TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

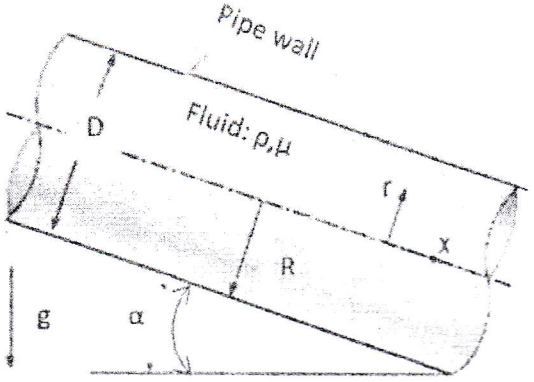
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BAG	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

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]



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   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

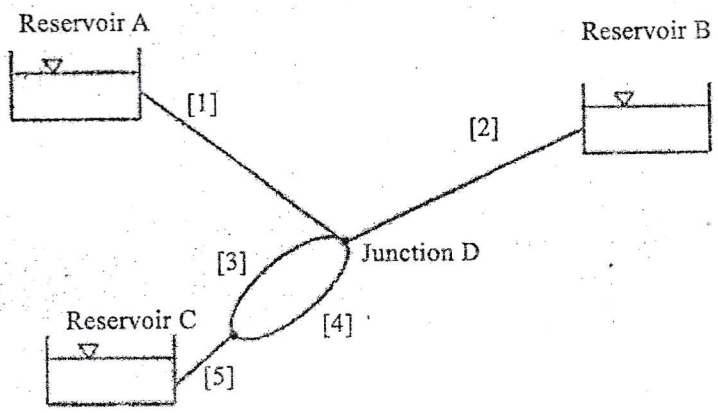
4. a) Three reservoirs are connected as shown below, with the connecting pipes having the following properties (length, diameter, friction factor and minor losses) as shown below:

$L_1 = 280$ 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:

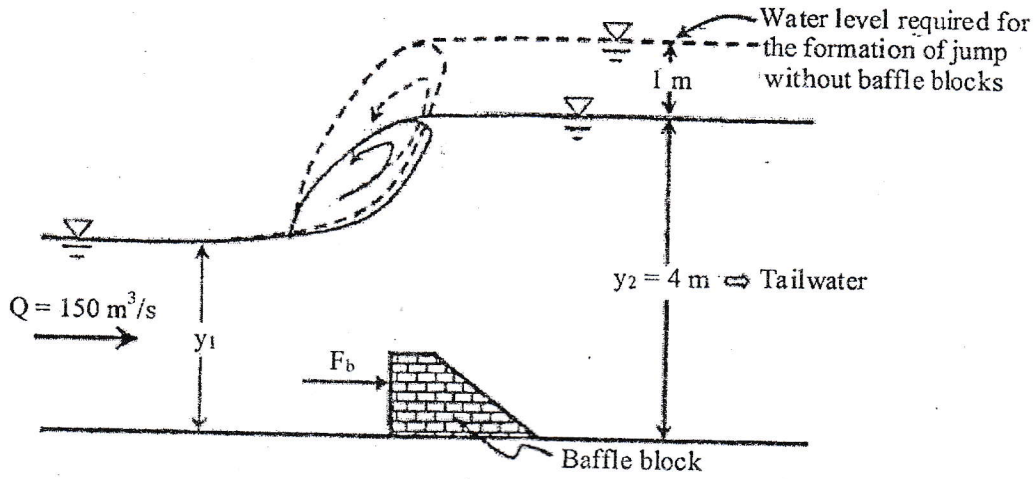
(i) The relationship between the flow rates in the two parallel pipes that form part of the system.
(ii) The value of the Hydraulics Grade Line (HGL) at junction D, and
(iii) The flow rates in all five pipes for this value. [2+2+4]



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.

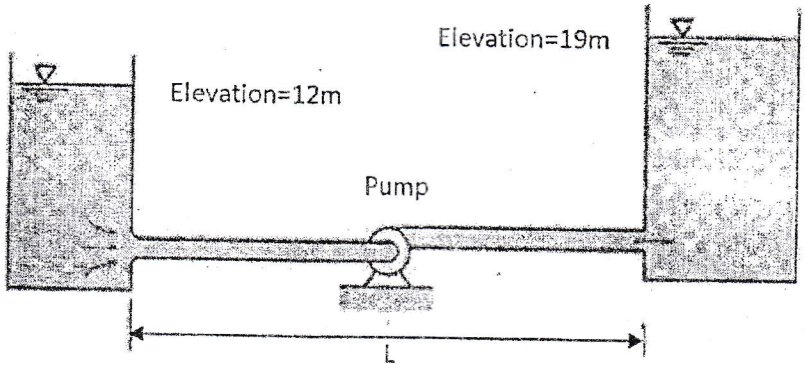
(i) Find the total frontal area of the baffle blocks and energy loss during jump.
(ii) Show on the specific force curve the initial and the sequent depths of the jump without baffle blocks.
(ii) Show in the same specific force curve the initial and the sequent depths of the jump with the baffle blocks 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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Year / Part	II / II	Time	3 hrs.

Subject: - Hydraulics *(CE 555)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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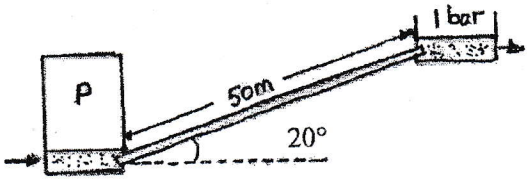
1. a) For the figure below, calculate:

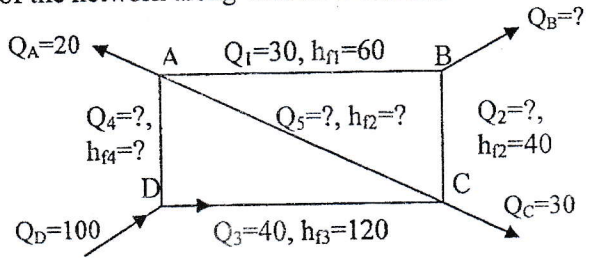
   What is the pressure needed to drive a viscous fluid upslope through a 12cm diameter pipe? The length of the pipe is 50m, slope is 20 deg. At the end of the pipe, the pressure is 1 bar. Oil of specific gravity 0.85 and viscosity 0.01 kg/m-s, and the target flow rate is 0.25 cubic meter per minute.

   (i) What is the pressure needed to drive the flow if there were no slope?
   (ii) The supplier is out of 12cm pipes and your manager wonders if multiple 8cm diameter pipes can be used side by side to achieve the same total flow rate at the same driving pressure, determine how many 8cm pipes are needed. Round up to nearest integer. [2+3+3]



   b) Describe Moody's Chart. What are the basis to draw such a diagram? State its uses. [2+4+2]

2. a) Figure below shows a network in which Q and h_r refer to discharges and pressure drops respectively. Subscripts 1, 2, 3, 4 and 5 designate respective values in pipe length AB, BC, CD, DA and AC. Subscripts A, B, C and D designate discharges entering or leaving the junction points A, B, C, and D respectively. By sticking to the values given in the figure find the following discharges Q_B, Q_2, Q_4 and Q_5 and the pressure drops h_{f4} and h_{f5} and give these computed values at their respective places on a neat sketches of the network along with flow directions. [4+4]



   b) A steel pipe 1.20m in diameter conveys 1.40m^3/s of water under a head of 300m. A value at the downstream end can be expected to close suddenly. Estimate the water hammer pressure due to this closure. Also determine the minimum thickness of the wall to the nearest millimetre needed to withstand the pressures involved. For steel: E=210kN/mm^2, and safe working stress = 0.1 kN/mm^2. For water: K=2.10kN/mm^2. [4+4]

3. a) Compare gradually varied flow, rapidly varied flow and spatially varied flow with sketches. [4]

   b) A 50m wide rectangular channel is carrying a flow of $250m^3/s$ at a flow depth of 5m. To produce critical flow in this channel, determine:

   (i) The height of the step in the channel bottom if the width remains constant.
   (ii) The reduction in the channel width if the channel-bottom level remains unchanged.
   (iii) A combination of the width reduction and the bottom step. [2+2+4]

   c) Develop the expression for specific force and explain the concept of conjugate depths using the specific force curve. [4]

4. a) Derive the equation of shear stress on the boundary of the open channel. Water flows in a channel whose bottom slope is 0.002 and whose cross section is as shown in figure below. The dimensions and the Manning' coefficients for the surfaces of different subsections are also given on the figure. Determine the flow rate through the channel and the effective Manning coefficient for the channel. [4+4]

   b) A hydraulic jump occurs in a 90° triangular channel. Derive an equation relating to two depth and the flow rate. If the depths before and after the jump in the above channel are 0.5m and 1.0m determine the flow rate and obtain Froude numbers before and after the jump. [6+2]

5. a) What is M1 Profile? A rectangular canal is 10m wide and carries a flow of $50m^3/s$. The bottom and sides of the canal are concrete-lined, the longitudinal bottom slope is 0.0006 and the canal ends in a free outfall. If the flow depth is critical at a distance of $4y_c$ upstream of the fall, what is the depth of flow 2km upstream of the fall? Use either direct integration method (Bresse's method) taking three steps or Standard step method. [2+8]

   b) Define mobile boundary and rigid boundary. What do you mean by incipient motion condition? Derive an expression for the shear stress reduction factor or tractive force ratio in the case of mobile boundary channel in terms of side slope angle and angle of repose of the sediment. [1+2+3]

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Examination Control Division
2076 Baisakh

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

Subject: - Hydraulics *(CE 555)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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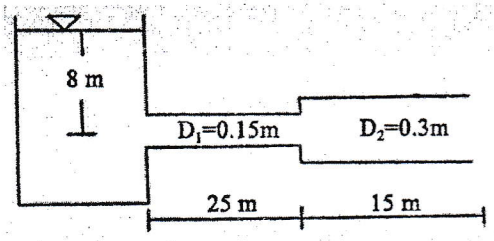
- ✓ *Assume suitable data if necessary.*

1. a) A straight smooth pipe 100mm diameter and 60m long is inclined at 10^{o} to the horizontal. A liquid of relative density 0.9 and kinematic viscosity 120 $mm^2.s^{-1}$ is to be pumped through it into a reservoir at the upper end where the gauge pressure is 120 kPa. The pipe friction factor f is given by 64/Re for laminar flow and by 0.32 $(Re)^{-1/4}$ for turbulent flow when $Re < 10^5$. Determine (a) the maximum pressure at the lower, inlet, end of the pipe if the mean shear stress at the pipe wall is not to exceed 200 Pa; (b) the corresponding rate flow. [8]

   b) Draw the hydraulic gradient line (HGL) and total energy line (TEL) for the following with considering all losses of head. The pipe laid horizontal and discharge freely into the atmosphere. Take coefficient of friction(f)=0.01 [8]



2. a) A reservoir A feeds two lower reservoirs B and C through a single pipe 10 km long, 750 mm diameter, having a downward slope of $2.2x10^{-3}$. This pipe then divides into two branch pipes, one 5.5 km long laid with a downward slope of $2.75x10^{-3}$ (going to B), the other 3 km long having a downward slope of $3.2x10^{-3}$ (going to C). Calculate the necessary diameter of the branch pipes so that the steady flow rate in each shall be 0.24 $m^3.s^{-1}$ when the level in each reservoir is 3m above the end of the corresponding pipe. Neglect all losses except pipe friction and take f=0.024 throughout. [8]

   b) A pump draws water from a reservoir and delivers it at a steady rate of 115 L/s to a tank in which for free surface level is 12m higher than that in the reservoir. The pipe system consists of 30m of 225mm diameter pipe (f=0.028) and 100m of 150mm diameter pipe (f=0.032) arranged in series. Determine the flow rate 2s after a failure of the power supply to the pump, assuming that the pump stops instantaneously. Neglect minor losses in the pipes and in the pump, and assume an incompressible fluid in rigid pipes with f independent of Reynolds number. [8]

3. a) In a rectangular channel, F_1 and F_2 are the Froude's number corresponding to the alternate depths at a certain discharge. Show that: $\left(\frac{F_2}{F_1}\right)^{\frac{2}{3}} = \frac{2+F_2^2}{2+F_1^2}$ [4]

b) Define the terms energy slope, prismatic channel, non-prismatic channel and spatially varied flow. [4]

c) The flow depth and the flow velocity upstream of a 0.2-m sudden step rise in the bottom of a 5-m wide rectangular channel are 5m and 4 m/s respectively. Assuming there are no losses in the transition, determine:

i) The flow depth downstream of the step and the change in the water level;

ii) The flow depth and the water level downstream of the step if the channel bottom has a 0.2-m drop instead of the rise, as in (i). [4+4]

4. a) A sluice across a rectangular prismatic channel 6m wide discharges a stream 1.2m deep. What is the flow rate when the upstream depth is 6m? The conditions downstream cause a hydraulic jump to occur at a place where concrete blocks have been placed on the bed. What is the force on the blocks if the depth after the jump is 3.1m? [8]

b) Write an algorithm, flow chart and computer program in any high level language to determine normal depth in a trapezoidal channel. [8]

5. a) A dam is built across a channel of rectangular cross section which carries water at the rates of 8.75 m^3/s. As a result the depth just upstream of the dam is increased to 2.5m. The channel is 5m wide and the slope of the bed is 1 in 5000. The channel is lined with concrete (Manning's n=0.015). How far upstream is the depth within 100mm of the normal depth? [8]

b) A channel which is to carry 15 cumecs through moderately rolling topography on a slope of 0.0015 is to be excavated in coarse alluvium with 50% of particles being 5cm or more in diameter. Assume that channel is to be unlined and of trapezoidal section. Find suitable value of base width and side slope. Take internal frictional angle as 34° and ratio between bed shear stress and critical shear stress as 0.7. Use tractive force method. Also explain about river bed formation in alluvial stream. [5+3]

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01 TRIBHUVAN UNIVERSITY
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Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	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.*
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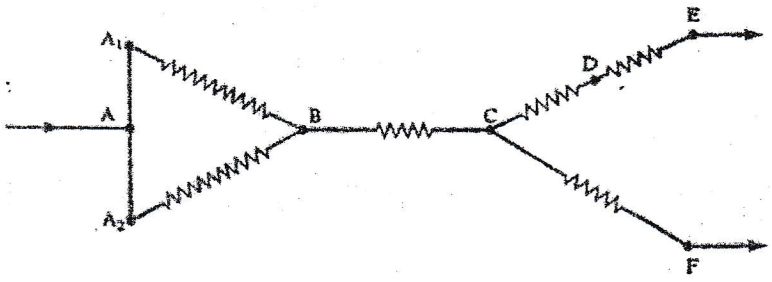
1. A system of pipes conveying water is connected in parallel and in series as shown in figure below. The section DE represents the resistance of a valve for controlling the flow, which has a resistance coefficient $K_{DE} = \left(\frac{4000}{n}\right)^2$, where n is the percentage valve opening.



The friction factor f in the Darcy formula is 0.024 for all pipes, and their lengths and diameters are given by

Pipe	Length (m)	Diameter (m)
AA_1B	30	0.1
AA_2B	30	0.125
BC	60	0.15
CD	15	0.1
CF	30	0.1

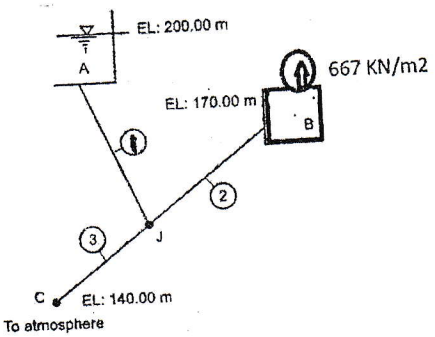
The head at A is 100m, at E is 40 m and at F is 60m. If the valve is adjusted to give equal discharge rates at E and F, calculate the head at C, the discharge through the system and percentage valve opening. Neglect all losses except those due to friction. [10]

2. A cast iron pipe of 300 mm diameter and 8 mm thick is 1500 m long. The pipe is to convey 200 litres per sec of water.
   a) Estimate the maximum time of closure of a valve at the downstream end that would be recognized as rapid closure?
   b) What is the peak water hammer pressure produced by rapid closure?
   c) What is the length of the pipe subjected to peak water hammer pressure if the time of closure is 2.0 sec? (For water E = 2200 MPa; for cast iron $E = 80 \times 10^9 Pa$) [2.5+2.5+3]

P.T.O.

3. For the reservoir system shown in figure, determine the flow in each pipe. At C, the pipe discharges into the atmosphere at a elevation of 140.00 m and at Tank B, the top is closed with pressure of 667 KN/m^2 of Hg. Take f =0.02 for all pipes and use following data: [8]

Pipe	Diameter	Length
1	15 cm	800 m
2	20 cm	500 m
3	30 cm	600 m



4. Pipes of 75 mm are to be used to syphon water from a main canal to branch canal, the difference of water level between the two canals being 15m. The length from the main canal to the summit of the pipe line is 20m. The total length of the pipe being 50m.

   a) Determine the number of pipes required to discharge at least 50 l/sec of water to the branch canal.

   b) Find also the maximum height of the summit above the water level of the main canal in order the pressure at the summit may not fall below 25 KPa (absolute). Take f = 0.03 and ignore minor loss. [4+4]

5. Explain variation of hydraulic radius with respect to depth in a very deep rectangular channel with suitable illustration. [6]

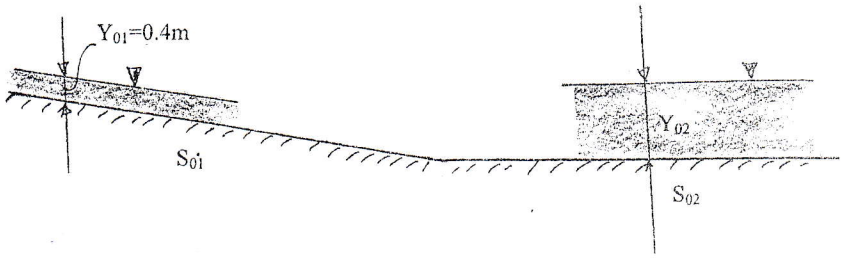
6. A 3m wide rectangular channel carries a discharge of 15m^3/s at a depth of 2 m. What will be the minimum height of hump at which the depth over the hump will be critical? Calculate the height of hump for which upstream water depth will be 2.5 m. What will be the depth of flow on the upstream and on the hump when its height is 0.2 m? [8]

7. A 3.6 m wide rectangular channel had badly damaged surfaces and had a Manning's n = 0.030. As a first phase of repair, its bed was lined with concrete with n = 0.015. If the depth of flow remains the same at 1.2 m before and after the repair, what is the increase of discharge obtained as result of repair. [7]

8. A rectangular channel section has a change in slope as shown in figure below. The channel is 4m wide having Manning's n = 0.0165. The bed slope So_2 = 0.0024 and the flowing discharge is 16 m^3/sec.

   a) Calculate the depth that must exist in the downstream channel for a hydraulic jump to terminate at uniform flow condition.

b) If upstream depth Y_{01} = 0.4m, calculate the length of hydraulic jump using at least three increments of depth in a step calculation. [5+5]



9. Draw a hydraulic jump profile and indicate conjugate depths and energy loss using specific energy and specific force diagram. Hence derive momentum equation for the hydraulic jump in rectangular channel. [8]

10. Distinguish between Rigid boundary and Mobile boundary channels with respect to design principle. Explain the procedures of designing rigid boundary channel by minimum permissible velocity approach. [3+4]

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2075 Bhadra

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Subject: - Hydraulics *(CE555)*

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- ✓ ***Necessary figures are attached herewith.***
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1. a) One meter diameter pipe is to carry a water discharge of 1.0 m^3/s at the minimum loss of energy. What will be the permissible height of surface roughness? [8]

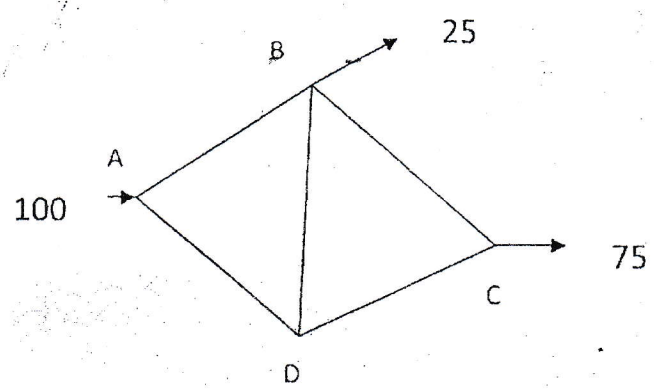
   b) Derive an expression for ratio of length of inlet to outlet leg for typical siphon as follows: [8]

$$\frac{l_1}{l_2} \leq \frac{P_a - (Z_B - Z_A)}{(Z_B - Z_C) - P_a}$$

   Where P_a is atmospheric pressure, Z_A, Z_B, Z_C are elevation of inlet, summit and outlet of syphon.

2. a) A pump draws water from a reservoir and delivers it through a pipe 150 mm diameter, 90 m long, to a tank in which the free surface level is 8 m higher than that in the reservoir. The flow rate is steady at 0.05 m^3/s until a power failure causes the pump to stop. Neglecting minor losses in the pipe and in the pump and assuming that the pump stops instantaneously, determine for how long flow into bank continues after the power failure. The friction factor f may be taken as constant at 0.028 and elastic effects in the water or pipe material may be disregarded. [8]

   b) Using Hardy-cross method, find the rate of flow in every pipe lines as given below. The constant factor for AB, BC, CD, DA and BD are 1,2,1,2 and 3 respectively. [8]



3. a) A 900 mm diameter conduit 3600 m long is laid at a uniform slope of 1 in 1500 and connects two reservoirs. When the levels in the reservoirs are low, the conduit runs partly full and it is found that a normal depth of 600 mm gives a rate of flow of 0.322 m^3/s. The Chezy coefficient C is given by KR^n where K is a constant, R is the hydraulic radius and n = 1/6.

Neglecting losses of head at entry and exit, obtain (i) the value of K, (ii) the discharge when the conduit is flowing full and the difference in level between the two reservoirs is 4.5 m. [8]

b) A 3.5 m wide rectangular channel section carries 4 m^3/s of water at a depth of 1 m. If the width is to be reduced to 2.5 m and bed raised by 10 cm, what would be the depth of flow in the contracted section? What maximum rise in the bed level of the contracted section is possible without affecting the depth of flow upstream of the transition? [8]

4. a) A hydraulic jump is formed in a 4 m wide outlet just downstream of the control gate, which is located at the upstream end of the outlet. The flow depth upstream of the gate is 20 m. If the outlet discharge is 100 m^3/s, determine: [8]

i) Flow depth downstream of the jump
ii) Trust on the gate; and
iii) Energy losses in the jump

Assume the losses through the gate is 5% of velocity head of flow gate.

b) Derive the expression for most economical rectangular section. [3]

c) A trapezoidal channel has side slope 1:2 (H:V) and the slope of the bed is 1 in 1500. The area of the section is 40 m^2. Find the dimensions if it is most economical. Determine the discharge of the most economical section if Chezy's constant (C) = 50. [5]

5. a) Sketch the water-surface profile in along rectangular channel (n=0.014), f the channel is 3 m wide; the flow rate is 9.6 m^3/s; and there is an abrupt change in slope from 0.0016 to 0.0150. [8]

b) What do you mean by incipient motion condition? Derive an expression for the shear stress reduction factor or tractive force ratio in the case of mobile boundary channel in terms of side slope angle and angle of repose of the sediment. [2+6]

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(98)

01 TRIBHUVAN UNIVERSITY
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Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
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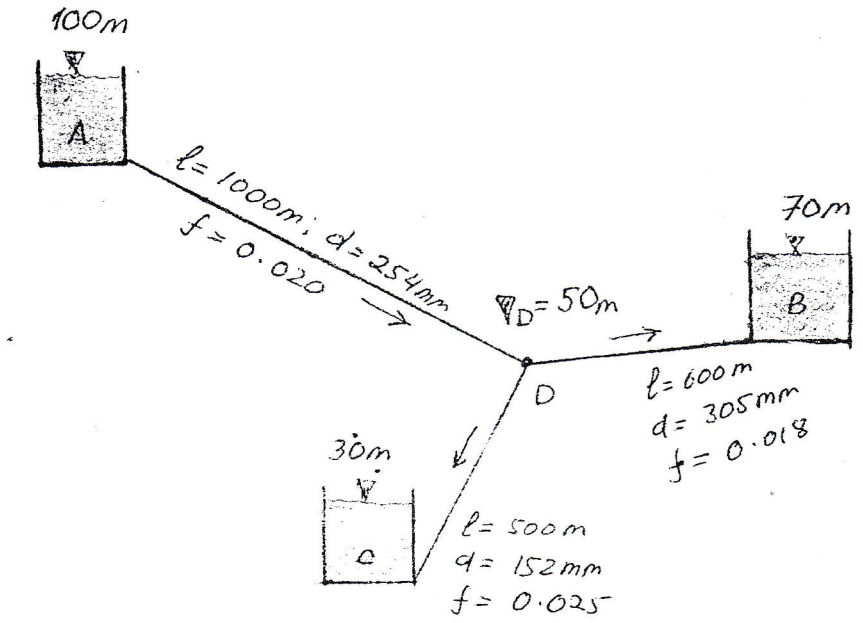
- ✓ *Assume suitable data if necessary.*

1. Determine the discharge rate in each pipeline for the following three-reservoir problems. [10]



2. In a pipe of length 500 m and uniform circular cross-section, water flows at a steady velocity of 2 m/s and discharges to atmosphere through a valve. Under steady conditions the static head just before the valve is 300 m. Calculate the ratio of internal diameter to wall thickness of the pipe so that, when the valve is completely and instantaneously closed, the increase in circumferential stress is limited to 20 MPa, and determine the maximum time for which the closure could be described as rapid. The bulk modulus of water = 2 GPa, and the elastic modulus of the pipe material = 200 GPa. [8

3. Petrol of kinematic viscosity 0.6 mm^2/s is to be pumped at the rate of 0.8 m^3/s through a horizontal pipe 500 mm diameter. However, to reduce pumping costs a pipe of different diameter is suggested. Assuming that the absolute roughness of the walls would be the same for a pipe of slightly different diameter, and that, for $Re > 10^6$, f is approximately proportional to the cube root of the roughness, determine the diameter of pipe for which the pumping costs would be halved. Neglect all head losses other than pipe friction. How are the running costs altered if n pipes of equal diameter are used in parallel to give the same total flow rate at the same Reynolds number as for a single pipe? [8

4. Difference in level between two reservoir is 100 m and distance between them is 10 km. The reservoir is connected by a single pipe to carry 200 lps. Calculate the diameter of the pipe and length of second pipe, which is connected to increase the rate of flow by 5×10^6 lit/day with same diameter pipe. Take friction factor for all pipes 0.03. [8]

5. Define gradually varied, rapidly varied and spatially varied of flow with examples. [2×3]

6. A 3.5 m wide rectangular channel carries a discharge of 10 m^3/s at a depth of 1.75m. If the width of the channel is reduced to 2.25 m and bed level is lowered by 0.97 m, determine the difference in water level elevation between upstream and contracted section. Assume no energy loss. [8]

7. A circular culvert has a capacity of 0.5 m^3/s when flowing full. Velocity should not be less than 0.7 m/s if the depth is one-fourth the diameter. Assuming uniform flow, determine diameter and slope taking manning's n = 0.012. [7]

8. A rectangular channel carrying a discharge of 40 m^3/sec a 16m wide having slope 1/5000 and Manning's coefficient n = 0.024. The depth of flow in a particular section is 1.5 m. Find how far upstream of downstream of this section the flow depth is 2.5m. Determine the type of flow profile and using direct step method calculate the length of profile taking 3 steps for calculation. [10]

9. Define specific force. Derive momentum equation for rectangular channel section. Draw a hydraulic jump profile and indicate conjugate depths using the specific force diagram. [8]

10. Write down the design procedures of mobile boundary channel using maximum permissible velocity method with appropriate expressions. Also describe Shield's approach of predicting critical tractive force. [4+3]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

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

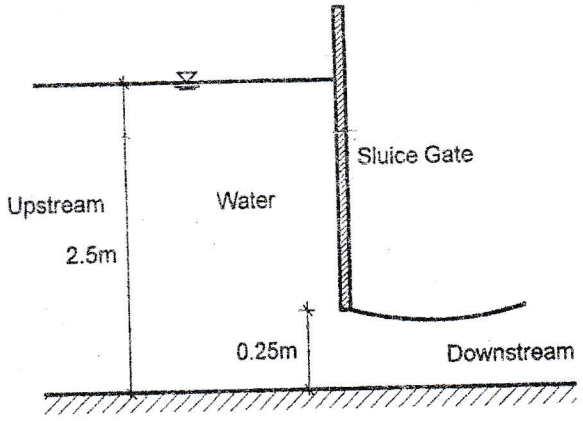
Subject: - Hydraulics *(CE555)*

- ✓ 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. In a hydro dynamically rough pipe of 100 mm diameter, the ratio of velocities at 10 mm and 30 mm from the pipe wall is 0.838. Determine the average height of the wall roughness, shear stress at the wall and mean velocity of flow if velocity at 30 mm is 1.90 m/s. [8]
2. A single uniform pipe joins two reservoirs. Calculate the percentage increase of flow rate obtainable if, from the mid-point of this pipe, another of the same diameter is added in parallel to it. Assume equal friction factor for both pipes and neglect minor losses. [8]
3. A reservoir A feeds two lower reservoirs B and C through a single pipe 10 km long, 750 mm diameter having a downward slope of 2.2×10^{-3}. This pipe then divides into two branch pipes, one 5.5 km long laid with a downward slope of 2.75×10^{-3} (going to B), the other 3 km long having a downward slope of 3.2×10^{-3} (going to C). Calculate the necessary diameters of the branch pipes so that the steady flow rate in each shall be 0.24 m^3/s, when the level in each reservoir is 3 m above the end of the corresponding pipe. Neglect all losses except pipe friction and take f = 0.025 throughout. [10]
4. Discuss Water hammet phenomenon. Develop Euler's equation as well as continuity equation for unsteady flow. [8]
5. Define steady Non uniform and spatially varied flow. Give at least two examples of each flows. [3]
6. a) Design an economical trapezoidal channel with a velocity of 0.6 m/s. The side slope Z of cannel is 1.5 and conveys a discharge of 3 m^3/s. Take manning's coefficient as 0.003. Also find the required bed slope. [6]

   b) Define hydraulic exponent. Show that the value of hydraulic exponent for rectangular section is equal to 10/3. [4]
7. a) Water flows in a 4 m wide rectangular channel at a depth of 1.8 m and velocity 1.4m/s. The channel is contracted to a width of 1.25m in particular reach. Is the flow possible in given specific energy? If not, what should be the discharge in channel so that flow is possible in the given specific energy? Also determine the depth of flow at contracted section and upstream of contracted section. [2+2+3]

b) Figure shows flow through the sluice gate provided in a rectangular channel of width 10 m. If the discharge in the channel is $7m^3/s$, determine the force exerted by water in the gate. Take momentum correction factor equals to 1.15. [5]

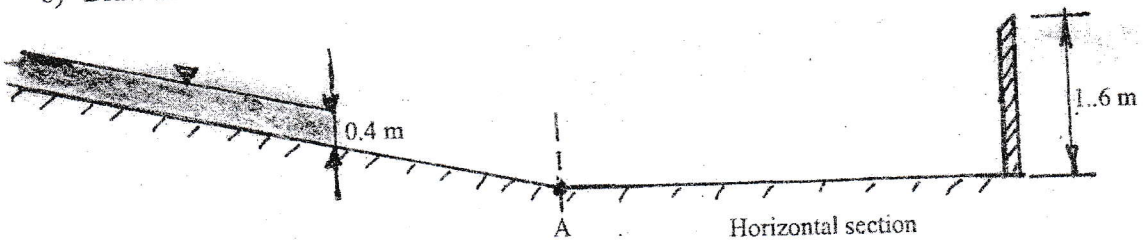


8. What is a mild slope? Justify analytically the nature of surface profiles (both upstream and downstream end) for mild slope. [1+4]

9. The partial water surface profile shown in figure below is for a rectangular channel of 3 m width in which water is flowing at a discharge of $5m^3/sec$.

   a) Does a hydraulic occur in a channel? If so, is it located upstream on downstream at point A? [5]

   b) Draw and name water surface profile. [5]



10. Why shear stress reduction factor "K" is necessary while designing the mobile boundary channel? Explain the design procedures (step by step) of mobile boundary channel by maximum permissible velocity approach. [2+4]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

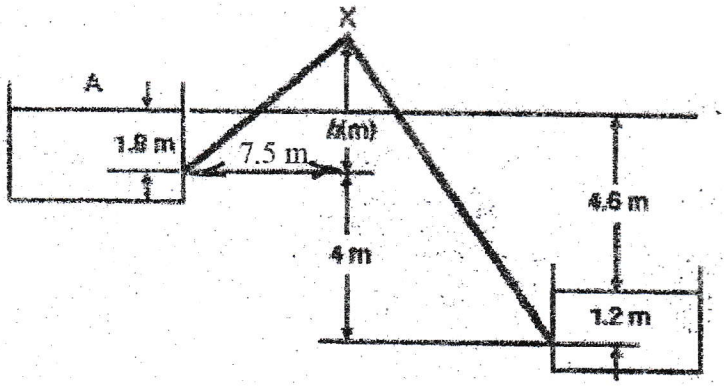
98

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

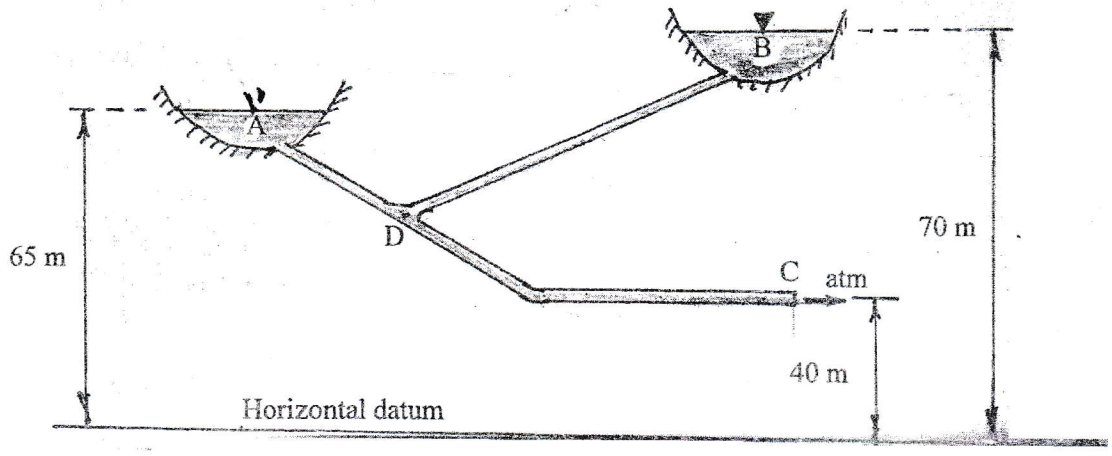
Subject: - Hydraulics *(CE555)*

- ✓ 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. Determine the size of steel pipe required to carry water at 30 *l*/s if the permissible energy gradient is 0.05. Will the boundary act as smooth or in transition? [8]
2. Two reservoirs are joined by a sharp-ended flexible pipe 100 mm diameter and 36 m long. The ends of the pipe differ in level by 4 m; the surface level in the upper reservoir is 1.8 above the pipe inlet while that in the lower reservoir is 1.2 m above the pipe outlet. At the position 7.5 m horizontally from the upper reservoir the pipe is required to pass over a barrier. Assuming that the pipe is straight between its inlet and the barrier and that f =0.04 determine the greatest height to which the pipe may rise at the barrier if the absolute pressure in the pipe is not to be less than 40kPa. Consider all losses. (Take atmospheric pressure = 101.3 kPa). [8]



3. In the reservoir system of figure Z_A= 65 m, Z_C = 40 m, Z_B = 70 m, BD = 900 m of 10 cm diameter pipe, AD = 600 m of 2.5 cm diameter pipe and DC = 150 m of 15 cm diameter pipe. Using f = 0.025 and neglecting minor losses, determine the flow in each pipe. [10]



4. Discuss water hammer phenomenon Describe with neat sketches, the one cycle pressure wave propagation in a pipe connected to a reservoir, when the valve is closed suddenly located at the end of pipe. [8]

   One cycle represents t = 0 to t = 4L/C

5. Define steady- nonuniform and steady- uniform flow hive at least two examples for each flow. [3]

6. a) Define hydraulic exponent. Show that the value of hydraulic exponent for triangular section is equal to 16/3. [4]

   b) A trapezoidal channel having side slope of 1:1 has to carry a flow of 15 m^3/s. The bed slope is 1 in 1000. Chezy's C is 45 if the channel is unlined and 70 if the channel is lined with concrete. The cost per m^3 of excavation is 3 times cost per m^2 of lining. Find which arrangement is economical. [6]

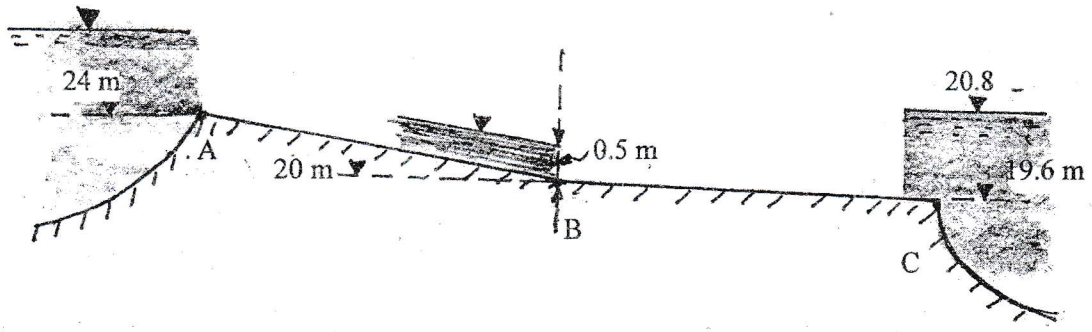
7. a) Find the expression for specific force and prove that when the specific force is minimum the flow is critical. [5]

   b) The width of a rectangular channel is reduced gradually from 3 m to 2 m and the floor is raised by 0.3 m at a given section. When the approaching depth of flow is 2.05 m, what rate of flow will be indicated by a drop of 0.2 m in the water surface elevation at the contracted section? [7]

8. What is a steep slope? Justify analytically the nature of surface profiles (both upstream and downstream end) for steep slope. [1+4]

9. Water is flowing from reservoir A to lake C via point B through a rectangular channel section of 4 m wide as shown in figure. The length of AB and BC are 100 m and the corresponding elevations are shown in figure. The normal depth above point B is 0.5 m taking Mapping's n = 0.025 and ignoring energy losses except in hydraulic jump.

   a) Determine the water surface elevation for upper reservoir. [3]
   b) Is there any possibility of formation of hydraulic jump? If so find the parameters of jump and its location. [4]
   c) Show all possible water surface profiles. [3]



10. With respect to design principle, distinguish between rigid boundary and mobile boundary channels. Explain the physical meaning of shear reduction factor "k" while designing mobile boundary channel. (no need derivation of any equation). [6]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

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

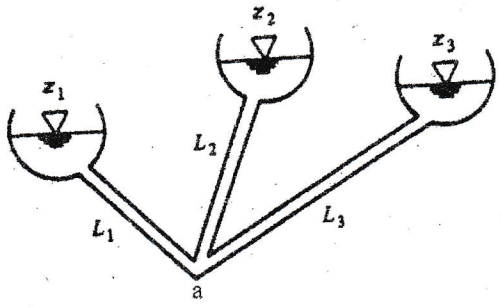
Subject: - Hydraulics *(CE555)*

- ✓ 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 horizontal pipe 60mm in diameter carries oil of specific gravity 0.8. The pressure difference between two sections 5km apart is found to be 200 kPa. The oil flowing through the pipe is collected in a tank. It is found that 1962 N of oil is collected in 4 minutes. Compute the dynamic viscosity of the oil. Assume the flow to be laminar and verify it. Also, find the velocity at a distance of 20 mm from the pipe wall. [4+2+2]

2. Two reservoirs are connected by a pipe 1000 m long of diameter 300 mm. The pipe passes over a hill whose height is 5 m above the level of water in the upper reservoir. The difference in water levels in the two reservoirs is 13 m. If the absolute pressure of water anywhere in the pipe is not allowed to fall below 1.2 m of water in order to prevent cavitations, calculate the length of pipe in the portion between the upper reservoir and the hill summit; and also the discharge through the pipe. Assume the reservoirs are open to the atmosphere having atmospheric pressure of 760 mm of mercury. Take friction factor, $f = 0.032$ and neglect bend losses. [8]

3. For the three reservoir system of figure below $Z_1 = 29$ m, $L_1 = 80$ m, $Z_2 = 129$ m, $L_2 = 150$ m, $Z_3 = 69$ m and $L_3 = 110$ m. All pipes are 250 mm diameter concrete with roughness height 0.5 mm. Compute the flow rates. Take $\upsilon = 1.02\times16^{-6} m^2/s$. You are not allowed to use the Moody's chart. [10]



4. Explain the water hammer phenomenon and mention its causes. Derive the momentum equation for unsteady flow through pipe. [3+5]

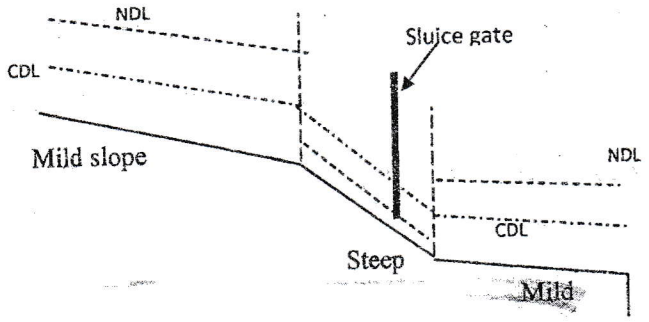
5. Define the following; non-perismatic channel, spatially varied flow, hydraulic slope, gradually varied flow. [4]

6. a) Determine the most economical section of a trapezoidal channel with side slope of 2:1, carrying a discharge of $9 m^3/s$ with a velocity of 0.75 m/s. Take Manning's $n = 0.025$. For conveying the same discharge, if a rectangular channel 1.2 m deep and 3 m wide is provided, what would be the saving in power per km length of channel? [4+2]

b) Using Manning's equation, show that the depth of flow is equal to 94% of the diameter for the partially filled most economical circular channel considering maximum discharge. [4]

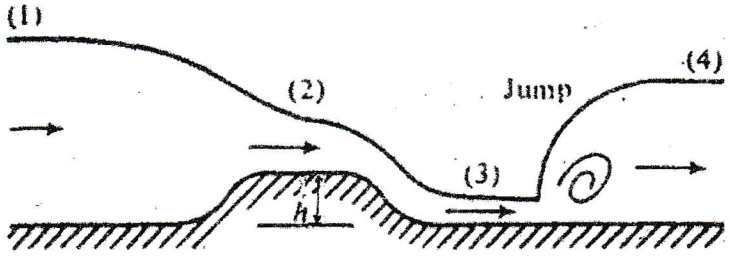
7. A trapezoidal channel of base width 6 m and side slope of 2 horizontal to 1 vertical carries a flow of 60 cumecs at a depth of 2.5 m. There is a smooth transition to a rectangular section 6 m wide accompanied by a gradual lowering of the channel bed by 0.6 m (i) Find the depth of water in the rectangular section and the change in water surface level. (ii) In case the drop in water surface level is to be restricted to 0.3 m. What is the amount by which the bed must be lowered? Assume no losses. [6+6]

8. a) Sketch the flow profile. [3]



b) Justify analytically the nature of surface profiles in critical sloped channels. [5]

9. Water in a horizontal channel accelerates smoothly over a bump and then undergoes a hydraulic jump as in figure below, if $y_1 = 1$ m, $y_3 = 30$ cm, estimate v_1, v_3, y_4 and bump height h. Neglect friction. [6]



10. a) Explain the Tractive Force Method of designing Mobile boundary channel. [3]

b) Design a regime channel for a discharge of 75 m^3/s and soil particle size of 0.65 mm using Lacey's method. Assume suitable side slope of channel. [3]

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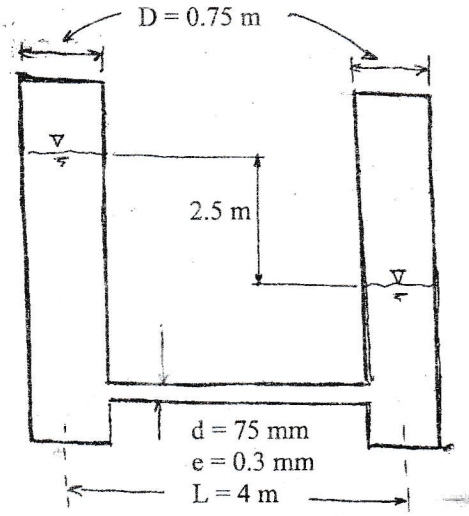
06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	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**.*
- ✓ ***Necessary figures are attached herewith.***
- ✓ *Assume suitable data if necessary.*

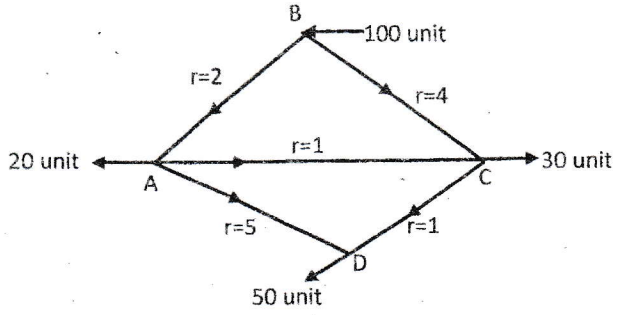
1. Water flows by gravity in two open stand pipes shown in figure. Estimate the rate of change of water level in left standpipe. [8]



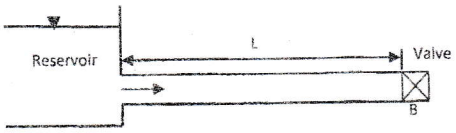
2. Water from a main canal is siphoned to a branch canal over an embankment by means of a wrought iron pipe of 100 mm diameter. The length of the pipeline up to the summit is 30 m and the total length is 90 m. Water surface elevation in the branch canal is 10 m below that of main canal. Take f = 0.025 and consider all losses. [4+4]
   a) If the total quantity of water required to be conveyed is 0.05 m^3/s, how many pipelines are needed?
   b) What is maximum permissible height of the summit above the water level in the main canal so that the water pressure at the summit may not fall below 20 kPa absolute, the barometer reading being 10 m of water?

3. Verify whether the following suggested distribution of discharge in the pipelines of the network shown in figure below is satisfactory by using Hardy-cross method. If not, determine the proper distribution. If the elevation at point B is 50 m and pressure head is 40 m and the elevation at D is 40 m, find the pressure at D. [8+2]

Line	AB	BC	CD	DA	AC
Suggested discharge (units)	58	42	32	18	20



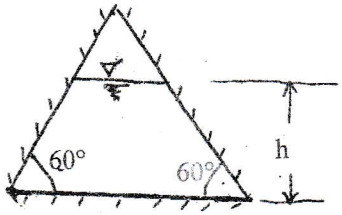
4. a) In the figure below, water flowing through a pipe from the reservoir is suddenly stopped by closing a valve at point B. Draw pressure-time diagram at the 2/3 L form valve of the pipe for one cycle of wave motion. [2]



b) Water flows through a 25 cm diameter 1500m long pipe at rate of 75 lps. The static pressure of water in the pipe is 200m at the downstream end of the pipe and the thickness of the pipe material is 6 mm. If a valve at the downstream end closed in 3 sec estimate the stress in the pipe wall. Take Bulk modulus of water = 2.2×10^9 N/m^2 and Young's modulus of elasticity of steel = 2.1×10^{11}N/m^2. [6]

5. Define the following; Hydraulic depth, Energy slope, gradually varied flow and spatially varied flow. [4]

6. a) In a partially full channel having a triangular section as shown in figure, the rate of discharge $Q = KAR^{2/3}$, in which K = a constant; A = flow area and R = hydraulic radius. Determine the depth at which the discharge is maximum. [5]

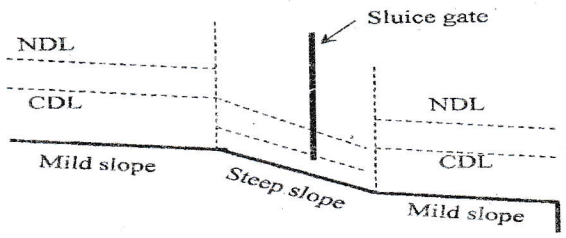


b) The velocity distribution in a channel section may be approximated by the equation $u = u_o(d/d_0)^n$ in which u is the flow velocity at depth d; u_0 is the flow velocity at depth d_0 and n = a constant. Derive expression for the energy and momentum coefficient. [5]

7. a) Define specific energy. Show that the flow is critical when the discharge is maximum for the given specific energy. Water flows at a depth of 1.8 m and velocity of 1.5 m/s in a 3 m wide rectangular channel. Find the width at contraction which just causes critical flow without a change in the upstream depth. [1+4+3]

b) An open rectangular channel carrying a discharge of 4.25 m^3/s is flowing at a depth of 1.15m with energy of 1.2 m and a width of 3 m. The flow encounters a simultaneous gradual contraction to a width of 1.5 m and a smooth downwards step of 0.6 m. With these flow conditions, determine the depth of the downstream flow. [4]

8. a) Sketch the flow profile: [4]



b) Justify analytically that A_3 curve meets the y_c line and channel bottom normally. [4]

9. What is hydraulic jump? Why is energy principle not applied for the analysis of the jump? Water flows in a 5 m wide rectangular channel at Froude number 3.5; the depth of flow is 1.2 m. If water undergoes a hydraulic jump, what is the Froude number downstream of jump? [1+1+4]

10. Explain the Tractive Force Method of designing Mobile boundary channel. Show the shear stress distribution on the Alluvial channel boundary with values. [3+3]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

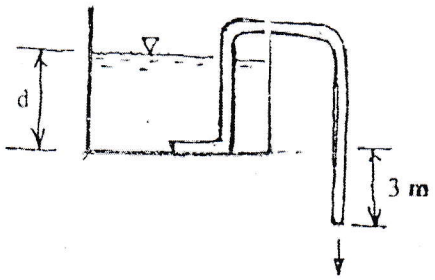
Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Hydraulics *(CE555)*

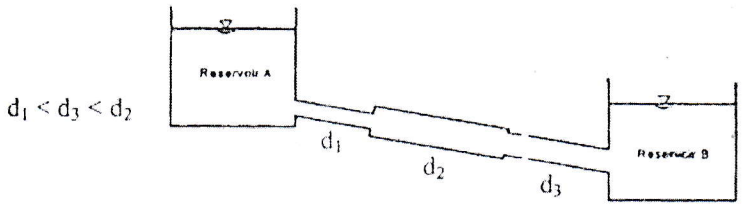
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Moody diagram provided.***
- ✓ *Assume suitable data if necessary.*

1. A total 12 liters per sec of oil is pumped through 2 pipes in parallel, one 12 cm in diameter and the other 10 cm in diameter, both pipes 1000 m long. The specific gravity of oil is 0.85, average roughness height is 0.26 mm for both pipes and kinematic viscosity is 9 cm^2/sec. Calculate the flow rate through each pipe, and power generated by pump. [8]

2. a) Small swimming pool is drained with velocity of 1.2 m/sec using a pipe with hose diameter 20 mm, length 30 m, and absolute roughness e = 0.2 mm. Find the water depth "d" at instant shown in figure below considering minor head loss coefficient at entrance K = 0.5. [5]

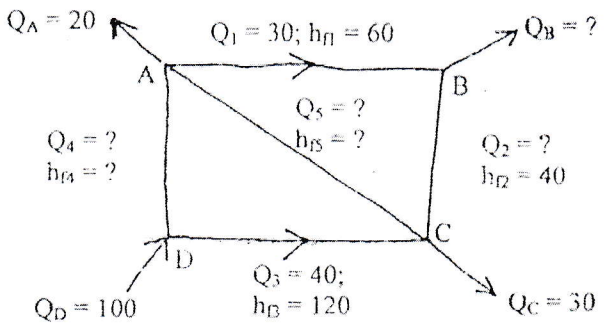


b) Draw HGL and EGL diagram for the flow system shown in the figure considering all major and minor losses. [1.5+1.5]



3. a) What do you understand by branching pipe system? Explain. Describe the solution procedures for three possible different cases of three reservoir problem. [6]

b) A pipe network is shown in figure in which Q and h represents the discharge and head losses respectively. Determine head losses and discharge indicated by a question mark, for this pipe network. [4]

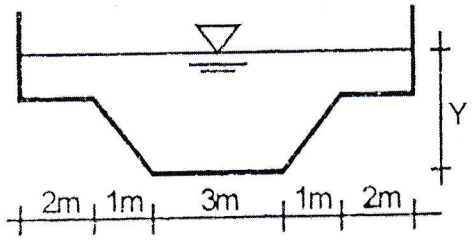


4. Water is flowing from a reservoir in a pipe of 600 mm diameter, 3000 m long and 6 mm thick at a velocity of 3.5 m/s. Assuming the value of bulk modulus of elasticity for water as 2.06 GPa, modulus of elasticity for pipe material 206 GPa and velocity of pressure wave 1400 m/s. Draw pressure-time diagram at location 1200 m from reservoir if the valve located at the end of the pipe is closed in 1 second. [8]

5. Define bed slope, hydraulic slope and energy slope. Why for non-uniform flow, these slopes are not parallel to each other, explain with neat sketch. [4]

6. a) Prove that for compound open channel, velocity distribution coefficient (momentum correction factor) $\beta = \frac{\sum\left(\frac{K_i^2}{A_i}\right)\left(\sum A_i\right)}{\left(\sum K_i\right)^2}$, where K_i = Conveyance factor of i^{th} section, A_i = Cross section area of i^{th} section. [4]

   b) For given channel section shown in the figure below with bed slope = 0.00017, Manning's roughness coefficient = 0.018, discharge 8.97 m^3/s, and side slope as 1:1, determine the normal depth of flow for uniform flow. [6]



7. A rectangular channel with a bottom width of 5 m, bottom slope of 0.00076 and energy correction factor of 1.1 has a discharge of 1.85 m^3/s. In a Gradually varied flow in this section the depth at certain location is found to be 0.25 m, considering Manning's roughness coefficient as 0.0165 determine the type of GVF profile. How far upstream or downstream will the depth be 0.40 m from depth 0.25 m. Use direct step method using increment equals to 0.05 m. [8]

8. a) A 3.5 m rectangular channel carries discharge of 4 m^3/s of water at a depth of 1.2 m. If the width is reduced to 2.0 m and bed raised by 0.15 m, determine the depth of flow at reduced section and upstream of the reduced section. [6]

   b) Find the expression for the specific force. Show that the flow is critical when the specific force is minimum. Explain the use of this concept in open channel flow. [4+2]

9. A rectangular channel with width 1.1 m carrying a flow discharge of 7.2 m^3/s changes its bed slope from 0.065 to 0.0085. Show that the hydraulic jump occurs and if so find the location of jump. Take Manning's roughness as 0.025. [6]

10. Define an alluvial channel and incipient motion. Find the expression for the shear reduction factor "K" and explain the physical meaning of this factor. [1+3+2]

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07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	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**.*
- ✓ ***Necessary Moody's diagram is attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Explain Prandtl Mixing length theory. Show that the velocity distribution in pipe for turbulent flow is Logarithmic. Derive an expression of head loss to sudden expansion of pipe. [2+3+3]

2. Water from a main canal is siphoned to a branch canal over an embankment by means of a wrought iron pipe of 100 mm diameter. The length of the pipeline up to the summit is 30 m and the total length is 90 m. Water surface elevation in the branch canal is 10 m below that of main canal. [8]

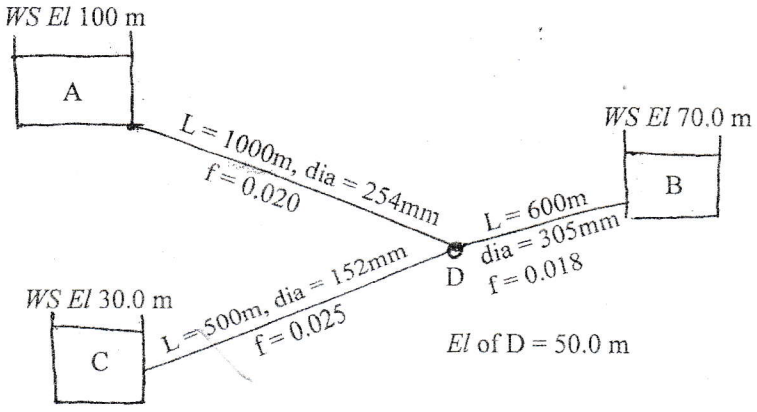
   a) If the total quantity of water required to be conveyed is 0.05 m^3/s, how many pipelines are needed?

   b) What is the maximum permissible height of the summit above the water level in the main canal so that the water pressure at the summit may not fall below 20 Kpa absolute, the barometer reading being 10 m of water?

   Take f = 0.025 and consider all losses.

3. a) Derive the expression of correction factor $\Delta Q = -\frac{\sum(rQ_0^2)}{\sum(2rQ_0)}$ for solution of pipe network using Hardy Cross method. Whether r is resistance coefficient of pipe and Q_0 is initial assumed discharge. [2]

   b) Determine the piezometric head at D for the following three reservoir problem. [8]



   Where, f is the friction factor of the Darcy-Weisbach equation used in Moody diagram.

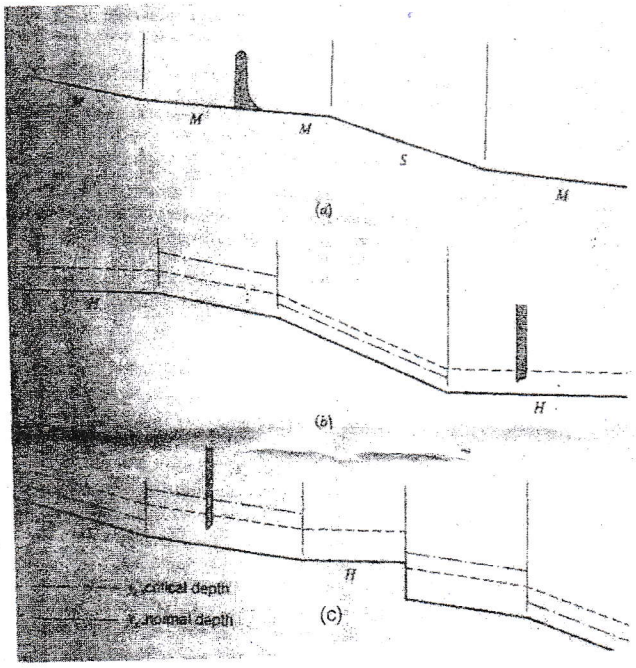
4. A steel pipeline (ϵ = 0.046 mm) 61 cm in diameter and 3.2 km long discharges freely at its lower end under a head of 61 m. What water-hammer pressure would develop if a valve at the outlet were closed in 4 sec? 60 sec? Wall thickness = 0.5 cm for both case of closure. Compute the stress that would develop in the walls of the pipe near the valve. If the working stress of steel is taken as 16,000 psi, what would be the minimum time of safe closure? Consider $E_{water} = 2.17 \times 10^9$ N/m^2 and $E_p = 1.9 \times 10^{11}$ N/m^2. [8]

5. Give the two practical examples of following flow regimes. [4]
   a) uniform and non-uniform flow
   b) spatially varied flow, gradually varied flow

6. Explain specific energy diagram and show that at minimum specific energy, the flow is critical. A rectangular channel 2 m wide has a flow of 2.4 m^3/s at a depth of 1.0 m. Determine if critical depth occurs (a) at the section where a hump of ΔZ = 20 cm high is installed across the bed, (b) a side wall constriction (no hump) reducing the channel width to 1.7 m, and (c) both the hump and side wall constriction combined. Will the upstream depth be affected for case (c)? If so, to what extent? Neglect head losses of the hump and constriction caused by friction, expansion and contraction. [6+2+2+2]

7. What are the conditions of uniform flow in open channel? A trapezoidal channel having side slope of 1:1 has to carry a flow of 15 m^3/s. The bed slope is 1 in 1000. Chezy's C is 45 if the channel is unlined and 70 if the channel is lined with concrete. The cost per m^3 of excavation is 3 times cost per m^2 of lining. Find which arrangement is economical. [2+8]

8. Sketch possible water surface profiles for the channel in figure below. First locate and mark the control points, then sketch the profiles, marking each profile with the appropriate designation. Show any hydraulic jumps that occur. [8]



9. The depth of uniform flow in a rectangular channel is 5 m wide (n = 0.02, S_0 = 0.04) is 0.5 m. A low dam raises the water depth of 2 m. Find whether a hydraulic jump takes place and if so at what distance upstream of the dam. [6]

10. A stream has a sediment bed of median size 0.35 mm. The slope of the channel is 1.5×10^{-4}. Stream is considered as trapezoidal with base width 3 m and side slope 1.5 H : 1 V. [6]
    a) If the depth of flow in the channel is 0.25 m, examine whether the bed particles will be in motion or not.
    b) Calculate minimum size of gravel that will not move in the bed of channel. Use empirical equation of critical shear stress as: $\tau_c(N/m^2) = 0.155 + \frac{0.409 d_{mm}^2}{(1+0.177 d_{mm}^2)^{1/2}}$.

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	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. Show that for turbulent flow in rough pipes $\frac{V}{V^*} = 5.75\log\left(\frac{R}{K}\right) + 4.75.$ [8]

   Where,

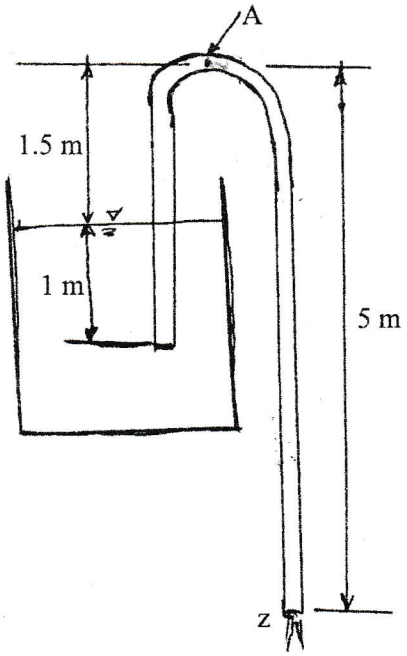
   V = Mean velocity

   V* = Shear velocity

   R = Radius of pipe

   K = Average height of surface protrusions

2. Liquid (s.g. = 0.6, $\nu = 5.0 \times 10^{-7}$ m^2/s) is drawn from a tank through a hose of inside diameter 25 mm (see figure). The relative roughness for the hose is 0.0004. Calculate the volumetric flow and the minimum pressure in the hose. The total length of hose is 9 m and the length of hose to point A is 3.25 m. Neglect minor losses at head entrance. [8]



3. Three reservoirs A, B and C are interconnected by three pipes which all meet at junctions J. The water surface of reservoir B is 20 m above the surface of C whilst the surface of A is 40 m above the surface of B. A flow control valve is fitted just before junction J in pipe AJ. [10]

   The head loss h_L through pipes and components can be written as $h_L = rQ^2$ where r is the resistance coefficient. The value of r for the valve and the pipes are $r_{AJ} = 150$, $r_{BJ} = 200$, $r_{CJ} = 300$, $r_{valve} = (400/n)^2$.

   Where n is the percentage valve opening. Find the value of n which will make the discharge into reservoir C twice into reservoir B.

4. a) Explain the importance of surge tank. Describe the types of surge tank. [1.5+1.5]

   b) A 300 mm diameter pipe of mild steel having 6 mm thickness carries water at the rate of 200 l/s. What will be the rise in pressure if the valve at the downstream end is closed instantaneously? Compare results assuming the pipe to be rigid as well as elastic. What should be the maximum closing time for the computed results to be valid? Take pipe length as 5.0 km, Modulus of elasticity of pipe material as 2.25×10^{11} N/m^2, Bulk modulus of elasticity of water as 2.0×10^9 N/m^2. [5]

5. Explain GVF, RVF and spatially varied flow with appropriate sketches. [4]

6. What condition make open channel flow uniform? The area of cross-section of flow in a channel is 6 m^2. Calculate the dimensions of the most efficient section if the channel is (a) triangular, (b) rectangular and (c) trapezoidal (2:1). Which has the least perimeter? [2+8]

7. a) A flow of 2 m^3/s is carried in a rectangular channel 1.8 wide at a depth of 1.0 m. Will critical depth occur at a section where (a) a frictionless hump 15 cm high is installed across the bed? (b) a frictionless sidewall reduces the channel width to 1.3 m? (c) the hump and the sidewall construction are installed together? [9]

   b) Define conjugate depths. Sketch the specific force curve showing conjugate depths and the zones of subcritical, critical and supercritical flow. [1+2]

8. A rectangular channel with a bottom width of 4 m, bottom slope of 0.00075 and energy correction factor of 1.1 has a discharge of 2.0 m^3/s. In a Gradually varied flow in this section the depth at certain location is found to be 0.2 m, considering Manning's roughness coefficient as 0.016 determine the type of GVF profile. How far upstream or downstream will the depth be 0.40 m from depth 0.20 m. Use Graphical Integration Method using increment equals to 0.1 m. [8]

9. For a hydraulic jump in a horizontal triangular channel show that $3Fr_1^2 = \frac{r^2(r^3-1)}{r^2-1}$,

   where $Fr_1^2 = \frac{v_1^2}{gy_1}$ and $r = \frac{y_2}{y_1}$. [6]

10. Write down the design procedures of mobile boundary channel using maximum permissible velocity method, tractive force method and regime theory approaches with appropriate expressions. [6]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

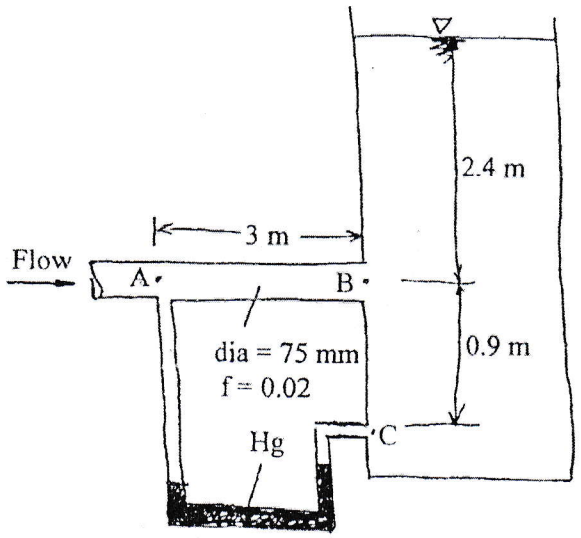
Subject: - Hydraulics *(CE555)*

- ✓ 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.*

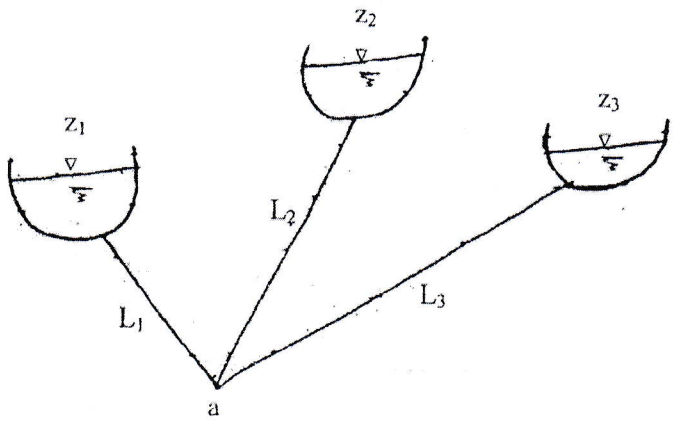
1. Show that in both smooth and rough pipes for turbulent flow $\frac{u-v}{v^*} = 5.75\log\left(\frac{y}{R}\right) + 3.75$

   Where v = mean velocity; u = point velocity at distance y from boundary. v^* = shear velocity; R = Radius of pipe. [8]

2. Calculate the magnitude and direction of the manometer reading when water is flowing with velocity of 4.5 m/s for figure below. Consider minor losses also. [8]



3.



For the three reservoir system of above figure, z_1 = 29 m, L_1 = 80 m, z_2 = 129 m, L_2 = 150 m, z_3 = 69 m and L_3 = 110 m. All pipes are 250 mm diameter concrete with roughness height 0.5 mm. Compute the flow rates for water. [10]

4. a) Define water hammer and write down continuity equation and momentum equation for unsteady flow in pipe. [3]

   b) A value is closed in 4.5 s at the down stream end of a 3200 m pipeline carrying water at 2.7 m/s, What is the peak pressure developed by the closure, if the wave travels with velocity of 1000 m/s? Determine the length of pipe subject to the peak discharge. [5]

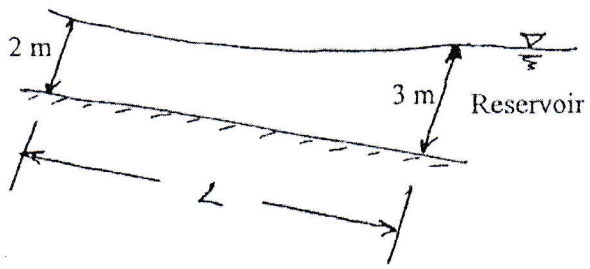
5. Given a practical example for each of the following open channel flow: (a) GVF (b) RVF (c) Spatially varied flow (d) Non uniform flow. [4]

6. a) Prove that for compound open channel, velocity distribution coefficient (Energy correction factor) $\alpha = \dfrac{\sum\left(\dfrac{K_i^3}{A_i^2}\right)\left(\sum A_i^2\right)}{\left(\sum K_i\right)^3}$, where k_i = Conveyance factor of i^{th} section, A_i = Cross section area of i^{th} section. [4]

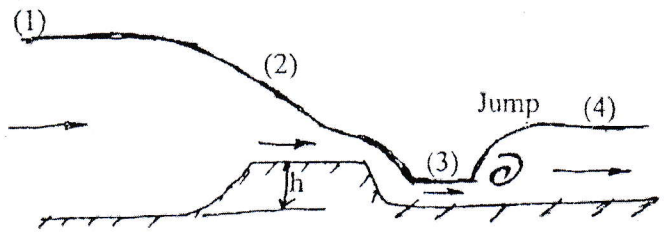
   b) Set up a general expression for wetted perimeter p_w of a trapezoidal channel in terms of the cross-sectional area A. depth y and angle of side slope ϕ. Then differentiate p_w with respect to y with A and ϕ held constant. From this, prove that R = y/2 for the section of greatest hydraulic efficiency (i.e, smallest p_w for a given A). [6]

7. What are the different conditions to be fulfilled when flow is critical open channel? A 3m wide rectangular channel carries 3 m^3/s of water at a depth of 1 m. If the width is to be reduced to 2 m and bed raised by 10 cm, what would be the depth of flow in the contracted section? What maximum rise in the bed level of the contracted section is possible without affecting the depth of flow upstream of transition? Neglect loss of energy in transition. What would be the change in water surface elevations if the rise in bed is 30 cm? [3+3+3+3]

8. The clean earth (n = 0.020) channel in figure below is 6m wide and laid on a slope of 0.005236. Water flows at $30m^3/s$ in the channel and enters a reservoir so that the channel depth is 3 m just before the entry. Assuming gradually varied flow, calculate the distance L. [8]



9. Water in a horizontal channel accelerates smoothly over a bump and then undergoes a hydraulic jump, as in figure below. If y_1 = 1 m and y_2 = 30 cm, estimate v_1, v_2 and y_4. Neglect friction. [6]



10. Describe the application of shield diagram for designing mobile boundary channel. [6]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	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. Describe with appropriate expressions (a) Prandtl's mixing length theory (b) Hagen poisseuille equation (c) Nikuradse's experiments and (d) Colebrook-white equation. [8]
2. Two pipes have a length L each. One of them has diameter D_1 and the other has diameter D_2. If the pipes are arranged in parallel, the loss of head when a total quantity of water Q flows through them is H_1. If the pipes are arranged in series and the same quantity Q flows through them, the loss of head is H_2. If $D_2 = D_1/2$, find the ratio of H_1 to H_2, neglecting minor losses and assuming same f. [8]
3. A reservoir A discharges through a pipe 450mm in diameter and 900m long which is connected to two pipes, one 1200m long leading to reservoir B 36m below A and the other 1500m long leading to reservoir C 45m below A. Calculate the diameters of these two pipes if they have equal discharges which together equal that of a 450mm diameter pipe of length 2100m connected directly from reservoir A to reservoir B. Neglect all losses except those due to friction and assume that the friction factor f is the same for all pipes. [10]
4. Derive an expression for the pressure rise due to instantaneous closure of valve considering the pipe to be elastic. From the derived expression for elastic pipe, obtain the pressure rise for rigid pipe. [7+1]
5. Explain Gradually varied and spatially varied flow with one practical example for each. [4]
6. a) Develop the relationship between Chezy's coefficient, Manning's coefficient and Darcy's coefficient. [4]

   b) A rectangular channel 8m wide and 1.5m deep has a slope of 0.001 and in lined with smooth plaster. It is desired to enhance the discharge to a maximum by changing the dimension of the channel, but keeping the same amount of lining. Work out the new dimension and the percentage increase in discharge.. Take roughness coefficient n = 0.015. [6]
7. What is specific force? Prove that for a given specific force the discharge in a given channel section is maximum when the flow is in the critical state. A venturiflume in a rectangular channel of width of "B" has the throat width of 'b'. The depth of liquid at entry is H and at the throat is h. Prove that following relation exists for the discharge and width ratio: [2+4+3+3]

$$Q = 3.13bH^{3/2}\left(\frac{h}{H}\right)^{3/2}$$

$$\frac{b}{B} = \sqrt{3}\left(\frac{h}{H}\right) - \sqrt{3}\left(\frac{h}{H}\right)^{3/2}$$

8. Derive the dynamic equation of Gradually varied flow (GVF) and convert the derived equation for the case of wide rectangular channel, using Manning's equation, into following form: [8]

$$\frac{dy}{dx} = \frac{S_0\left[1-(y_n/y)^{10/3}\right]}{1-(y_c/y)^3}$$ Where S_0 = bed slope, y_n = normal depth, y_c = critical depth.

9. Draw a hydraulic jump profile and indicate depths and energy loss using specific energy and specific force diagram. Also derive momentum equation for the hydraulic jump in rectangular channel. [6]

10. A trapezoidal channel 1.5m deep, 10m bed width, with 2:1 side slopes is excavated in gravel of median size of 60mm. What is the maximum permissible channel slope and what discharge can the channel carry without disturbing its stability? Take angle of repose(ϕ) = 37° and K_2 = 0.9. [6]

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(12)

01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Poush

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

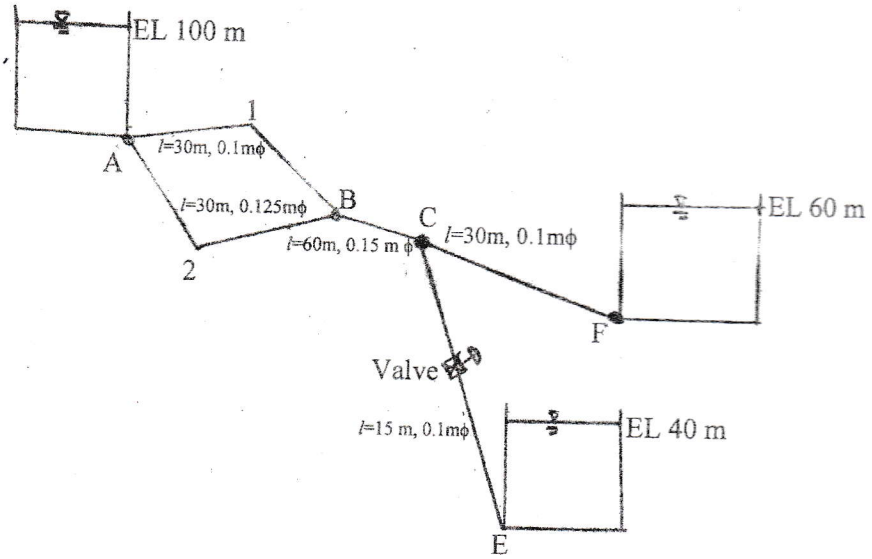
Subject: - Hydraulics *(CE 555)*

- ✓ 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.*

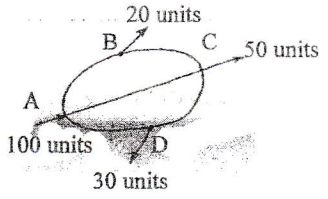
1. a) Measurement in a fully developed turbulent flow in pipe indicate that velocity midway between the pipe wall and the pipe centerline is 0.9 meters centerline velocity. Determine the expression for the average velocity in multiples of maximum velocity. What is the value of e/D or K/D (relative roughness) if pipe acts as rough pipe? [4]

   b) Write down Colebrook and white equation. Show that this equation is also valid for variation of friction factor for turbulent rough as well as smooth pipes. [4]

2. A system of pipes conveying water from the tanks is connected in parallel and series as shown in figure below. The elevations of tanks, lengths and diameters of the pipes are also shown figure. The valve is fitted on pipeline CE which has a resistance coefficient $r_{valve} = (4000/n)^2$, where n is the percentage of valve opening. If the valve is adjusted to give the equal discharge rates at E and F. Calculate the head at C, total discharge through the system and the percentage of valve opening. Take f = 0.024 for all pipes. [8]



3. Determine the distribution of flow in the pipe network show in figure below. The value of each pipe is as given below. use n = 2 ($h_f = kQ^n$). [10]



Pipe	Length m	Diameter mm.	Friction factor
AB	300	200	0.02
BC	250	150	0.03
CD	300	100	0.02
AD	250	150	0.03
AC	500	100	0.025

4. Describe with appropriate and enough illustrations one complete cycle of wave motion in a pipe due to sudden closure of valve. (You are required to show the direction of flow velocity and wave celerity at specified time periods). [8]

5. Define conveyance and section factor for the open channel. Also prove that hydraulic radius is equal to depth of flow for wide rectangular channel and half of the bed width for deep gorges. [1+1+1+1]

6. Find the proportions of a trapezoidal channel which will make the discharge a maximum for a given cross sectional area of flow and given side slopes. Show also that if the side slopes can be varied, the most efficient of all trapezoidal sections is half-hexagon. [10]

7. a) Calculate the critical depth for a discharge of 6 cumecs in the following section of channel: [8]

   i) Circular having diameter 1.5 m.
   ii) Rectangular having bed width 3m.
   iii) Trapezoidal having bed width 2.5 m and side slope 2:1
   iv) Triangular having side slope 1:1

   b) A uniform flow of $12m^3/s$ occurs in a long rectangular channel of 5 m width and depth flow of 1.5 m. A flat hump is to be built at a certain section. Assuming a loss of head equal to upstream velocity head, compute the minimum height of the hump to provide the critical flow. [4]

8. A rectangular channel 10m wide is laid with a break in its bottom slope from 0.01 to 0.0064. If it carries $125m^3/s$, determine the nature of the surface profile and compute its length. Take n = 0.015. [8]

9. Write algorithm and program coding in any high level language (C for Fortran) for computing alternate depths in a rectangular channel section. [6]

10. Derive an expression for the shear stress reduction factor or tractive force ratio in the case of mobile boundary channel in terms of side slope angle and angle of repose of the sediment. Also prove that the critical diameter of sediment in the channel for incipient motion condition assuming fully developed turbulent flow is: $d_{cr} = 10\ R\ S_o$, where R is hydraulic radius and So is bed slope. [4+2]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Bhadra

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

Subject: - Hydraulics

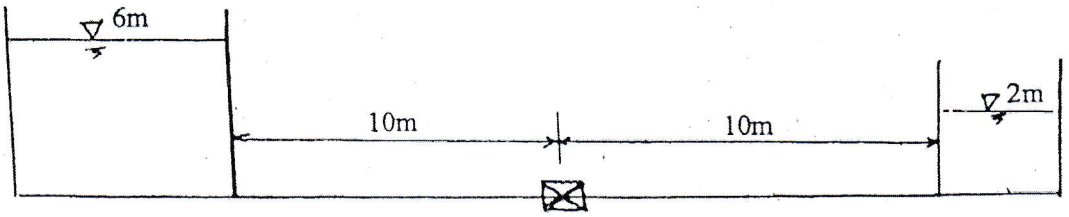
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary figure is attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Explain Prandtl mixing length theory. Starting from the expression for turbulent shear stress derive the velocity distribution in the region of turbulent flow near hydrodynamically smooth boundaries in the form $\frac{u}{u^*} = 5.75\log_{10}\left(\frac{u^* y}{D}\right) + 5.5.$ [2+6]

2. What size of new cast iron pipe is needed to transport 400 lps of water for 1 km long pipe with 2m head loss? Take roughness height of the pipe is 0.26mm and the viscosity of water 0.0014 Pa.S. [8]

3. Reservoir A, water surface elevation 120m is connected to reservoir B and C having surface elevation 70m and 50m respectively. A pipe line 150mm diameter and 400m long connects reservoir A to Junction D: Reservoir B and C are connected to Junction D by 75mm diameter 100m long and 100mm diameter 250m long pipeline respectively. Assuming friction factor f = 0.04 for all pipes, estimate the rate of flow for each pipe, neglecting minor head losses. [10]

4. A 20m long, 75mm diameter, steel pipeline, wall thickness 6mm, carries water from a large reservoir tank, held at a constant head of 6m. Discharge is 0.022m3/s through a variable speed valve positioned 10m from the supply tank. Discharge is to a second constant head tank held at 2m head as shown in figure below. If the valve closure is instantaneous, determine the theoretical magnitudes of the pressure wave propagated away from the valve under frictionless conditions. Draw pressure (both steady and unsteady) time curve at point 5m, 2.5m and 0.5m from the upstream tank. Take K = 2×10^9 N/m^2 and E = 204×10^9 N/m^2. [8]



5. Differentiate gradually, rapidly and spatially varied flow with neat sketches and examples. What is energy slope? [3+1]

6. Find a expression for the theoretical depth for maximum velocity in a closed circular channel in terms of the diameter "d". Compare the discharge at maximum velocity with that when the channel is running full, assuming that the Chezy's coefficient is unaltered, and the pressure remains atmospheric. [5+2]

OR

Write algorithm and programme coding in any high level language (C or Fortran) for calculating uniform depth for rectangular channel. [2+5]

7. Draw and explain the velocity profile in a cross-section of rectangular, triangular and trapezoidal channel shapes. [3]

8. Why the critical depth varies for the constriction flow analysis and does not vary for the hump flow analysis? A rectangular channel 2m wide has a flow of 2.4 m^3/s at a depth of 1.0m. Determine if critical depth occurs (a) a section where a hump of ΔZ = 20cm high is installed across the channel bed, (b) a side wall constriction (with no humps) reducing the channel width to 1.7m, and (c) both the hump and side wall constrictions combined. Will the upstream depth be affected for case (c)? If so, to what extent? Neglect head losses of the hump and constriction caused by friction, expansion and contraction. [2+2+3+3+2]

9. A rectangular channel conveying a discharge of 30 m^3/sec is 12m wide with a bed slope 1 in 6000 and having Manning's n = 0.025. The depth of flow at a section is 1.5m. Find how far upstream or downstream of this section the depth of flow will be 2m. Find also the types of profile. Use direct step method for calculation and take only two steps for calculation. [7+1]

10. A wide channel with uniform rectangular section has a change of slope from 1 in 95 to 1 in 1420 and the flow is 3.75m^3/s per m width. Determine the normal depth of flow corresponding to each slope and show that a hydraulic jump will occur in the region of the junction. Calculate the height of the jump and sketch the surface profiles between the upstream and downstream regions of uniform flow. Manning's coefficient n = 0.013 and it may be assumed that the channel is wide in comparison with the depth of flow, so that the hydraulic mean depth is approximately equal to the depth of flow. [6]

OR

Find the pre jump and post jump heights of the hydraulic jump formed at the toe of the spillway. Neglect energy loss due to flow over spillway. [6]

Height of the crest above D/S bed level = 3m
Discharge = 80 m^3/s
Width of the canal = 10.0m
Head over the crest level = 2.47m

Explain the formation condition of repelled and submerged jump for the above flow condition.

11. A channel which is to carry 10 m^3/s through moderately rolling topography on a slope of 0.0016 is to be excavated in coarse alluvium with 50% of particles being 3cm or more in diameter. Assume that channel is to be unlined and of trapezoidal section. Find suitable value of base width and side slope. Take φ = 34° and K_2 (ratio between bed shear stress and critical shear stress) = 0.75. Use tractive force method. [6]

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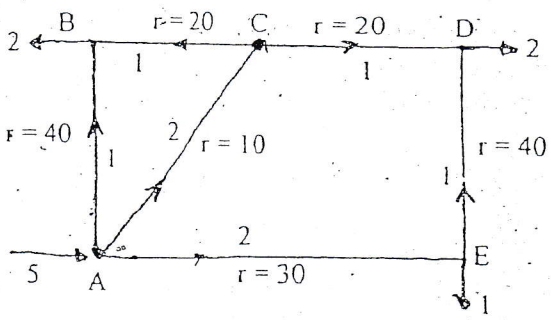
01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Magh

Exam.	[redacted]		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Hydraulics

- ✓ 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 2cm diameter 20km long pipeline connects two reservoirs filled with water open to the atmosphere. What is the discharge in the pipeline if the surface elevation difference of the reservoirs level is 5m? $\nu_{water} = 1.02 \times 10^{-6} m^2/s$. [8]
2. Explain the experiment made by Nikuradse on resistance to artificially roughened pipes. Discuss the characteristic features of the result obtained. [3+5]
3. For a pipe network shown in figure below, trial discharge distribution is shown, if n = 2 for all the pipes. Obtain the correct distribution. Find also the available pressure at C, if the supply pressure at A is provided by 6m high water tank. [8+2]

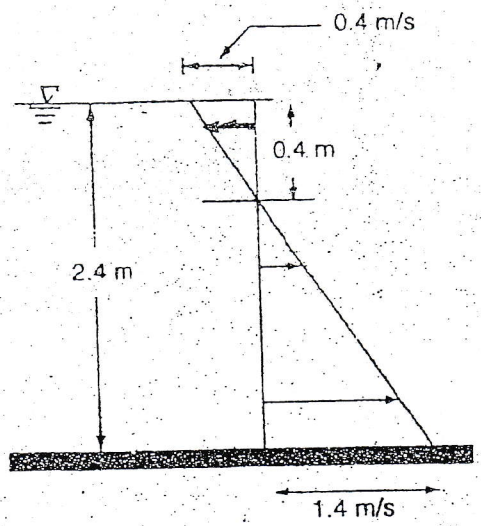


4. Derive following continuity equation for unsteady flow in pipes $\frac{1}{\rho}\frac{dp}{dt} + c^2\frac{\partial v}{\partial s} = 0$.

Where $c = \sqrt{\frac{k'}{\rho}}$ is celerity and other symbols have their usual meanings. [8]

5. Give one example of each of : [4]
   a) Steady, uniform flow
   b) Steady, non uniform or gradually varied flow
   c) Steady, rapidly varied flow
   d) Unsteady, non uniform flow

6. For the velocity distribution given in figure below, find energy and momentum correction factors. [4]



7. Establish the relationship between Darcy, Chezy and Manning's equations based on the shear stress distribution on the channel boundary for uniform flow. Explain the ways of estimating Manning's coefficient for composite channel boundary. [4+2]

8. Find at what bed slope a 4m wide rectangular channel be laid so that the flow is critical at a normal depth of 1.25m, with Manning's coefficient (n) = 0.015. [6]

9. A discharge of $16m^3/s$ flows with depth of 2m in a 4m wide rectangular channel. At a downstream section, the width is reduced to 3.5m and the channel bed is raised by 0.35m. To what extent will the surface elevation be affected by these changes? [6]

OR

Write algorithm and programme coding in any high level language (C or Fortran) for determination of critical depth in trapezoidal channel section.

10. A wide rectangular channel conveys a discharge of $5m^3/sec$ with a bed slope of 1 in 3600 with Manning's coefficient (n) = 0.02. If the depth at a section is 3.5m, determine how far upstream or downstream of the section, the depth would vary within 5% of the normal depth. Find the nature of profile and make calculation with direct step method and take only 2 steps for calculation. [7+1]

11. A vertical sluice gate with an opening of 0.67m produces a downstream jet depth of 0.4m when installed in a long rectangular channel 5m wide conveying a steady discharge of $20m^3/s$. Assuming that the flow downstream of the gate eventually returns to the uniform flow depth of 2.5m, [6]

a) Verify that a hydraulic jump occurs. Assume $\alpha = \beta = 1$
b) If the downstream depth is increased to 3m, analyze the flow conditions at the gate.

12. A stream has a sediment bed of median size 0.35mm. The slope of the channel is 1.5×10^{-4}. Stream is considered as trapezoidal with base width 3m and side slope 1.5H:1V. [6]

a) If the depth of the flow in channel is 0.25m, examine whether the bed particles will be in motion or not.
b) Calculate minimum size of gravel that will not move in the bed of channel. Use Emperical equation of critical shear stress as: $\tau_c\left(\frac{N}{m^2}\right) = 0.155 + \frac{0.409 d^2_{mm}}{\left[1 + 0.177 d^2_{mm}\right]^{1/2}}$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Bhadra

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

Subject: - Hydraulics *(CE 555)*

- ✓ 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) Test on a 500 mm diameter commercial pipe indicated that head loss in 100 m length of pipe at different discharge of water is as given below.

Q (l/s)	40	200	400	800
h_f (m)	0.01	0.210	0.820	3.27

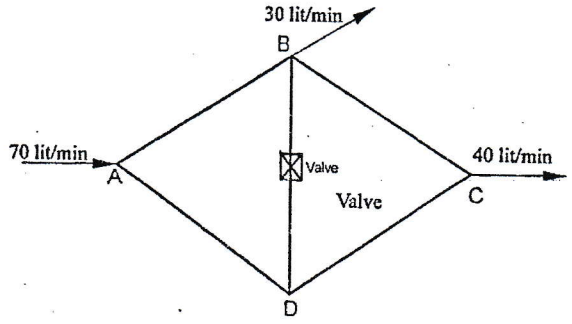
(i) Determine the equivalent sand grain roughness of the pipe.
(ii) What is the maximum water discharge at which this pipe will act as smooth pipe?
(iii)What is the maximum discharge at which this pipe will act as rough pipe? [6]

b) A fluid of constant density ρ enters a horizontal pipe of radius R with uniform velocity V and pressure p_1. At a downstream section the pressure is p_2 and the velocity varies with radius r according to the equation $u = 2V\{1 - \{r^2 / R^2\}\}$. Show that the friction force at the pipe walls from the inlet to the section considered is given by $\pi R^2\left(p_1 - p_2 - \frac{\rho V^2}{3}\right)$ [6]

c) A pipe line system consists of the following sources of head losses.
(i) Entrance loss in 200 mm diameter
(ii) Friction loss in 500 m of 200 mm diameter pipe with f = 0.02
(iii)Sudden expansion from 200 mm to 250 mm diameter
(iv)Exit loss from 250 mm diameter pipe
Obtain the equivalent length of 200 mm diameter pipe with f = 0.02. [4]

2. a) Determine discharge distribution in the pipes shown in the figure using hardy cross method. [10]

Pipes	AB	BC	CD	AD	DB	Valve
Resistance coefficient (r)	1	2.5	1.5	2	3	1.5



b) A valve which normally operates under a net head of 300m is supplied with water at 2.5 m^3/s through a pipe 1m diameter and 1.6 km long for which f = 0.02. When the valve is gradually stopped over an interval of 8 seconds, the retardation of the water being proportional to $t^{5/4}$ i.e. $a \propto t^{5/4}$, where t represents the time measured from the beginning of the shut-down. Neglecting minor losses and assuming an incompressible fluid in a rigid pipe with f independent of Reynolds number, determine the head at the valve inlet and the velocity in the pipe at t = 6 seconds. [6]

3. a) Differentiate between pipe flow and open channel flow. Also, define non-uniform open channel flow with examples. [1+2]

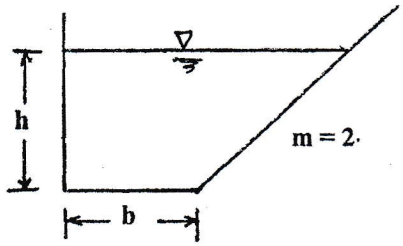
   b) Show that the minimum specific energy (E_c) is 5/4 times the critical depth (y_c) for triangular channel. [6]

   c) A rectangular channel 2m wide carries 3 m^3/s of water at a flow depth of 1.5m. What is the maximum height of the obstruction placed across the channel that will not cause a rise in the water surface upstream? [7]

4. a) If y_1 and y_2 are alternate depths in rectangular channel show that specific Energy

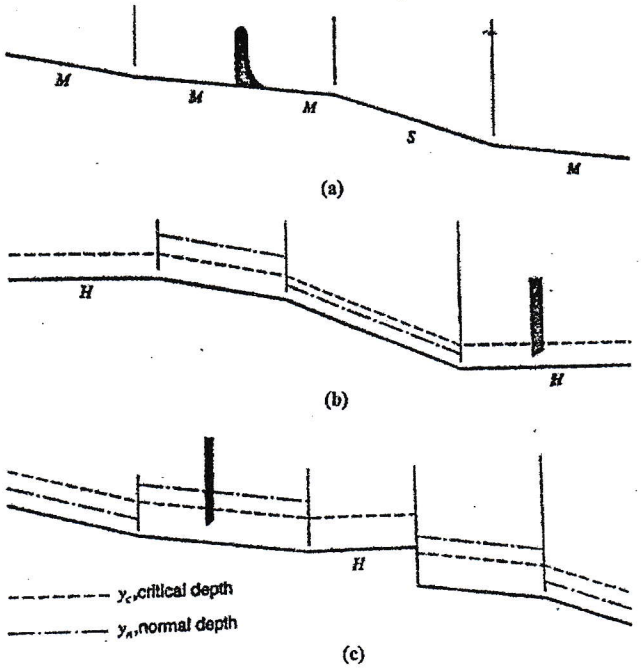
$$E = \frac{y_1^2 + y_1 y_2 + y_2^2}{(y_1 + y_2)}$$ [6]

   b) If the channel in the figure is to deliver 10 m^3/s when laid on a slope of 0.0001, calculate dimensions of the efficient section which require minimum lining. Take n = 0.015. [8]



   c) The longitudinal bed slope of Seti River is 10cm to a kilometer with hydraulic mean depth of 2.5m. Find; Chezy's coefficient and Manning's rugosity coefficient, if the velocity at the peak flood is measured to be 2.4 m/s. [2]

5. a) Sketch possible water surface profiles for the channel in figure. First locate and mark the control points, then sketch the profiles, marking each profile with appropriate designation. Show any hydraulic jumps that occur. [3+3+4]



   b) Discuss Shield's diagram and its application in designing mobile boundary channel. [6]

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