THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering
Bachelor of Technology - Level 3

CEX3232 - HYDRAULICS AND HYDROLOGY

FINAL EXAMINATION 2015/16

Time Allowed : Three Hours Index Number :

Date : 06th December, 2016 Time : 0930 - 1230

ANSWER **ALL THREE** QUESTIONS IN **PART A** AND **ANY TWO** QUESTIONS IN **PART B**. ALL QUESTIONS CARRY EQUAL MARKS.

PART A

Answer **all three** questions

1) A conical tank has a circular cross-section and a half-angle of 45 degrees and is placed with its axis vertical and its apex downward, as shown in Figure 1. The tank has a small circular hole, of diameter 1 cm , at the apex as shown in the figure. The tank is empty at time $t = 0$, and at that time a constant flow of 0.25 litres/second is allowed to flow into the tank. The water level in the tank at any time $t = t$ is given by h(t) as shown in the figure.

a) Derive, from first principles, an expression for the rate of change of the water level in the tank – dh(t)/dt .

b) Use the expression derived in section a) to sketch a graph of the variation of the water level h(t) with time t . Explain your answer.

c) Calculate the steady water level in the tank. Assume a reasonable value for any coefficient that is needed for your calculation.

The discharge into the tank is suddenly stopped after the water level has reached the steady value.

d) Explain how you would calculate the time taken for the water level in the tank to decrease to half the steady value. State all your assumptions. You DO NOT have to obtain the final result.

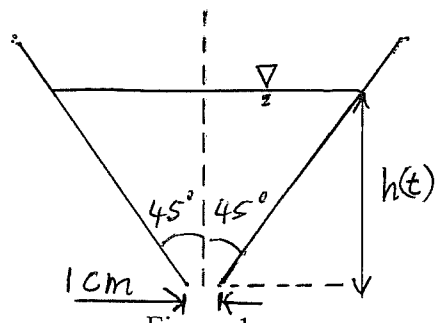

Figure 1

2) A pipe section AB consists of a 90 degree bend in the horizontal plane – as shown in Figure 2a (side view) and Figure 2b (plan view). The pipe has a circular cross-section with a uniform diameter of 5 cm . Two simple manometer tubes are connected to the pipe, as shown in the figures.

When water (density 1000 kg/m3) flows through the pipe bend at a certain discharge in the pipe the water levels in the manometer tubes connected to A and B are found to be 9 cm and 10 cm , respectively, as shown in Figure 2a. The rate of energy loss as the water flows through the pipe bend is found to be 0.05 W .

a) In what direction is the water flowing? Explain your answer.

b) Explain, using neat figures if necessary, why there is an energy loss when water flows through the pipe bend.

c) Calculate the discharge in the pipe section.

d) Calculate the magnitude and direction of the force on the pipe section due to this flow.

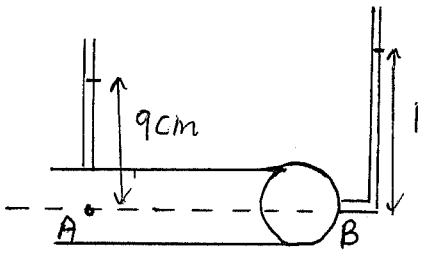

Figure 2a (side view)

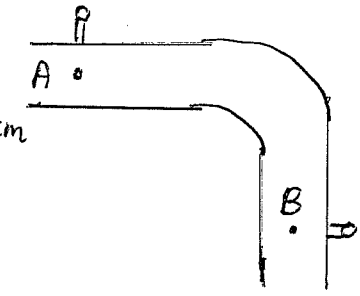

Figure 2b (plan view)

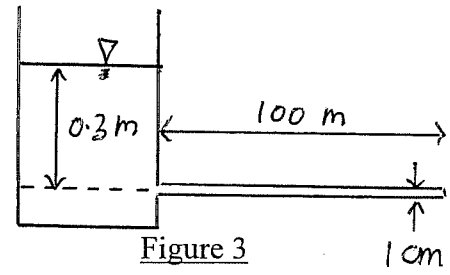

Figure 3

3) a) Explain, using neat diagrams, the differences between Laminar Flow and Turbulent Flow.

b) Explain the Moody Diagram and what it is used for. Identify and define the quantities on the horizontal and vertical axes of the diagram.

Water (density 1000 kg/m^3, dynamic viscosity 0.001 Pa s) is discharged from a large tank (or cross-section area 10 m^2) through a smooth, long horizontal pipe as shown in Figure 3. The pipe has a length of 100 m and a diameter of 1 cm . At a certain time the water level in the tank is 0.3 m above the level of the outlet pipe, as shown in the figure.

c) Calculate the discharge through the pipe. Assume Laminar Flow and assume that the head loss in friction in the pipe is the ONLY source of energy loss.

d) Use the result obtained in section c) to show that the assumption of Laminar Flow in the pipe is correct.

PART B

Answer **any two** questions

4) a) Explain, using a neat diagram, what a Pitot Tube is.

b) What is measured using a Pitot Tube?

c) Explain, using a neat diagram, what a Pitot-Static Tube is.

d) Explain how a Pitot-Static Tube can be used to measure the velocity of a flow.

A Pitot-Static Tube is used to measure the velocity in a flow of water in a large pipe. The two sections of the Pitot-Static Tube are connected to two simple water manometers. At a certain location the difference between the levels in the two manometers is found to be 15 mm .

e) Calculate the velocity of the flow at that location. Explain your answer.

f) If the water manometers are read using scale marked in millimeters, estimate the accuracy of the velocity calculated in section e). Explain your answer.

5) A roof, ABCD, has the dimensions shown in Figure 5. The length AB, measured along the roof, is 5 m , while AB makes an angle of 20 degrees with the horizontal. BC is horizontal and has a length of 30 m . The roof, ABCD is drained by a gutter, BC, which has a single down-pipe at B, as shown in the figure.

At time $t = 0$, rain falls on the roof with a steady and uniform intensity of 100 mm/hour.

a) Sketch the variation of the discharge from the down-pipe with time. Explain your answer.

b) Calculate the maximum discharge from the down-pipe. Explain your answer.

The discharge from the down-pipe is directed to a drain with a depth of 15 cm and a slope of 0.01 .

c) State the Manning's Equation for flow in an open channel.

d) Identify and define the terms in the Manning's Equation.

e) Calculate the width of the drain required to receive the discharge from the down-pipe without overflowing. Use a value of 0.015 for the Manning's coefficient. (You may have to use a trial-and-error solution to obtain the required width of the drain.)

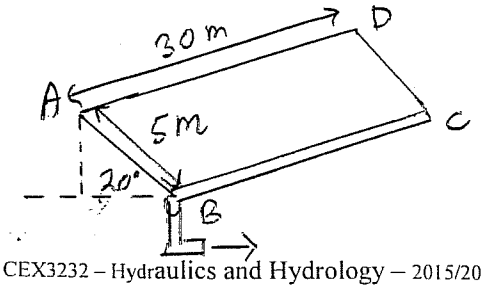

Figure 5

6) a) Explain, using neat diagrams, how a Centrifugal Pump works.

A Centrifugal Pump is tested at a constant rotational speed and the results are presented in Table 6.

Pump Discharge (litres/second)	0	2	4	6	8
Pump Head (m)	20	18	14	8	1
Pump Efficiency (%)	20	45	70	40	10

Table 6

This pump is to be used to pump water through a pipe with a circular cross-section that has a length of 50 m and a diameter of 5 cm . The outlet of the pipe is situated 10 m above the inlet. The friction factor of the pipe is 0.012 .

b) Calculate the discharge through the pipeline when the pump is run at the same rotational speed as in the test. Explain your answer. Neglect all minor losses.

c) Calculate the power required to operate the pump.

7) The Kandy Lake has an area of 0.16 km^2 . The lake receives runoff from the hills around Kandy and discharges into a canal that leads to the Mahaweli Ganga. The lake discharges water to the canal over a rectangular weir that has a length of 30 m and a coefficient of discharge of 0.65 .

a) Draw the flood hydrographs that you would expect for the canal with and without the Kandy Lake. Explain your answer.

b) By considering the differences between the hydrographs you drew in section b), identify the two ways in which a reservoir reduces the risk of downstream flood damage.

During a rainy day the water level in the lake was 0.5 m above the crest of the weir at 0900 hours. The water level rises by 0.5 m by 1000 hours the same day.

c) Estimate the volume that flowed into the lake between 0900 hours and 1000 hours. Explain your answer.
(Note : The discharge over the rectangular weir is given by the formula

$$Q=\frac{2}{3}C_d b\sqrt{2g}H^{3/2})$$

It is proposed to increase the length of the discharge weir to 40 m.

d) Sketch, on the same graph, the variation of the flood level in the lake with time, before and after the increase in the length of the weir for the same rainfall. Explain your answer.

e) Sketch, on the same graph, the variation of the flood discharge in the canal with time, before and after the increase in the length of the weir for the same rainfall. Explain your answer.

THE OPEN UNIVERSITY OF SRI LANKA

Bachelor of Technology - Level 3

CEX 3233 - Surveying 1

Final Examination - 2015/2016

Time Allowed 3 hours

Date: 18th November 2016 Time 9.30 a.m. - 12.30 p.m.

Answer any **five** questions

Q1. i). Levelling is one of the most important surveying technique used in Civil Engineering. List down three different applications of Levelling used in Civil Engineering. (3 Marks)

ii). a). Height of collimation error is one of the main instrument error of errors in Levelling. What do understand by this error? (2 Marks)

b). A level set up in a position 30 m from peg A and 60 m from peg B reads 1.914 m on a staff held at A and 2.237 m on a staff held at B. It is known that reduced levels of the points A and B are 87.575 m and 87.279 m respectively. Find the collimation error and hence find correct readings of two points. (5 Marks)

iii). The table 1 was extracted from a "level field book". Some of the entries being illegible. Insert the missing figures, check your results, and re book all the figures using the "rise and fall" method. (10 Marks)

Station	B.S.	I.S.	F.S.	Rise	Fall	R.L	Remarks
1	2.285					232.46	BM-1
2	1.650		x	0.020			
3		2.105			x		
4	x		1.96	x			
5	2.05		1.925		0.300		
6		x		x		232.255	BM-2
7	1.690		x	0.340			
8	2.865		2.100		x		
9			x	x		233.425	BM-3

Table 1

Q2. i). a) Explain how angular error of a closed traverse is determined and corrected. (2 Marks)

b) An anticlockwise traverse ABCDEA was surveyed with the following results.

Angle	Corrected Value	Side	Measured Length (m)
BAE	128° 10′ 20″	AB	101.01
AED	103° 56′ 30″	BC	140.24
EDC	121° 30′ 30″	CD	99.27
DCB	84° 18′ 10″	DE	120.01
CBA	102° 04′ 30″	EA	67.99

Table 2.1

Assuming AB is due South, Calculate the Whole Circle bearings of the other lines. (6 Marks)

iii). Table 2.2 shows the lengths and Bearings calculated for closed traverse.

Line	Length (m)	WCB
AB	130	55° 30′
BC	66	114°
CD	85	205°
DE	56	257°
EA	88	297°

Table 2.2

a). Calculate the Latitude and Departure of each line and hence find the total linear error of the traverse. (8 Marks)

b). Distribute the linear error, assuming the linear error is in permissible range. (4 Marks)

Q3). i). Explain the importance of carried out Reconnaissance Survey before starting chain surveying. (3 Marks)

ii). List down five systematic errors that can be found in chain surveying. (3 Marks)

iii). Explain how to obtain 90° in taking perpendicular offsets in chain surveying. (2 Marks)

iv). What do you understand by slope correction of the chain line. Derive the formula to calculate the slope correction, C in the terms of measured length, l and height difference, h. (5 Marks)

v) . AB is a chain line crossing a lake. A and B are on the opposite sides of the lake. A line AC, 800 m long is ranged to the left of AB clear of the lake. Similarly another line AD, 1000 m long is ranged to the right of AB such that the points C, B and D are collinear. (Figure Q3). The length BC and BD are 400 m and 600 m respectively. If the chainage at A is 1262.44 m, calculate the chainage of B. (7 Marks)

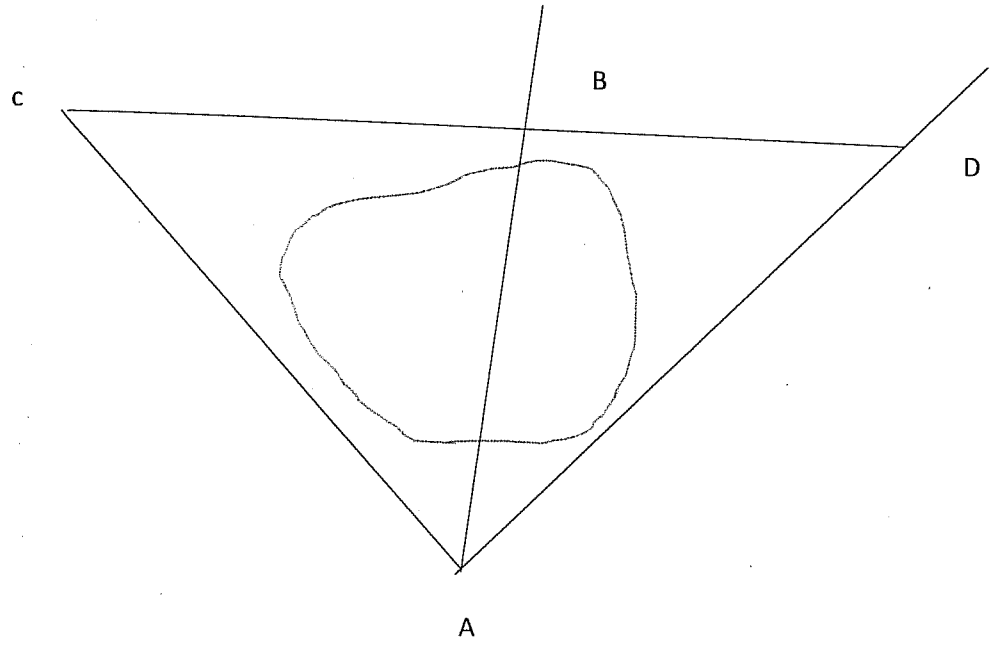

Figure 3

Q4. i). "Counting square method can be used to find area of the plane specially with irregular boundaries"

a). Briefly explain the method using suitable example. (2 Marks)

b). Discuss the drawbacks of the method and state how these drawbacks can be minimized. (3 Marks)

c). Name the mechanical instrument can be used to find the area of plot with irregular boundaries. (1 Mark)

ii). The following perpendicular offsets were taken from a chain line to a wire fence.

Chainage (m)	0	20	40	60	80	95	110	140	170
Offsets (m)	6.7	5.8	10.3	12.8	9.7	8.8	6.9	8.2	6.5

Calculate the area between chain line, the fence, and offsets by using a suitable method. (6 Marks)

iii). A straight level road is to be constructed on a plane hillside with a lateral slope uniformly 1 vertically to 9 horizontally and the side slopes being likewise 1:1 and 1:2 in cut and fill respectively and the formulation width is 10 m as illustrated in Figure Q4. Find the unknown value b if area of cut and fill are same. (8 Marks)

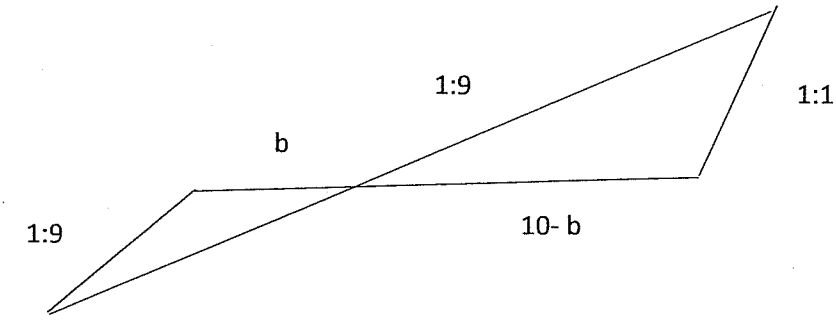

Figure Q4

Q5. i). Explain a method that can be used to find the volume of sand pile with stating the assumptions. How you can increase the accuracy of your results. (5 Marks)

ii). In a proposed hydroelectric project a storage reservoir was required to provide a storage of 4.5 million cubic meters between Lowest Draw Down (L.D.D) and Top Water Level (T.W.L). The areas contained within the stated contours and upstream face of the dam are as follows.

Contour (m)	100	95	90	85	80	75	70	65
Area (Hectares)	30	25	23	17	15	13	7	2

Take 1 Hectare = 10000 m^2

Table 5

a). Find the total volume of the water in reservoir if L.D.D is 65 m and T.W.L is 100 m using end area method and primordial formula. (10 Marks)

b). When L.D.D is changed to 68 m calculate the T.W.L if reservoir is supplied to minimum requirement of the project. (based on end area method) (5 Marks)

The prismoidal formula

$$V = (x/3).[A_0 + 4A_1 + 2A_2 + 4A_3 + 2A_4 + ... + 2A_{n-2} + 4A_{n-1} + A_n]$$

Q6. i). Contour maps are very important in different engineering applications.

a). Define the term "contour map" (2 Marks)

b). Briefly describe three characteristics of contours with appropriate sketches.

(3 Marks)

c). Briefly explain the three uses of contours. (2 Marks)

ii). A tacheometer was set up at an intermediate station C on the line AB and following readings were obtained. Take K = 100 (7 Marks)

Find the gradient of line joining station A and station B.

Staff Station	WCB	Vertical Angle	Stadia Readings (m)
A	$6^0\,20'$	$+\,11^0\,30'$	0.445/ 1.675 / 2.905
B	$138^0 00'$	$-\,17^0\,00'$	0.950/ 1.880 / 2.810

Take $H = K S \cos^2\theta$ $V = (1/2) KS \sin 2\theta$

iii). Vertical angles to the two points fixed at 1 m and 3 m above the foot of staff held vertically at station A were $3^0\,10'$ and $5^0\,24$ respectively. (Figure Q6). Find the horizontal distance between instrument and point A. Also find reduced levels of A if the height of the instrument axis is 138.556 m above datum. ' (6 Marks)

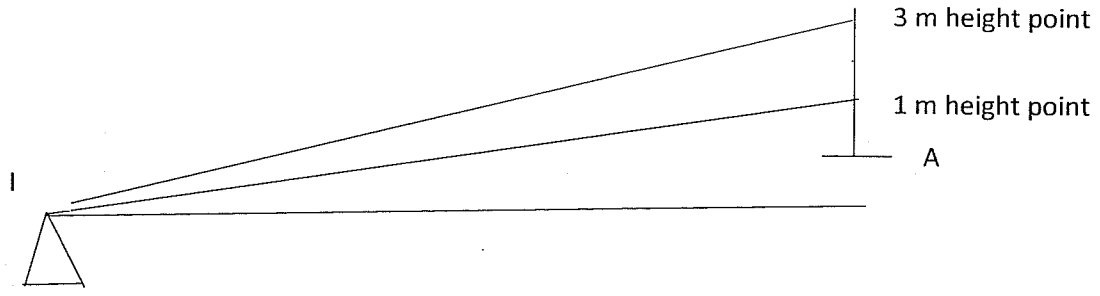

Figure Q6

Q7). i). Explain the advantage of using EDM to measure the distances. And what are the disadvantages of using EDM. (4 Marks)

ii). Explain with appropriate example, the purpose of using check lines in chain surveying (4 Marks)

iii). List five different errors found in levelling. Categorize them according to the main types. Clearly explain the reasons for your categorization. (7 Marks)

iv). Explain what is meant by setting out the building. Explain how the surveying knowledge and practice can be used to increase the accuracy of the setting out. (5 Marks)