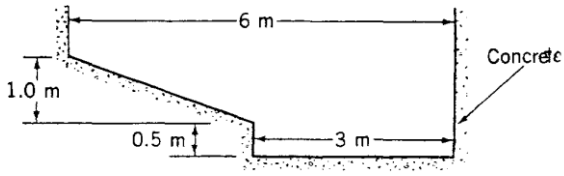
BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE
MID-SEMESTER EXAMINATION (1st SEMESTER) 2023-2024
HYDRAULIC ENGINEERING (CLOSE BOOK)

CE F312 **Dated: 14.10.2023**
Max. Marks: 50 **Max. Duration: 90 minutes**

Answer all questions. Begin each answer on a new page. Any assumptions can be made reasonably, if needed.

1. The smooth concrete-lined open channel shown in Figure is built on a slope of 2 *m/km.* Determine the flow rate if the depth of flow is y = 1.5 m. Take n=0.012. **(5M)**



2. Derive the correlation between roughness factor f and Manning's coefficient n, in open channel flow. Given $V=(8g/f)^{1/2}(RS)^{1/2}$, where R and S have the usual meaning in open channel flow. **(5M)**

3. Consider a circular pipe of radius R, maximum velocity v_{max}, the velocity at radius r from the center of the pipe as v. Velocity distribution follows in the pipe as given: $v=v_{max}\,[1-(r/R)]^{1/7}$
Find the following
(i) The ratio of the mean and the maximum velocity;
(ii) The radius at which the actual velocity equals the mean velocity. **(5M)**

4. The velocity of flow in a rough pipe increases by 10 % as the point of measurement is shifted from a point 1.5 cm from the wall to a point 3.0 cm from the wall. The diameter of the pipe is 100 mm.
$\frac{u}{u_*}=5.75\log\frac{y}{\varepsilon}+8.5,\ \frac{1}{\sqrt{f}}=2\log\frac{r0}{\varepsilon}+1.74$
Estimate the relative roughness and friction factor for the pipe if the velocity at point 1.5 cm from the wall is 1 m/s and the density of the fluid is 1000 kg/m^3. **(5M)**

5. A smooth two-dimensional flat plate is exposed to a wind velocity of 300 km per hour. If the laminar boundary layer exists up to a value of Re_x equal to 3×10^5, find the maximum distance up to which the laminar boundary layer persists, and find its maximum thickness. Assume the kinematic viscosity of air as 4.47×10^{-5} m^2/s. **(5M)**

6. Compare the cost of pumping water between two sections at the same volumetric rate in 10 cm and 15 cm diameter pipes with the same absolute roughness magnitude of 0.2 mm. The pipe is laid horizontally. Flow is a fully developed rough-turbulent flow. $\frac{1}{\sqrt{f}}=2\log\frac{r0}{\varepsilon}+1.74$. **(10M)**

7. Answer the following (Tick the correct answer) **(0.5x30=15M)**

1. In a pipe flow the shear velocity u_* is related to friction factor f and mean velocity V as u_*/V

a) $\sqrt{\frac{f}{8}}$ b) $\sqrt{\frac{8}{f}}$ c) $\sqrt{\frac{8g}{f}}$ d) $\frac{1}{\sqrt{f}}$

2. In a pipeline design the usual practice is to assume that due to aging
a) the effective roughness increases linearly with time
b) the friction factor increases linearly with time
c) the pipe becomes smoother with time
d) the friction factor decreases linearly with time

3. In a boundary layer flow the parameter $u_*\varepsilon/\nu$ was equal to 12. The boundary can be classified hydrodynamically as
a) smooth b) rough c) in transition d) unstable

4. The rate of growth of the boundary layer thickness with the longitudinal distance on a flat plate
a) is faster when the boundary layer is laminar than when it is turbulent
b) is the same whether the boundary layer is laminar or turbulent
c) is faster in a turbulent boundary layer when compared to that in a laminar boundary layer
d) depends only on the aspect ratio of the plate

5. Uniform flow in an open channel exists when the flow is steady and the
a) channel is frictionless
b) channel is non-prismatic
c) channel is prismatic
d) channel is prismatic and the depth of flow is constant along the channel.

6. The turbulent shear stress in **xy** plane is given by
a) $\overline{\rho u'^2}$ b) $\frac{1}{\rho}\overline{(u'v')}$ c) $\rho u'v'$ d) $-\overline{\rho u'v')}$

7. For hydrodynamically smooth pipes the friction factor f
a) is a constant b) is a function of $\varepsilon_s/\boldsymbol{r_0}$ only
c) is a function of Re and $\varepsilon_s/\boldsymbol{r_0}$ only d) is a function of Re only
where Re =Reynolds Number and $\varepsilon_s/\boldsymbol{r_0}$= relative roughness*

8. In a pipe network

a) the algebraic sum of discharges around each elementary circuit must be zero

b) the head at each node must be the same

c) the algebraic sum of the piezometric head drops around each elementary circuit is zero

d) the piezometric head loss in each line of a circuit is the same

9. If the velocity distribution in a laminar boundary layer can be assumed as $u/U = y/\delta$ the ratio of momentum thickness θ to nominal thickness d is given by θ/δ =

a) 1/2 b) 1/3 c) 1/6 d) 1.25

10. A laminar boundary layer has a velocity distribution given by $u/U = y/\delta$. The displacement thickness δ^*) for this boundary layer is

a) δ b) $\delta/2$ c) $\delta/4$ d) $\delta/6$

11. Uniform flow in a channel is characterized by the following statement:

a) Total energy remains constant along the channel.

b) Gradient of the total energy is parallel to the channel bed

c) Specific energy decreases along the channel.

d) Total energy line either rises or falls depending upon the Froude number.

12. In pipe flow the Prandtl mixing length ***l*** is assumed as equal to

a) ky^2 b) ky c) k log y d) -k/y

13. In using Darcy–Weisbach equation for flow in a pipe, the friction factor is misjudged by + 25%. The resulting error in the estimated discharge Q is

a) +25% b) –16.67% c) –5% d) –12.5%

14. Two tanks are connected in parallel by two pipes A and B of identical friction factors and lengths. If the size of pipe A is double than that pipe B, then their discharges will be in the ratio of

a) 2 b) 4 c) 5.66 d) 32

15. The following boundary conditions exist at the wall y = 0) in a boundary layer

a) u = U b) dp/dx = – ve c) $\tau_0 = 0$ d) u = 0, v = 0

16. The velocity distribution in a turbulent flow is given by

a) Blausius equation b) Prandlt's velocity deficiency equation

c) Parabolic velocity distribution d) logarithmic distribution

17. Manning's roughness coefficient n is related to Darcy–Weisbach friction factor *f* as

a) $n = \left[\frac{fR^{1/3}}{8g}\right]^{1/2}$ b) $n = R^{1/3}/\sqrt{8g/f}$

c) $n = \sqrt{\frac{8fR^{1/3}}{g}}$ d) $n = R^{1/6}/\sqrt{8g/f}$

18. In a turbulent flow, $\bar{u}, \bar{v}$ and $\bar{w}$ are time averaged velocity components. The fluctuating components are u', v' and w' respectively. The average kinetic energy per unit mass is given by

a) $\frac{1}{T}\int_0^T u'v'dt$ b) $\frac{1}{2}(\bar{u}'^2 + \bar{v}'^2 + \bar{w}'^2)$

c) $\sqrt{\frac{1}{3}u^2 + v^2 + w^2)}$ d) $\frac{1}{V}\sqrt{\frac{1}{3}(\bar{u}'^2 + \bar{v}'^2 + \bar{w}'^2)}$

19. Minor losses in a pipe flow are those losses

a) which is insignificantly small b) which can be neglected always

c) caused by local disturbance due to pipe fittings d) caused by frictional resistance

20. Three pipes are connected in series. Then

a) the head loss in each pipe is the same

b) the total discharge is the sum of the discharge in the individual pipes

c) the discharge through each pipe is the same

d) the Reynolds number for each pipe is the same

21. The separation of boundary layer takes place when the pressure gradient is

a) negative b) positive c) zero d) constant

22. The separation of a boundary layer occurs when

a) the flow is accelerated past a boundary b) the boundary layer comes to rest

c) any adverse pressure is encountered d) the fluid is ideal

23. The Chezy coefficient C and Manning's n are related as

a) $C = n^{1/3} * R^{1/6}$ b) $C = \frac{1}{n}R^{1/6}$ c) $C = \frac{n^{1/6}}{R}$ d) $n = C * R^{1/6}$

24. The dimensions of Manning's roughness coefficient n are

a) $L^{1/2}T^{-1}$ b) $L^{-1/3}T$ c) $M^0L^0T^0$ d) L

25. The intensity of turbulence refers to

a) Correlation of u' and v'

b) average kinetic energy of turbulence per unit mass
c) root mean square value of turbulent velocity fluctuations
d) the Reynolds stresses

26. Two pipe systems in series are said to be equivalent when
a) the average diameter in both systems is the same
b) the average friction factor in both systems is the same
c) total length of the pipe is the same in both the systems.
d) the discharge under the same head is the same in both systems.

27. At the point of separation
a) velocity is negative
b) shear stress is zero
c) shear stress is maximum
d) pressure gradient is zero

28. In a boundary layer developed along the flow, the pressure decreases along the downstream direction. The boundary layer thickness would
a) tend to decrease along the flow
b) remain constant
c) increase rapidly along the flow
d) increase gradually along the flow

29. The dimensions of Chezy coefficient C are
a) $L^{-1/3}T^{1}$
b) $M^{0}L^{0}T^{0}$
c) $L^{1/2}T^{-1}$
d) LT^{-1}

30. Prandtl's mixing length in a pipe flow is
a) constant
b) zero at the pipe wall
c) a function of the shear stress at the wall
d) a function of the Reynold's number