TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

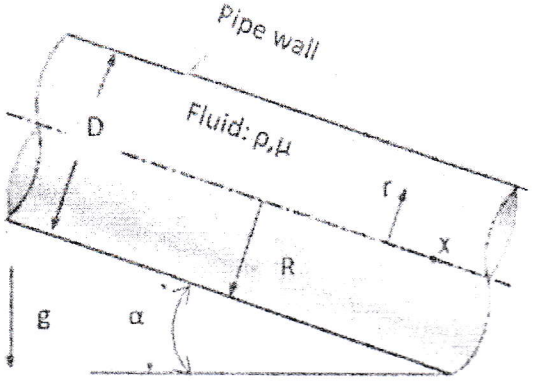
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BAG	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Hydraulics *(CE555)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Calculate first hydraulic exponent for critical flow and second hydraulic exponent for uniform flow for wide rectangular channel and triangular channel. [4]

   b) Consider steady, incompressible, laminar flow of a Newtonian fluid in an infinitely long round pipe of diameter D or radius r = D/2 inclined at angle α as shown in the figure. The fluid flows down the pipe due to gravity alone. Consider the coordinate system shown, with X down the axis of pipe. Derive an expression for the X-component of velocity u as a function of radius and the other parameters of the problem. [6]



   c) Kerosene (density = 800 Kg/m^3) flows in a 20cm diameter pipe with a mean velocity of 5 m/s. The pipe has an equivalent sandgrain roughness of 0.5 mm. If the friction factor f =0.02. Is the pipe behaving as rough, smooth or in transition? [4]

2. a) Describe the manning's equation and the various terms that make it up. In particular define the slope S, used in the manning's equation and show how it relates to the energy diagram. Explain also why the uniform flow assumption is usually made for most application of the manning's equation. [1+1+1+1+1]

   b) What are the primary and secondary purpose of surge tank? Two reservoirs with constant difference of 10 m in their water surface elevation are connected by a 15 cm diameter pipe length 400 m and f = 0.025. The minor losses in the pipe can be taken as 15 times the velocity head in the pipe. If a valve controlling the flow is suddenly opened, a) estimate the time for 95 % of ultimate flow to be established and b) find the flow at the end of 10 s from the start of valve operation. [2+6]

3. a) A rectangular channel is 20 m wide carries a discharge of 65m^3/s. It is laid at a slope of 0.0001. At a certain section along the channel length the flow depth is 2m. What is the type of surface profile? How far upstream or downstream will the depth be 2.6m? Use direct integration (Bresse's) method considering increment of depth = 0.3m. Take energy correction factor equals to 1.1 and manning's roughness coefficient n= 0.025. [3+6]

b) Plot the open channel cross-section from the following table given below and calculate the following geometric properties: area, conveyance factor, equivalent hydraulic radius, hydraulic depth and section factor for uniform flow. Take manning's n=0.02.

[1+1+1+1+1+1]

Distance from left Bank (m)	Water depth (m)
0.0	0.0
1.0	3.0
3.0	3.0
5.0	5.0
7.0	3.0
10.0	0.0

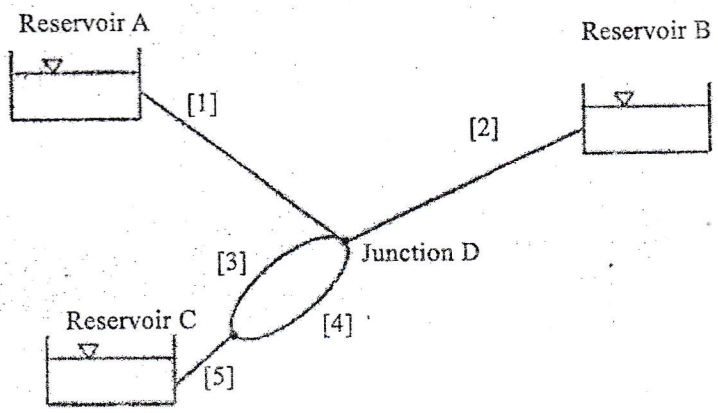
4. a) Three reservoirs are connected as shown below, with the connecting pipes having the following properties (length, diameter, friction factor and minor losses) as shown below:

$L_1 = 280$ m, $D_1 = 500$mm, $f_1 = 0.021$, and $\Sigma K_1 = 3.5$
$L_2 = 980$ m, $D_2 = 300$mm, $f_2 = 0.022$, and $\Sigma K_2 = 0.0$
$L_3 = 270$ m, $D_3 = 550$mm, $f_3 = 0.017$, and $\Sigma K_3 = 0.0$
$L_4 = 700$ m, $D_4 = 650$ mm, $f_4 = 0.028$, and $\Sigma K_4 = 3.5$
$L_5 = 780$ m, $D_5 = 750$mm, $f_5 = 0.030$, and $\Sigma K_5 = 1.5$

The corresponding reservoir elevation are:
$Z_A = 185$ m, $Z_B = 105$ m and $Z_C = 70$ m

Calculate:

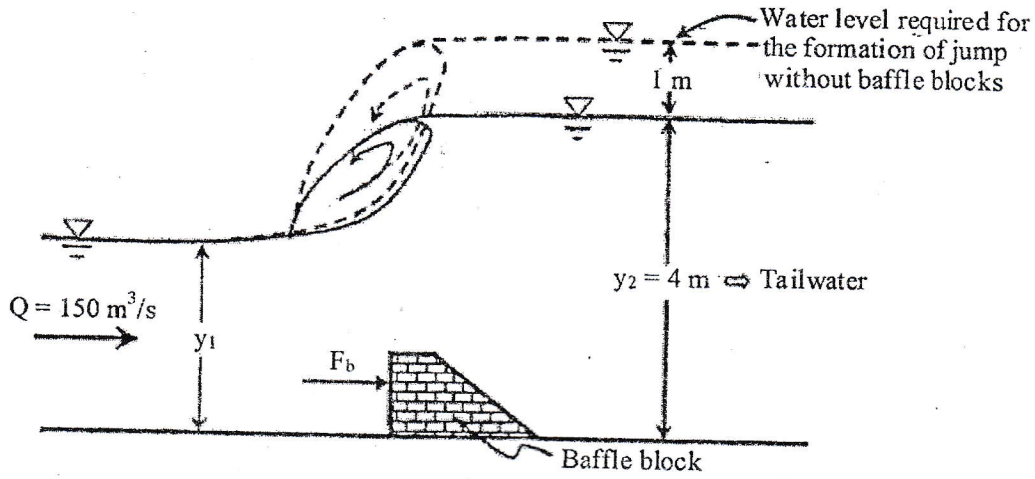
(i) The relationship between the flow rates in the two parallel pipes that form part of the system.
(ii) The value of the Hydraulics Grade Line (HGL) at junction D, and
(iii) The flow rates in all five pipes for this value. [2+2+4]



b) A rectangular channel section to have critical flow and at the same the wetted perimeter is to be minimum. Show that for the these two conditions to occur simultaneously, the width of the channel must be equal to 8/9 times minimum specific energy. [4]

5. a) A hydraulic jump is to be formed in a rectangular channel of 10 m wide. The discharge is 150 m^3/s the tail water depth in the channel is 4 m, which is 1 m less than the depth required for the formation of the jump without any baffle blocks. Therefore, baffle blocks should be placed for the formation of the jump. The force on the baffle blocks can be estimated as $F_b = 2\Upsilon A E_1$, where A is the frontal area of the baffle blocks, E_1 is the specific energy of the supercritical flow and Υ is the specific weight of the water.

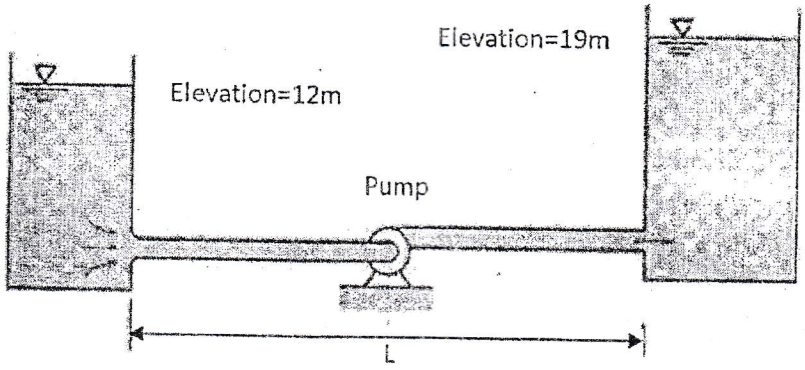
(i) Find the total frontal area of the baffle blocks and energy loss during jump.
(ii) Show on the specific force curve the initial and the sequent depths of the jump without baffle blocks.
(ii) Show in the same specific force curve the initial and the sequent depths of the jump with the baffle blocks and the force on the baffle blocks.
(iv) If height of baffle block is increased by 10%, what will be the percentage increase or decrease of energy loss? [4+1+1+2]



b) Explain briefly, by sketching the graph between specific energy and water depth of a horizontal rectangular channel, how the depth upstream changes with the height of hump as it is gradually increased in three stages: i) less than the critical hump height; (ii) at the critical hump height, and (iii) exceeding the critical hump height. [6]

6. a) If a flow of 0.25 m^3/s of water is to be maintained in the system shown below, the power required by the pump to maintain the water levels is 54642 watts. The pipe is made of iron (e= 0.26 mm) and is 250 mm in diameter. Take μ = 0.0021 N s/m^2. Take all losses and Use Colebrook- white equation, if needed.

(i) Find the length of the pipe.
(ii) For the same power if the loss of head is doubled, find the discharge. Write your comment on the result. [3+3]



b) Using the tractive force method, design a trapezoidal channel (side slop 4H:2V) to carry 20 m^3/s through a slightly sinuous channel on a slope of 0.0015. The channel is to be excavated in a coarse alluvium with 75 percentile diameter, D_{75}= 2cm with the particles on the perimeter of channel moderately rounded. Use manning's n = 0.025. Check if the flow is subcritical under the uniform flow condition as a supercritical flow is not desired in an excavated channel. Take ϕ =40°. [6]

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