The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX5241 Hydraulic Engineering II**
Academic Year	: 2020/2021
Date	: 21st January 2022
Time	: 1400-1700 hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Three (3)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand written.
8. Do not use Red colour pen.

Q1. A 3 m wide rectangular channel with a smooth horizontal bed carrying water passes over smooth upward step of height 0.25 m.

(i) If Froude numbers of the flow upstream of the channel and over the step are 0.40 and 0.60, respectively, compute; (8 marks)
(a) the flow rate in the channel
(b) water depths of the flow upstream of the channel and on the step

(ii) If the channel width at the section where the step is introduced is smoothly expanded to 4 m, compute the new water depth on the step. (6 marks)

(iii) Represent the conditions in i) and ii) above on an E-y diagram. (6 marks)

Q2. (i) For a hydraulic jump occurring in a wide rectangular open channel, with usual notation show that, (10 marks)

$$\frac{y_2}{y_1} = \frac{1}{2}\left[\sqrt{1 + 8Fr_1^2} - 1\right]$$

(ii) A hydraulic jump occurs in a wide, smooth, horizontal channel carrying water and the flow velocity upstream of the jump is 10 m/s. If the sequent depth of the jump is 2.0 m, compute (10 marks)

(a) the water depth upstream of the jump and unit discharge in the channel
(b) percentage of energy decapitation.

Q3. A 3 m wide rectangular open channel carrying water has a bed slope of 0.009, Manning's coefficient of 0.012 and uniform depth of 0.75 m. The Froude numbers at two locations P and Q along the channel are 1.2 and 1.6, respectively.

(i) Sketch and name the water surface profile between sections P and Q and indicate which is the upstream section (8 marks)
(ii) Compute the distance between two sections using direct step method with a single step (6 marks)
(iii) If a sluice gate is placed in the channel between P and Q stations with a gate opening size which is less than the uniform flow depth, sketch a possible water surface profile in the channel upstream and downstream of the gate (6 marks)

Q4. (i) Briefly explain the advantages and disadvantages of sediment transport in channels (6 marks)

(ii) A Farmer organization plans to construct an irrigation channel on a slope of 1:1000 through an area consisting of fine gravel (d = 7 mm) and $\rho s/\rho = 2.65$. Find the minimum width for the channel if it needs to carry 20 m^3/s of clear water. Maximum allowable shear stress (T_{ocr}) for no erosion over find gravel was found to be 7.8 Pa. State any assumptions made. (14 marks)

Note: Manning's roughness coefficient (n) = $0.039.d^{1/6}$, where d is the grain diameter

Q5. (i) Briefly explain the difference between a confined aquifer and an unconfined aquifer with an aid of a neat sketch (6 marks)

(ii) Briefly explain what groundwater exploration is and discuss two surface investigation methods (6 marks)

(iii)An unconfined aquifer with a specific yield of 0.15 and horizontal area of 20 m^2 was used for extracting water for industrial project. If 2 m reduction of water table was observed due to extraction of groundwater. Estimate the extracted volume of water from the aquifer. (8 marks)

Q6. (i) Show that pumping discharge of a well using the drawdown of two observation wells shown in Figure 01 can be expressed as; (12 marks)

$$Q = \pi K \frac{h_2^2 - h_1^2}{\ln(r_2/r_1)}$$

(ii) The drawdown in two observation wells (Figure 01) 30 m (r_1) and 80 m (r_2) from the pumping well were found to be 4 m (s_1) and 3 m (s_2), respectively. Hydraulic conductivity of the aquifer is 26 m/day. If the depth of the aquifer (h_0) is known to be 50 m, determine the discharge rate. (8 marks)

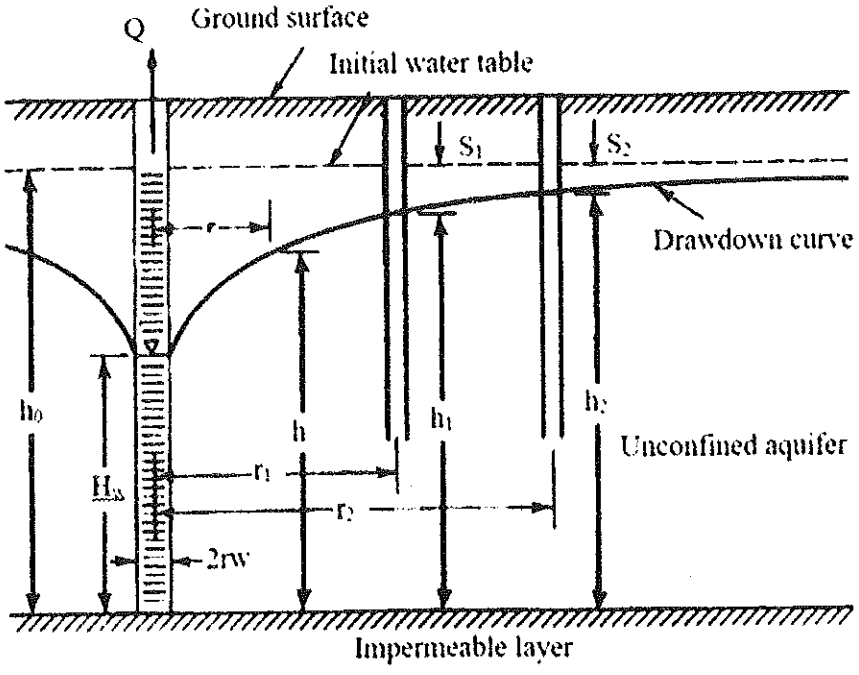

Figure 01

Q7. (i) Briefly explain how water springs occur with the aid of a neat sketch. (5 marks)

(ii) A pump test was carried out to investigate the permeability of a 30 m thick confined aquifer. Water was pumped out from a 1 m diameter well with a steady discharge of 200 m^3/hr. The initial piezometric level was at 40 m above the datum and the drawdown was observed as 6 m. The drawdown of an observation well 50 m away from the pumping well was 0.5 m.

(a) Derive the relationship between the permeability, pumping rate and drawdowns of pumping well and observation well in a confined aquifer, in usual notations. (7 marks)

(b) Estimate the permeability and the transmissivity of the aquifer. (4 marks)

(c) Compute the radius of influence of the pumping well. (4 marks)