KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR SCIENCE

EMM 400: FLUID MECHANICS IV

DATE: THURSDAY 12TH APRIL 2012 **TIME: 11.00 A.M. – 1.00 P.M.**

INSTRUCTIONS

Attempt any 3 (THREE) questions

All questions carry equal marks

Question 1

a. Name the two main classifications of fluid machinery and give their main differences. (4 marks)

b. Name the main assumptions in one dimensional theory of rotodynamic machines. Hence using an appropriate diagram of a radial flow pump impeller, show the main velocity components, and explain the significance of each. (10 marks)

c. A centrifugal pump has an impeller of diameter 0.15 m and axial width of 20mm at the outlet. The blades occupy 5% of the circumference and are inclined at 25° to the tangent to the periphery. The flow rate through the impeller is 9 m^3/hour when it rotates at 900 rpm. Calculate the head developed by the pump if it is pumping water of density 1000 kg/m^3. Assume one dimensional flow theory. (6 marks)

Question 2

a. What are the main differences between an impulse and reaction turbine? Name the two common reaction turbines and specify the heads suitable for each. (6 marks)

b. In a Pelton wheel the diameter of the bucket circle is 2 m and the deflecting angle of the bucket is 162°. The jet is of 165 mm diameter, the pressure behind the nozzle is 1000Kn/m^2 and the wheel rotates at 320 rpm. Neglecting friction, find the power developed by the wheel and the hydraulic efficiency. Take coefficient of velocity at nozzle C_v = 0.99, and assume the relative velocity is constant. (10 marks)

c. Name two Pelton wheel design parameters of consideration and their effect to the overall efficiency of a Pelton wheel. (4 marks)

Question 3

a. What do you understand by homologous series as used in rotodynamic machines? What key feature is common in all of them? (3 marks)

b. A quarter scale turbine model is tested under a head of 10.8 m. The full-scale turbine is required to work under a head of 30 m and run at 44.86 rad/sec. At what speed must the model run? If it develops 100kW at a flow rate of 1.085 m^3/s at this speed, what power will be obtained from the full scale turbine, its efficiency being 3% better than that of the model. What is the power specific speed of the full scale turbine? (12 marks)

c. Briefly describe cavitation in rotodynamic machines. How can it be minimised in turbines? (5 marks)

Question 4

a. What are pump and system characteristics? Using a simple sketch, describe how they are used in pump selection (6 mark)

b. A centrifugal pump running at 2950 rpm gave the following results at peak efficiency when pumping water during a laboratory test:

Effective head, H = 75 m of water
Flow rate, Q = 0.05 m^3/s
Overall efficiency, η = 76%

i. Calculate the specific speed of the pump in dimensionless terms and based on rotational speed in revolutions per second (3 marks)

ii. A dynamically similar pump is to operate at a corresponding point of its characteristic when delivering 0.45 m^3/s of water against a total head of 117 m. Determine the rotational speed at which the pump should run to meet the duty and the ratio of its impeller diameter to that of the model pump stating any assumptions made. What will be the power consumption of the pump? (9 marks)

c. Name the main classifications of rotodynamic pumps (2 marks)

Question 5

a. Name the two common hydrodynamic transmission devices. What is their fundamental difference? (4 marks)

b. Name two advantages of positive displacement machines over rotodynamic machines (2 marks)

c. A single acting reciprocating pump, having a bore and stroke of 200 mm and 400 mm respectively, runs at 20 rpm. The suction pipe, which has a diameter of 100 mm has a length of 9.1 m, has no air chamber fitted. The suction lift is 3.6 m. The discharge pipe is also 100 mm bore and is 470 m long, the discharge being 15.2 m above the pump level, and is fitted with an air chamber 15 m from the pump. Assuming simple harmonic motion for the piston motion and taking friction factor as 0.01 for all pipes, calculate the cylinder pressures at the start, middle and end of both suction and discharge strokes. Take atmospheric pressure as 10.34 m. (10 marks)