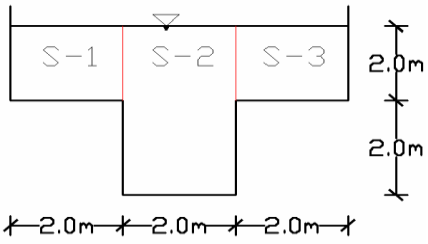
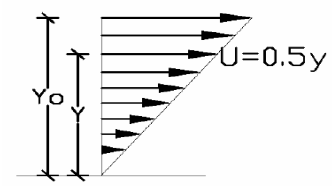
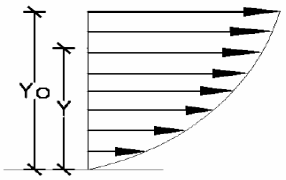
Open channel hydraulics chapter 1,2 and 3 work sheet

1. ♣.Determine the energy correction coefficient, momentum correction coefficient, hydraulic radius and section factor of the channel shown below if the mean velocities of partial areas are given below. Mean velocity for S-2 is 0.8m/s.





Velocity profile of S-1



$U = 0.5\sqrt{Y}$

Velocity profile of S-3

2. The velocity distribution in a very wide river 3m deep can be approximately as:

$$U = 1 + 2\left(\frac{y}{h}\right)^{1/2}$$ calculate α and β.

3. In a rectangular channel F1 and F2 are the Froude numbers corresponding to the alternate Depths at a certain discharge. Show that:

$$\left(\frac{F1}{F2}\right)^{2/3} = \frac{2+F2^2}{2+F1^1}$$

4. Show that in a triangular channel the Froude number corresponding to alternate depth are given by :

$$\frac{F1}{F2} = \frac{\left(4+F1^2\right)^{5/2}}{\left(4+F2^2\right)^{5/2}}$$

5. If y1 and y2 are alternate depths in a rectangular channel show that:-

$$\frac{2y_1^2y_2^2}{(y_1+y_2)} = y_c^3$$ and hence the specific energy $E = \frac{y_1^2+y_1y_2+y_2^2}{(y_1+y_2)}$

6. ♣.If y1 and y2 are alternate depths in a triangular channel show that:-

$$\frac{4y_1^4y_2^4}{(y_1^2+y_2^2)(y_1+y_2)} = y_c^5$$

7. Show that for a trapezoidal channel the minimum specific energy E_C is related to the critical depth y_c as

$$E_C = \frac{y_c}{2}\left[\frac{3+5\xi}{1+2\xi}\right]$$

8. A circular culvert 1.2m diameter is flowing half full and flow is in critical state. Estimate the discharge and the specific energy.
9. ♣.A circular channel is to carry a discharge of $5m^3$/se. find the diameter of the conduit such that the flow is critical when the conduit is running quarter full.
10. ♣A brick lined sewer has a semicircular bottom and vertical side wall 0.6m apart. If the depth of flow at a section when the flow is known to be at critical state is 0.6m. Estimate the discharge in the sewer.
11. A rectangular channel is 4.0m wide and carries a discharge of $20m^3$/s at a depth of 2.0 m. at a certain section it is proposed to build a hump. Calculate the water surface elevations at upstream of the hump and over the hump if the hump height is
    a) 0.33m and
    b) 0.2m (assume no loss of energy at the hump)
12. ♣A discharge of $16m^3$/s flows with a depth of 2m in a rectangular channel 4m wide. At a downstream section the width is reduced to 3.5m and the channel bed raised by ΔZ. Analyze the water surface elevations in the transition when
    (a) ΔZ=0.20m and
    (b) ΔZ=0.35m.
13. A rectangular channel 2.5m wide carries 6m3/s of flow at a depth of 0.5m. Calculate the Height of the flat-topped hump required to be placed at a section to cause critical flow. The energy loss due to the obstruction by the hump can be taken as 0.1 times the upstream velocity head.
14. What is the critical depth corresponding to a discharge of 5m3/s in
    a) trapezoidal channel of B=0.8 and 1.5:1 slope
    b) a circular channel of D=1.5m
15. A trapezoidal channel with bed width 6m and side slope 2:1 carries discharge of 10m3/s. Determine the critical depth, critical velocity and minimum specific energy.
16. A rectangular channel is 2.5m wide and conveys a discharge of $2.75m^3$/s at a depth of 0.9m. A constriction of width is proposed at a section in this canal. Calculate the water surface elevations in the contracted section as well as in an upstream 2.5m wide section when the width of the proposed contraction is:-

a) 2.0m
b) 1.5m (neglect energy losses in the transition).
c) What width is needed at downstream section to enable the critical flow to occur at downstream section without affecting the u/s depth?
d) Determine the minimum allowable bed width without affecting downstream section if 0.1m Smooth hump is provided at downstream section?

17. ♣Water flows at a velocity of 1m/s and depth of 2.0 m in an open channel of rectangular Cross section and bed width of 3.0m. At a certain section the width is reduced to 1.8m and bed is raised by 0.65m. Will the upstream depth be affected and if so, to what extent?
18. ♣ Water flows in a rectangular channel 3.0m wide at a velocity of 2.5 m/s and a depth of 1.8m. If at a section there is a smooth upward smooth step of 0.3m, what width is needed at that section to enable the critical flow to occur on the hump without any change in the u/s depth?
19. A rectangular channel 4m wide carries a flow at **2m** depth .at a certain section the width is reduced to **3m** and the channel bed raised by **0.3m** through a streamlined hump.

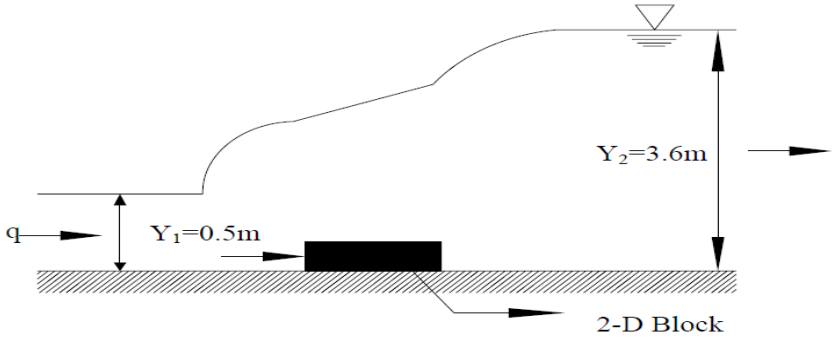
a) Estimate the discharge in the channel when the water surface drops by **0.2m** over the hump.

b) What change in the bed elevation at the contracted section would make the water surface have the same elevation upstream and downstream of the contraction?

20. A hydraulic jump occurs in a horizontal rectangular channel at an initial Froude number of 10.0. What percentage of initial energy is lost in this jump?
21. Show that the energy lost in the jump of a horizontal, frictionless rectangular channel is :

$$E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

22. A hydraulic jump in a rectangular channel has a Froude number at the beginning of the Jump F1=5. Find the Froude number F2 at the end of the jump.
23. ♣.A hydraulic jump occurs in a horizontal rectangular channel with sequent depths of 0.7m and 4.2 m. calculate the rate of the flow per unit width, energy loss and the initial Froude number.
24. A hydraulic jump assisted by a two dimensional block is formed on a horizontal apron as shown in figure below. Estimate the force F_D in KN/m width on the block when a discharge of 6.64m^3/s per m width enters the apron at depth of 0.5m and leaves it at a depth of 3.6m.

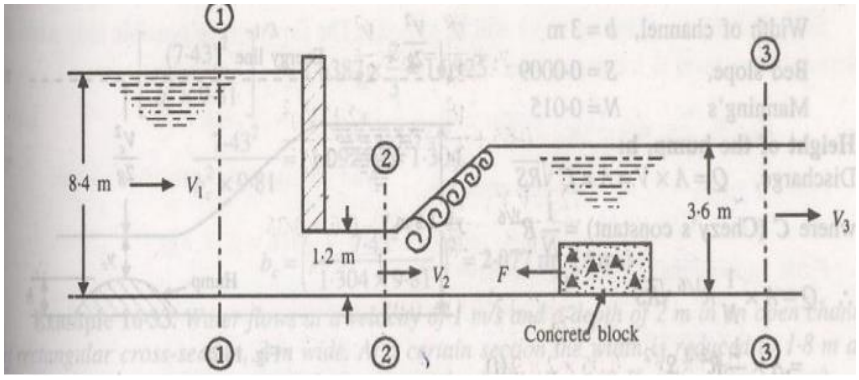


25. ♣.A sluice across a channel **7.2m** wide discharges a stream **1.2m** deep. On the downstream side concrete blocks have been placed to create condition for hydraulic jump to occur.

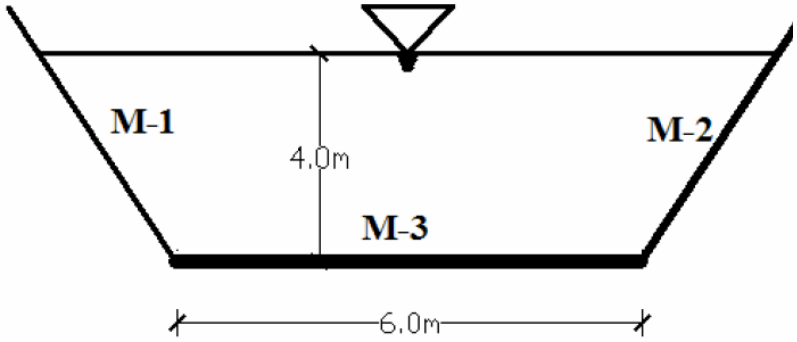
a) What is the flow rate when the depth of upstream of the sluice is **8.4**m?

b) Calculate the force on the blocks if the downstream depth is **3.6**m.

c) Estimate the energy loss due to the block



26. a trapezoidal channel of bed width 3.0m and side slope of 1.5:1 carries a full supply of 10m3/s at a depth of 1.5m.
    a) What would be the discharge at half of full supply depth (i.e. at 0.75m)?
    b) What would be the depth of half of full supply discharge?
27. a trapezoidal channel is 5.0m wide and has a side slope of 0.5:1. Find the depth of flow which can make the channel an efficient section. If So= 0.0002 and n = 0.02, find the corresponding discharge.
28. a circular channel 2.5m in diameter is made of concrete (n=0.014) and is laid on a slope of 1 in 200.
    a.) Calculate the discharge if the normal depth is 1.5m.
    b.) Calculate the depth of flow for a discharge of 15m3/s.
29. an earthen trapezoidal channel (n = 0.025) has a bottom width of 5.0m, side slope of 1.5:1 and a uniform flow depth of 1.1m. In an economic study to remedy excessive seepage from the channel two proposals are planned
    a.) to line the sides only and
    b.) to line the bed only are considered.
    If the lining is of smooth concrete (n=0.012), determine the equivalent roughness in the above two cases.
30. ♣.A trapezoidal composite channel 6.0m wide and side slope of 1:1 has bed materials M-1, M-2 and M-3 with Manning's coefficient 0.019, 0.022 and 0.012 respectively. At the first phase of the repair the side channels were lined with concrete material of 0.018 Manning's but the bed material was not repaired. Determine the percentage increase or decrease of discharge as a result of repair?



31. ♣ A rectangular channel is to be laid on a slope of 0.0005. The sides will be of smooth concrete (n=0.013). What width of channel is necessary to carry a discharge of $9m^3/s$ with a normal depth of 1.6m?
32. What size of concrete pipe is required (n=0.015) to carry a flow of 2m3/s at a depth of 0.9m diameter, when laid on a slope of 0.0002?
33. A trapezoidal channel of bed width 3m and side slope 1.5 horizontal: 1 vertical carries a full supply of $10m^3/s$ at a depth of 1.5m.
    A. What will be the discharge at half of the full supply depth (i.e. at 0.75m)?
    B. What will be the depth at half of the full supply discharge?
34. ♣A trapezoidal channel having a side slope 1.5 horizontal: 1 vertical carries a discharge of $100m^3/s$ with a depth of flow equal to 0.75 width. If So=0.0006 and n=0.015, find the bed width and depth of flow.

35. Determine the dimensions of a concrete lined (n=0.015) trapezoidal channel of efficient proportions to carry a discharge of 7m3/s. The bed slope of the channel is 0.0006 and m=1.25 (1.25H: 1V).
36. A triangular channel of apex angle 90° and a rectangular channel of the same material have the same bed slope. If the rectangular channel has the depth of fl ow equal to the width and the flow areas in both channels are the same, fi nd the ratio of discharges in the rectangular and triangular channels respectively.
37. ♣An open rectangular channel is to be designed to carry 1m3/s. The channel material has an n value of 0.011. Find the most efficient cross section. Assume S=0.015.
38. ♣ For a trapezoidal section B = 3m, side slope m = 1.5 and n = 0.02, find the
    (a) Bed slope required to have a uniform flow at a Froude number of 0.02 and depth of flow = 2.5m
    (b) Depth of flow with a bed slope of 0.0009 to cause a uniform flow Froude number of 0.5.
39. The cross section of a stream could be approximated by a rectangular section of bottom width 6m. The stream is in a mountainous region and is formed by cobbles (d_{90}=300mm). Estimate the discharge if the depth of flow is 1.5m and the bed slope is 0.001.
40. ♣ For the compound section shown in figure below. Find the discharge when h = 1 m using :
    a. Whole section method
    b. Partial discharges method (both zero shear and posey's method)
    Assume n = 0.02 and S_o =0.0005 for all parts of the perimeter.