الفرقة الثالثة
٣٠/ ٥/ ٢٠١٥ م

Minoufiya University Faculty of Engineering Mechanical Power Eng. Dept. Second Semester Examination Academic Year: *2014-2015*	Subject/Code: *Hydraulic Machines/ MPE 321* Academic level: *3th Mech Power.* *Date: 30/05 /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) Indicate the effect of the centrifugal force on the performance of axial and centrifugal pumps. How is it prevented?

b) What is an axial thrust in centrifugal pump? State it is causes. Describe a few methods to overcome the axial thrust for: i) small pumps, ii) large pumps and iii) Multi-stage pumps.

c) A centrifugal pump delivers 60[lit /sec] against manometric head of [35 m] and runs at [1350 RPM], the external diameter of its impeller is [30 cm]; blade height at exit is [5cm], hydraulic efficiency is [90%] and overall efficiency is [75%]. If the vapor pressure =0.15[kg /cm^2], atmospheric pressure 1.013 [kg$_f$/cm^2], and cavitations factor б =0.1. Find: (i)-maximum allowable manometric suction head; ii) - Exit blade iii) Shaft power required to drive the pump and iv) - Specific speed.

Question-2 *[30 marks]*

a) What change can be expected in the "discharge-head" curve when two pumps are connection, i) in series and ii) in parallel.

b) Explain the performance curves of axial flow pump.

c) The characteristics of a centrifugal pump at constant speed 1450 r.p.m are as follows:

Q(m^3/s)	0	0.012	0.018	0.024	0.03	0.036
H(m)	22.6	21.3	19.4	16.2	11.6	6.5
η (%)	0	74	86	85	70	46
NPSHR(m)	0	0.9	1.2	1.43	1.7	1.87

The pump is used to lift water over a vertical distance of 8 m by means of a 10 cm diameter pipe, 65 m long for which the friction coefficient f=0.024. i) Determine the rate of flow and the power supplied to the pump. ii) If it is required to increase the rate of flow by an addition of a second identical pump. (Running at the same speed), investigate whether it should be connected in series or in parallel with the original pump. Justify your answer by determining the increased rate of flow and power consumed by both pumps.

c) The single pump in the previous question 3(c), is connected to a (10 cm) diameter and 10 m length. Suction pipe having one bend (k_b=0.20), and a valve (k_v=1.10). The entrance loss is equivalent to an additional 1 m of pipe. The friction coefficient is 0.024. The atmospheric and vapour pressures are 101 kPa and 0.25 bar, respectively. If the suction lift is 2 m. Find: i) NPSHA and Cavitation occur? ii) Optimum impeller eye diameter, and iii)-suction specific speed and compare it with the Nss at which pump failure occurs rapidly.

Question-3 ***[20 marks]***

a) Define cavitation and explain how cavitation destroys the material of the impeller.
b) Define NPSHA and NPSHR, How are related to each other?
c) What is slip? How negative slip occurs?
d) A double- acting single cylinder reciprocating pump is operated at 120 strokes per minute. The pump discharges 15 lit/sec. of water to a height of 40 m through 15 cm diameter and 50 m long delivery pipe. The pump slip is 16.234%. The ratio of pump stroke length to cylinder diameter is 10. The suction head is 5 m and the suction pipe is 10 cm in diameter and 8 m long. The friction coefficient for the pipes is 0.032. The overall efficiency of the pump is 70%. Cavitation occurs at 2.6 m of water absolute, and the atmospheric pressure head is 10.2 m of water. Large air vessels are fitted on both sides of the pump. The air vessels in suction and delivery side are 1 m and 6 m respectively, away from the cylinder measured along pipe. Determine: (i) Cylinder diameter and stroke length, (ii)Total pressure head difference between the two sides of the piston at the beginning of the stroke, (iii) power required to drive the pump, (iv) Is cavitation occur? If cavitation occurs, find the speed in rpm at which the pump runs without separation.

Quetsion-4 ***[20marks]***

a) - Prove that the impeller eye diameter at minimum NPSH is given by $D_e = 4.5\sqrt[3]{Q/N}$
b) - Show with sketches and brief comments:
   i) The velocity diagrams at inlet and outlet of the blades of a typical pelton wheel and Francis turbine.
   ii) The methods of power regulation of pelton wheel and Kaplan turbine
   ii)A pumped storage installation.
c) -A Francis 135 kW turbine, having an overall efficiency of 75%, is required to produce under a head of 9 m and at 120 r.p.m. the velocity of periphery of the wheel and velocity of flow at inlet is $3.47\sqrt{H}$ and $1.1\sqrt{H}$ respectively. If the hydraulic losses in the turbine are 20% of the available energy, find: (a) Guide blade angle at inlet (b) Wheel vane angle at inlet and (c) Diameter of the wheel