MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 309: HYDRAULICS II

DATE: 14/6/2017 **TIME: 8:30 – 10:30 PM**

INSTRUCTIONS

i) Answer Question One and Any Other Two Questions
ii) Necessary charts and tables are attached
iii) Assume water temperature, where required is 15^0C (Kinematic viscosity = 1.3 x 10-6 m2/s).

QUESTION ONE (COMPULSORY) (30 MARKS)

a) With aid of a well labelled sketch, show the head developed by a pump sucking water from a lower reservoir and delivering it to a higher reservoir (5 marks)

b) Derive by dimensional analysis an expression for the dimensionless specific speed or type number of a turbine in terms of rotational speed N, power transferred between fluid and runner P, density ρ and viscosity μ of the fluid, the acceleration due to gravity g and the difference of head across the machine H. (5 marks)

c) Derive from first principles an expression for the hydraulic efficiency of a Pelton wheel turbine (5 marks)

d) Show that the speed at which pumping commences in a centrifugal pump is given by

$$N = 83.5\frac{\sqrt{h}}{D}$$

Where, h is the static lift for a centrifugal pump (m), N is the speed of rotation (rev/min) and D is the external diameter of the impeller.

Assume only rotation of water in the impeller at 'no flow' conditions. (3 marks)

e) With the aid of well labelled sketches, explain the difference in the installation of a Pelton wheel turbine and a reaction turbine. (5 marks)

f) State the basic equation of wave motion and, with illustrations, discuss its implication in coastal hydraulics problems. (7 marks)

QUESTION TWO (30 MARKS)

a) Derive an equation for the power transmitted from water to the runner vanes in a reaction turbine (10 marks)

b) An inward flow reaction turbine has a runner 0.5 m diameter and 75 mm wide at inlet. The inner diameter is 0.35 m. The effective area of flow is 93 percent of the gross area and flow velocity is constant. The guide vane angle is 23^o, inlet vane angle is 93^o, and outlet vane angle is 30^o. Calculate:-

i. The speed so that the water enters without shock.

ii. The shaft output power when the effective supply head is 60 m.

Assume hydraulic friction loss of 10 percent and a mechanical efficiency of 94 percent. (10 marks)

QUESTION THREE (20 MARKS)

A double jet Pelton wheel is supplied with water through a pipeline 1650 m long from a reservoir in which the level of water is 375 m above that of the wheel. The turbine runs at 500 rev/min and develops power of 5000 kW. If the pipe losses are 10 percent of the gross head and coefficient of friction is 0.005, calculate:

a) The diameter of the pipe.

b) The cross sectional area of the jet.

c) The mean diameter of the wheel. (20 marks)

QUESTION FOUR (20 MARKS)

A variable speed pump running at 1450 rev/min gave the relation in Table Q4.

Table Q4

Discharge (l/s)	0	10	20	30	40	50	60	70
Total head (m)	45.0	44.0	42.5	39.5	35.0	29.0	20.0	0

The pump is installed to deliver water from reservoir A to reservoir B through 250 mm suction and delivery pipe, the total length of which is 2000 m, effective roughness is 0.06 mm. Minor losses are $10V^2/2g$. Elevations of water in reservoirs: Z_A =135 m and Z_B =150 m.

a) Calculate the discharge in l/s

b) If it is required to adjust the flow by varying the pump speed, estimate the speed to reduce the flow by one-third. (20 marks)

QUESTION FIVE (20 MARKS)

Reservoir A delivers to reservoirs C and D through pipelines AB, BC and BD, whose characteristics are listed in Table Q5.1. A pump, whose characteristics are listed in Table Q5.2, is installed in pipeline BD to boost the flow to D. Elevation of water in reservoirs: Z_A=100m, Z_C = 60 m, Z_D= 50 m.

Neglecting minor losses, calculate the flow to the service reservoirs:-

a) With the pump not installed.

b) With the pump operating and determine the power consumption.

Table Q5.1

Pipe	Length (m)	Diameter (mm)	Roughness (mm)
AB	10000	350	0.15
BC	4000	200	0.15
CD	5000	150	0.15

Table Q5.2

Discharge (l/s)	0	20	40	60	80
Total head (m)	30	27.5	23.5	17.0	7.5
Overall efficiency (%)	-	44	58	50	18

(20 marks)