- a) What are the important losses in centrifugal pumps? What factors cause these losses
- b) With the aid of neat sketch, explain the construction and working of an axial flow pump.
- c) A centrifugal pump has the following performance characteristics at 875 RPM:

Q (lit. /sec)	75	150	225	300	375	450
H ( m )	16.5	16.5	15.9	14.6	12.2	8.2
( % ) $\eta$	36	63	76	83	80	70
NPSH (m)	1.4	2.3	3.0	3.7	4.3	4.8

The pump lifts water from an open container 3.5 m below pump axis. The suction pipe is 40 cm in diameter. The friction loss of head in suction line is given by the equation  $h_f = 11.11 Q^2$  m H<sub>2</sub>O, where Q is in m<sup>3</sup>/s. When this pump is interposed in a piping system having a static lift of (9.8 m), it gives a maximum discharge of (300 lit/sec)

when rotating at (875 RPM). Estimate the pump speed to give (450 lit/sec) when it is working in the same system. What should be the shaft power required in both cases.

- d) Is cavitation occur for single pump at its operating point whose performance is given in the previous table? The atmospheric pressure is 1.01 bar and vapour pressure is 0.127 bar. What is value of suction specific speed?. Compare this value with the optimum value.

Question-3 [20 marks]

a) What is meant by indicator diagram for a single cylinder single acting reciprocating pump? Sketch the diagram and explain the effect of a acceleration and friction on both suction and delivery stroke.

b) What is the use of air vessels in reciprocating pump?

c) A single acting single cylinder reciprocating pump is installed ( 3 m) above the water level of the sump. The suction pipe is (15 cm) diameter and (12 m) long. The pump cylinder is (22.5 cm) diameter and (37.5 cm) stroke. If the coefficient of friction is (0.03), the Barometric head is (10.3 m) of water, vapour head is (2.4m) of water abs. and the piston moves in simple harmonic motion. Find: i) The speed at which the cavitations may take place at the commencement of suction stroke. ii) The change in the maximum speed of the pump, if a large air vessel is fitted on the suction pipe closed the cylinder.

Quetsion-4 [20marks]

a) Derive and show with diagram the variation of Pelton Wheel hydraulic efficiency with the speed ratio ( $u/V_j$ )

b) Explain with the aid of net sketch the theory of operation of Francis turbine

c) A Pelton Wheel turbine running at (500 RPM) and operating under an affective head of (400 m) is required to develop (500 kW). There are two equal jets and the bucket deflection angle is ( $165^\circ$ ). The overall efficiency is (85%) when the water is discharge from the wheel in a direction parallel to the axis of rotation. The coefficient of velocity of the nozzle is (0.97) and speed ratio is (0.44). The relative of water at exit from the bucket is (0.86) times the relative velocity of water at inlet. Calculate:

i) Cross-sectional area of each jet. ii) Hydraulic efficiency of the turbine.