MADE EASY

India's Best Institute for IES, GATE & PSUs

PTQ

Prelims Through Questions

for

ESE 2021

Civil Engineering

Day 11 of 11

Q.451 - Q.450

(Out of 500 Questions)

Fluid Mechanics + Engg. Hydrology + Irrigation

www.madeeasy.in

Fluid Mechanics + Engg. Hydrology + Irrigation

Q.451 Consider the following conditions for any network of pipes:
1. The flow into each junction must be equal to the flow out of the junction.
2. The algebraic sum of head losses around each loop must be zero.
3. The head loss in each pipe is expressed as $h_e = rQ^n$.

Which of the above statements are CORRECT?
(a) 1 and 2
(b) 2 and 3
(c) 1 and 3
(d) 1, 2 and 3

451. (d)

Q.452 A Pitot tube (coefficient = 1.0) is used to measure the velocity of an air mass of density 1.2 kg/m^3. If the head difference in a vertical u-tube manometer filled with water is 12 mm, then the velocity of air (in m/s) is
(a) 10
(b) 14
(c) 17
(d) 20

452. (b)

$$v = C\sqrt{2g\Delta h}$$

$$\Delta h = X\left(\frac{s_w}{s_{air}} - 1\right)$$

$$= 0.012\left(\frac{1000}{1.2} - 1\right)$$

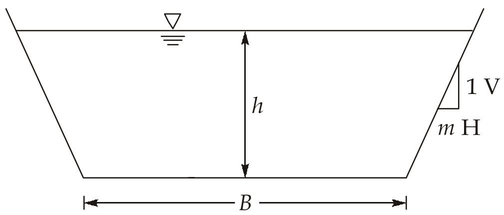
$$= 9.988 \text{ m}$$

$$v = \sqrt{2g \times 9.988}$$

$$\therefore \quad v = 13.99 \simeq 14 \text{ m/s}$$

Q.453 When discussing most efficient section in open channels, what is the perimeter, P as a proportion of depth of flow h $\left(\text{i.e } \frac{P}{h}\right)$ for a trapezoidal section?
(a) $\frac{6}{\sqrt{3}}$
(b) $\frac{\sqrt{3}}{6}$
(c) $\frac{8}{\sqrt{3}}$
(d) $\frac{\sqrt{3}}{8}$

453. (a)



For most efficient trapezoidal section

$$m = \frac{1}{\sqrt{3}} \text{ and } B = \frac{2}{\sqrt{3}}h$$

$$\therefore \quad P = B + 2h\sqrt{m^2+1}$$

$$\Rightarrow \quad P = \frac{2}{\sqrt{3}}h + 2h\sqrt{\left(\frac{1}{\sqrt{3}}\right)^2 + 1}$$

$$\Rightarrow \quad \frac{P}{h} = \frac{2}{\sqrt{3}} + \frac{4}{\sqrt{3}}$$

$$\Rightarrow \quad \frac{P}{h} = \frac{6}{\sqrt{3}}$$

Q.454 In the Moody's diagram the values of f for turbulent flow are based on
(a) Nikurade's uniform sand grain data
(b) Data on non-uniform sand grains coated to a pipe
(c) Colebrook-White data on commercial pipes
(d) Hazen-William pipe flow formula

454. (c)

Moody's diagram shows the variation of $f = f_n\left(\text{Re}, \frac{K_s}{D}\right)$ for the full range of Reynolds number.

(Colebrook formula)

Q.455 Two homogeneous pumps runs at a same speed of 500 rpm. Pump A has diameter 50 cm and discharges 0.6 m^3/s of water under net head of 50 m. If discharge in pump B is 0.3 m^3/s, then the diameter of impeller of pump B is [Take $\sqrt[3]{2} = 1.26$]

(a) 67.8 cm (b) 83.4 cm
(c) 39.7 cm (d) 21.4 cm

455. (c)

$$\left(\frac{Q_A}{N_A D_A^3}\right) = \left(\frac{Q_B}{N_B D_B^3}\right)$$

$$\Rightarrow \quad D_B = \left[\left(\frac{0.3}{0.6}\right) \times (50)^3\right]^{1/3} \qquad (N_A = N_B \text{ given})$$

$$= 50 \times \frac{1}{(2)^{1/3}} = 50 \times \frac{1.26}{}$$

$$= 39.68 \text{ cm} \simeq 39.7 \text{ cm}$$

Q.456 In a 5 cm diamater pipeline carrying laminar flow of liquid with μ = 1.5 centipoise, the velocity at the axis is 2 m/s. What is the shear stress midway between the wall and the pipe axis?
(a) 0.12 N/m^2 (b) 0.06 N/m^2
(c) 0.24 N/m^2 (d) 0.48 N/m^2

456. (a)

$$u = -\frac{1}{4\mu}\left(\frac{\partial P}{\partial x}\right)(R^2 - r^2)$$

At $r = 0$, $u = 2$ m/s

$$2 = -\frac{1}{4\mu}\left(\frac{\partial P}{\partial x}\right)R^2 \quad \text{...(i)}$$

We know that,
$$\tau = -\frac{r}{2}\left(\frac{\partial P}{\partial x}\right) \quad \text{...(ii)}$$

By equation (i) and (ii), we get

$$\frac{\tau}{2} = \frac{-\frac{r}{2}\left(\frac{\partial P}{\partial x}\right)}{-\frac{1}{4\mu}\left(\frac{\partial P}{\partial x}\right)R^2}$$

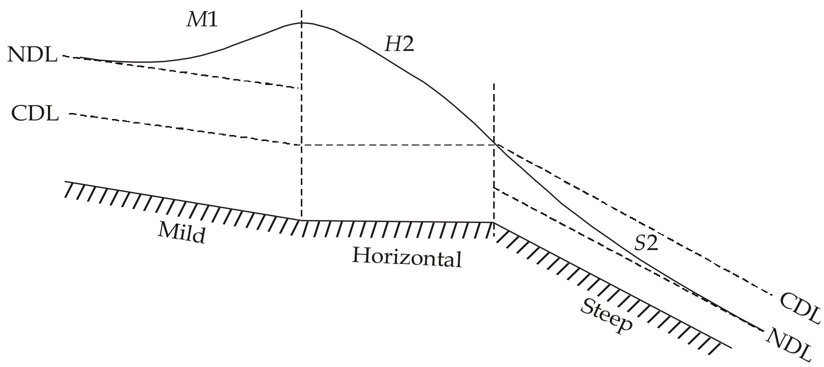
$$\tau = \frac{4\mu r}{R^2} = \frac{4 \times (0.15 \times 10^{-2}) \times (0.0125)}{(0.025)^2}$$

$$= 0.12 \text{ N/m}^2$$

Q.457 A channel with mild slope is followed by a horizontal channel and then by a steep channel. What gradually varied flow profiles will occur?

(a) M1, H2, S1
(b) M2, H2, S2
(c) M1, H2, S3
(d) M1, H2, S2

457. (d)



Q.458 For a turbulent boundary layer (under zero pressure gradient), the velocity profile is described by the one-fifth power law. What is the ratio of displacement thickness to boundary layer thickness?

(a) $\frac{1}{7}$
(b) $\frac{1}{6}$
(c) $\frac{1}{5}$
(d) $\frac{1}{4}$

458. **(b)**

$$\frac{u}{U} = \left(\frac{y}{\delta}\right)^{1/5}$$

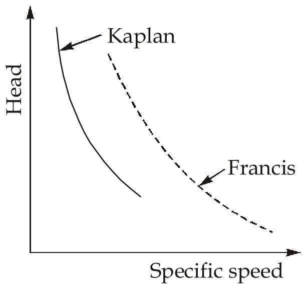
Displacement thickness,

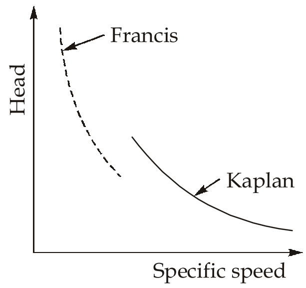
$$\delta^* = \int_0^\delta \left(1 - \frac{u}{U}\right) dy = \int_0^\delta \left[1 - \left(\frac{y}{\delta}\right)^{\frac{1}{5}}\right] dy$$

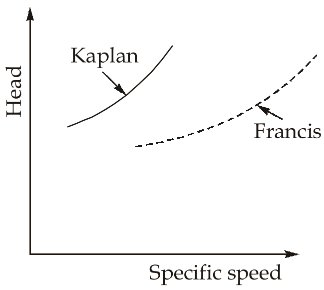
$$= \left[\delta - \frac{(\delta)^{6/5} \times 5}{(\delta)^{1/5} \times 6}\right] = \left[\delta - \frac{5\delta}{6}\right] = \frac{\delta}{6}$$

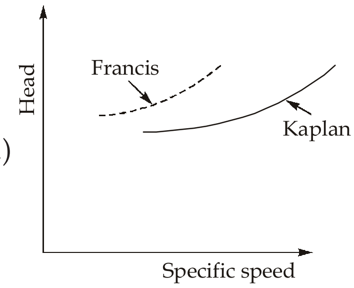
$$\therefore \quad \frac{\delta^*}{\delta} = \frac{1}{6}$$

Q.459 Which one of the following graph correctly represents the relationship between head and specific speed for Kaplan and Francis turbine?

(a)


(b)


(c)


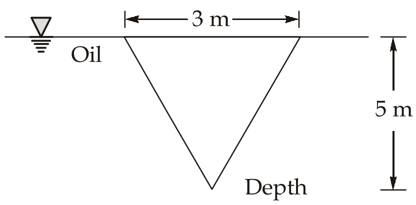
(d)


459. **(b)**

Q.460 An isosceles triangular plate of base 3 m and altitude 5 m is immersed vertically in an oil of specific gravity 0.8. The base of the plate coincides with the free surface of oil. The centre of pressure will lie at a distance of (from free surface).

(a) 2.5 m
(b) 2 m
(c) 1.33 m
(d) 1.5 m

460. **(a)**



Centre of pressure depth, $\bar{h} = \bar{x} + \frac{I_a}{A\bar{x}}$

$$= \frac{5}{3} + \frac{5^3 \times 3}{36 \times \frac{1}{2} \times 5 \times 3 \times \frac{5}{3}}$$

$$= \frac{5}{3} + \frac{5}{6} = 2.5 \text{ m}$$

Q.461 Consider the following statements:

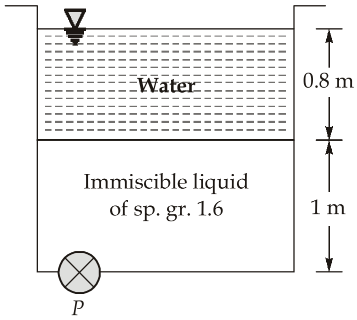
1. Direct step method of computation for gradually varied flow is applicable to both prismatic and non-prismatic channels.
2. For the most economical trapezoidal section of an open channel, half of the top flow width is equal to length of the sloping side.

Which of the above statement(s) is(are) CORRECT?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

461. (b)
Direct step method is suitable for use in prismatic channels only.

Q.462 What is the gauge pressure at point P in the figure? Assume g = 10 m/s^2

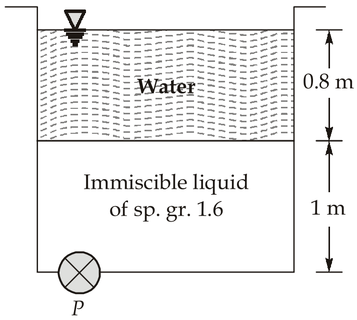


1. 2.4 m of oil 2. 1.5 m of water
3. 15 kPa 4. 24 kPa

Select the correct answer using the codes given below:

(a) 1 and 4 (b) 2 and 3
(c) 1 only (d) 4 only

462. (d)



$$\text{Total pressure at } P = \gamma_w \times 0.8 + 1.6\,\gamma_w \times 1$$
$$= 2.4\,\gamma_w = (2.4 \text{ m of water}$$
$$= 2.4 \times 10000$$
$$= 24 \text{ kPa}$$

Q.463 If a single pipe of length L and diameter D is to be replaced by three pipes of same material, same length and equal diameter d ($d < D$) connected in series to convey the same total discharge under the same head loss, then d and D are related by

(a) $D = \dfrac{d}{3^{1/5}}$ (b) $D = \dfrac{d}{2^{5/3}}$

(c) $D = \dfrac{d}{3^{2/3}}$ (d) $D = \dfrac{d}{2^{3/2}}$

463. (a)

$$\frac{L}{D^5} = \frac{L_1}{D_1^5} + \frac{L_2}{D_2^5} + \frac{L_3}{D_3^5}$$

Since,
$$L_1 = L_2 = L_3 = L$$
$$D_1 = D_2 = D_3 = d$$

$\therefore$
$$\frac{L}{D^5} = \frac{L}{d^5} + \frac{L}{d^5} + \frac{L}{d^5}$$

$\Rightarrow$
$$D = \frac{d}{(3)^{1/5}}$$

Q.464 A pelton wheel works under a head of 400 m. Frictional loss through the pipe flow is limited to 10%. The coefficient of velocity for the jet is 0.98. What is the velocity of the jet? [Take, g = 10 m/s^2]

(a) 83 m/s (b) 85 m/s

(c) 87 m/s (d) 89 m/s

464. (a)

$$\text{Head at the nozzle} = 0.9 \times 400$$
$$= 360 \text{ m}$$

$\therefore$
$$\text{Velocity of jet, } v = C_v\sqrt{2gH}$$
$$v = 0.98\sqrt{2 \times 10 \times 360}$$
$$\simeq 83 \text{ m/s}$$

Q.465 In the case of flow over a flat plate, growth of the boundary layer δ/x

(a) decreases with an increase in the kinematic viscosity in both laminar and turbulent boundary layers.

(b) increases with an increase in the free stream velocity in both laminar and turbulent boundary layers.

(c) decreases with an increase in the free stream velocity only if the boundary layer is laminar.

(d) increases with an increase in the kinematic viscosity in both laminar and turbulent boundary layers.

465. (d)

For laminar boundary layer flow, $\frac{\delta}{x} \propto \frac{1}{\sqrt{\text{Re}_x}} \propto \sqrt{\frac{\nu}{Vx}}$

For turbulent boundary layer flow, $\frac{\delta}{x} \propto \frac{1}{(\text{Re}_x)^{1/5}} \propto \left(\frac{\nu}{Vx}\right)^{1/5}$

Therefore, as kinematic viscosity increases $\frac{\delta}{x}$ increases.

Q.466 The discharge was measured in a small stream. It was found that the depth of flow increase at a rate of 0.20 m/hr. If the discharge at that section was 30 m^3/s and the surface width of the stream was 18 m, then the discharge at a section 1200 m upstream was (in m^3/s).

(a) 32.20
(b) 28.8
(c) 35.35
(d) 31.20

466. (d)

This is a case of unsteady flow and the continuity equation will be used

$$T\frac{dy}{dt} = \frac{18 \times 0.20}{60 \times 60} = 0.001$$

$$\Rightarrow \quad \frac{Q_2 - Q_1}{\Delta x} = \frac{\partial Q}{\partial x} = -T\frac{\partial y}{\partial t}$$

Discharge at the upstream section,

$$Q_1 = Q_2 + T\frac{\partial y}{\partial t}\cdot \Delta x = 30 + 1200 \times 0.001$$

$$= 31.2 \text{ m}^3/\text{s}$$

Q.467 The capillary rise of water at 20°C in a clean glass tube, 1.0 mm in diameter is about (Assume surface tension of water at 20°C as 0.07 N/m)

(a) 28.54 mm
(b) 28.20 mm
(c) 27.65 mm
(d) 27.30 mm

467. (a)

$$h = \frac{2\sigma\cos\theta}{\rho g R}$$

Now, $\sigma = 0.07$ N/m, $\theta = 0°$

$\therefore$ $\cos\theta = 1$

$D = 1$ mm

$\rho = 1000 \text{ kg/m}^3$

$g = 9.81 \text{ m/s}^2$

$R = \frac{D}{2} = 0.5 \text{ mm} = 0.5 \times 10^{-3}$ m

$$\therefore \quad h = \frac{2 \times 0.07 \times \cos 0}{1000 \times 9.81 \times 0.5 \times 10^{-3}} \times 10^3 \text{ mm}$$

$$= 28.54 \text{ mm}$$

Q.468 A nozzle discharges water at a velocity of 20 m/s. If the head loss through the nozzle is 6 m, then the coefficient of velocity of this nozzle will be
(a) 0.98 (b) 0.95
(c) 0.90 (d) 0.88

468. (d)

H_L = Head loss through nozzle
c_v = Coefficient of velocity
v = Velocity of fluid

$$\therefore \quad H_L = 6 = \left[\frac{1}{c_v^2} - 1\right] \cdot \frac{v^2}{2g}$$

$$\therefore \quad \frac{1}{c_v^2} = \frac{2 \times 9.81 \times 6}{400} + 1 = 1.29$$

$$\Rightarrow \quad c_v = \frac{1}{\sqrt{1.29}} = 0.88$$

Q.469 In a 1:50 model of a spillway, the discharge was measured to be 0.3 m^3/s. The corresponding prototype discharge in m^3/s is [Take $(50)^{0.5} = 7.07$]
(a) 12.0 (b) 215.0
(c) 1106.0 (d) 5303.0

469. (d)

$$Q_r = (L_r)^{2.5}$$

$$\frac{Q_p}{Q_m} = (50)^{2.5}$$

$$\Rightarrow \quad Q_p = 0.3 \times (50)^{2.5} = 5303.3 \text{ m}^3/\text{s}$$

Q.470 A Francis turbine has an inlet diameter of 2 m and an outlet diameter of 1 m. The breadth of the blades is constant as 0.2 m. The peripheral velocity at inlet is given as 25 m/s. The vanes are radial at the inlet and the discharge is radially outwards at the outlet. The peripheral velocity of the blade at outlet will be
(a) 15 m/s (b) 25 m/s
(c) 20 m/s (d) 12.5 m/s

470. (d)
Peripheral velocity at inlet,

$$u_1 = \frac{\pi D_1 N}{60} = \frac{\pi \times 2 \times N}{60} = 25 \text{ m/s}$$

$$N = \frac{750}{\pi} \text{ rpm}$$

Peripheral velocity at outlet,

$$u_2 = \frac{\pi D_2 N}{60} = \frac{\pi \times 1 \times 750}{\pi \times 60} = 12.5 \text{ m/s}$$

Q.471 An air stream flows over a smooth plate with Reynolds number of 10^6. The boundary layer can be assumed to be turbulent over the entire plate. If the length of the plate is increased by 10%, taking all the factors same, what is percentage change in the total drag coefficient?
[Take $(1.1)^{0.2} = 1.019$]

(a) 4% (b) 2%
(c) 5% (d) 1%

471. (b)

Drag coefficient, $$C_D = \frac{0.074}{(\text{Re})^{1/5}}$$

$$\text{Re} = \frac{\rho v L}{\mu}$$

$\Rightarrow$ Re $\propto L$ if other factor remains constant.

$$\therefore \quad \frac{C_{D_1}}{C_{D_2}} = \left(\frac{1.1}{1}\right)^{1/5}$$

$$\Rightarrow \quad C_{D_2} = 0.98\, C_{D1}$$

$$\therefore \quad \%\ \text{change} = 2\%$$

Q.472 Consider the following statements regarding streamlines:
1. There is no flow across a streamline.
2. In the region where the streamlines converge, a phenomenon known as separation of flow generally occurs.
3. Any function ψ which is continuous is a possible case of fluid flow which may be rotational or irrotational.

Which of the above statement(s) is(are) CORRECT?

(a) 1 only (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

472. (b)
Statement 2 is incorrect. In the region where the streamlines diverge, a phenomenon known as separation of flow generally occurs. That is, in such cases the flowing fluid does not remain in contact with the boundary surface i.e. it separates from the boundary.

Q.473 In Couette flow with zero pressure gradient the shear stress τ_0 at the boundary is given by

(a) $\tau_0 = \frac{UB}{\mu}$ (b) $\tau_0 = \frac{\mu U}{B}$

(c) $\tau_0 = \frac{B}{\mu}$ (d) $\tau_0 = \frac{\mu B}{U}$

Where: B = Gap between the plates
U = Velocity of the moving upper plate

473. (b)

$$\therefore \quad u = \frac{Uy}{B} - \frac{1}{2\mu}\left(\frac{\partial p}{\partial x}\right)(By - y^2)$$

$$\because \quad \frac{\partial p}{\partial x} = 0$$

$$\therefore \quad u = \frac{Uy}{B}$$

$$\because \quad \tau = \mu\frac{du}{dy}$$

At $y = b$, $u = U$

$$\therefore \quad \tau_0 = \frac{\mu U}{B}$$

Q.474 Consider the following data of gravity dam:

Maximum vertical stress at toe = 2000 kN/m^2.

Intensity of water pressure = 60 kN/m^2 on downstream side.

Downstream slope of dam = 3H : 4V.

The major principal stress at toe will be

(a) 3091.25 kN/m^2
(b) 4000 kN/m^2
(c) 3791.25 kN/m^2
(d) None of these

474. (a)

$$\text{Slope} = \tan\alpha = \frac{3}{4}$$

$$\therefore \quad \sin\alpha = \frac{3}{5} \qquad \cos\alpha = \frac{4}{5}$$

$\therefore$ Major principal stress at toe,

$$\sigma_1 = \sigma_{r(toe)}\sec^2\alpha - p\tan^2\alpha$$

$$= 2000 \times \frac{1}{(4/5)^2} - 60 \times \left(\frac{3}{4}\right)^2$$

$$= 3091.25 \text{ kN/m}^2$$

Q.475 Consider the following statements:

1. Cyclonic precipitation is due to convergence of storms towards a high pressure belt.
2. Station year method is a method of extending the length of record for a frequency curve at a station.
3. As per IS code recommendation, there should be one gauge per 260 km^2 in predominately hilly region with heavy rainfall.
4. Symon's rainguage does not produce the mass curve of precipitation as record.

Which of the above statements are CORRECT?

(a) 1 and 3
(b) 3 and 4
(c) 2 and 4
(d) 1 and 2

475. (c)

Cyclonic precipitation is due to convergence of storms towards a low pressure belt.

As per IS code recommendation, there should be one gauge per 130 km^2 in predominately hilly region with heavy rainfall.

Symon's rainguage is non-recording raingauge.

Q.476 The rainfall in 3 successive 6 hours periods is 1.2, 4.0 and 3.0 cm. If the initial basin loss is 0.6 cm and the surface runoff resulting from this rain storm is 4 cm, then the ϕ-index for the storm is

(a) 0.23 cm/h (b) 0.25 cm/h
(c) 0.46 cm/h (d) 0.50 cm/h

476. (b)

$$\text{Total loss} = P - Q = (1.2 + 4 + 3) - 4 = 8.2 - 4 = 4.2 \text{ cm in } 18h$$

$$\therefore \quad W_{index} = \frac{4.2}{18} \text{ cm/h} = 0.233 \text{ cm/h}$$

Since ϕ_{index} will be equal to or slightly more than this, the minimum potential infiltration per $6h = 6 \times 0.233 = 1.4$ cm. This shows that 1st $6h$ period cannot contribute to runoff, and the 2nd and 3rd 6h periods will give rise to direct runoff. If ϕ_{index} is x, then direct runoff ordinate

$$=(4.0 - 6x) + (3.0 - 6x) = 4.0 \text{ cm (given)}$$

$$\therefore \quad 12x = 3.0$$

$$\Rightarrow \quad x = 0.25 \text{ cm/h}$$

Hence, $\phi_{index} = 0.25$ cm/h

Q.477 For a drainage basin of 600 km^2, isohyets drawn for a storm gave the following data:

Isohyets interval (cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyets area (km^2)	92	128	120	175	85

The average depth of precipitation over the catchment, is

(a) 8.23 cm (b) 7.41 cm
(c) 6.82 cm (d) 5.97 cm

477. (b)

$$\text{Average depth} = \frac{13.5 \times 92 + 10.5 \times 128 + 7.5 \times 120 + 4.5 \times 175 + 2 \times 85}{92 + 128 + 120 + 175 + 85} = 7.41 \text{ cm}$$

Q.478 Consider the following statements:

1. Soil moisture tension (SMT) is force per unit area that must be exerted in order to extract water from soil.
2. If plant has to exert more force that means soil has less tenacity.
3. SMT is usually expressed in terms of atmosphere.

Which of the above statement(s) is(are) CORRECT?

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 3 only

478. (c)

If plant has to exert more force then it means soil has more tenacity.

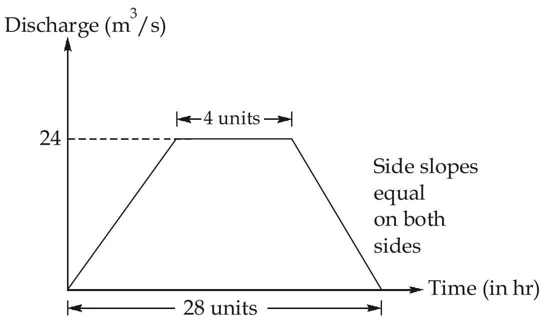
Q.479 Which of the following energy dissipaters are suitable when tail water curve lies above post jump height?

1. Slopping apron above river bed
2. Roller bucket
3. Ski jump bucket
4. Slopping apron below river bed

(a) 1, 2 and 3 (b) 3 and 4
(c) 1 and 2 (d) All of the above

479. (c)

Q.480 A 2-hour unit hydrograph can be approximated as trapezium as shown in figure. The UH refers to catchment of area



(a) 138.24 km^2 (b) 0.0384 km^2
(c) 384 km^2 (d) 3840 km^2

480. (a)

$$1 \text{ cm} \times \text{Area of catchment} = \frac{28+4}{2} \times 24 = 384 \text{ m}^3/\text{s-hr}$$

$$\Rightarrow \quad 1 \times 10^{-2} \times A = 384 \times 3600$$

$$\Rightarrow \quad A = \frac{384 \times 3600 \times 100}{10^6} \text{ km}^2 = 138.24 \text{ km}^2$$

Q.481 Match **List-I** (Type of hydrograph) with **List-II** (Characteristics) and select the correct answer using the codes given below the lists:

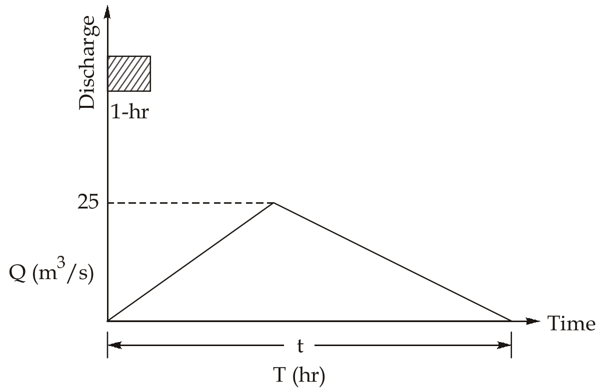
List-I	**List-II**
A. Synthetic unit hydrograph	**1.** A unit hydrograph with ordinates showing the percentage of the surface runoff.
B. Instantaneous unit hydrograph	**2.** A hydrograph of Infinitesimally small duration and of unit rainfall excess.
C. S-hydrograph	**3.** A unit hydrograph constructed based on empirical equation suiting to regions.
D. Distribution hydrograph	**4.** A hydrograph produced by a continuous effective rainfall at a constant rate for an infinite period.

Codes:

	A	B	C	D
(a)	3	2	4	1
(b)	2	3	4	1
(c)	2	4	3	1
(d)	4	3	1	2

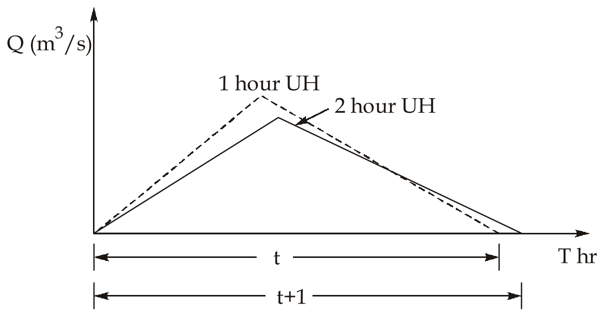
481. (a)

Q.482 Assuming the given 1-hr UH to be triangular in shape with the time to peak as 1-hr, the peak of the 2-hr UH for the catchment (in m^3/s) is



(a) > 25
(b) < 25
(c) = 25
(d) Insufficient data

482. (b)



For 2-hr UH, the base time will increase, hence peak will go down.

Q.483 The flood data and base flow in a storm are estimated for a storm in a catchment area of 600 km^2. Find the rainfall excess.

Time (in days)	0	1	2	3	4	5	6
Discharge (m^3/s)	20	63	151	133	90	29	20
Base flow (m^3/s)	20	22	25	28	28	21	20

(a) 5.73 cm
(b) 4.92 cm
(c) 2.68 cm
(d) None of these

483. (b)

Ordinates of DRH after the separation of base flow:

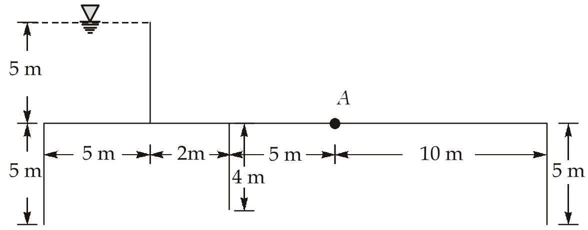
0, 41, 126, 105, 62, 8, 0 m^3/s

Runoff depth of rainfall excess

$$= \frac{\Sigma O \times t}{A} = \frac{342 \times 1 \times 24 \times 60 \times 60}{600 \times 10^6} \times 100$$

$$= 4.92 \text{ cm}$$

Q.484 Consider the following hydraulic structure formed on sand:



The uplift pressure at point A is

[Use Bligh's creep theory and take γ_w = 10 kN/m^3]

(a) 30 kN/m^2
(b) 25 kN/m^2
(c) 10 kN/m^2
(d) 20 kN/m^2

484. (d)

Length of creep $= 2 \times 5 + 5 + 2 + 2 \times 4 + 5 + 5 + 2 \times 5$

$= 50$ m

∴ Hydraulic gradient $= \frac{5}{50} = \frac{1}{10}$

Now, length of creep upto point A

$= 2 \times 5 + 5 + 2 + 2 \times 4 + 5 = 30$ m

∴ Unbalanced head at A, $h = 5\left(1 - \frac{30}{50}\right) = 2$ m

∴ Uplift pressure at A, $= \gamma_w h = 20$ kN/m^2

Q.485 Wheat is to be grown in the field having value of field capacity equal to 30% and permanent wilting point is 15%. If the dry unit weight of soil is 20 kN/m^3 then maximum storage capacity will be [Take depth of soil is 80 cm]

(a) 24 cm
(b) 30 cm
(c) 21 cm
(d) 12 cm

485. (a)

$$\text{Max. storage capacity} = \frac{\gamma_d\, d}{\gamma_w}\left[\text{Field capacity} - \text{Permanent Wilting point}\right]$$

$$= \frac{20}{10} \times 0.8[0.3 - 0.15] = 0.24 = 24 \text{ cm}$$

Q.486 Which of the following is(are) the correct reasons for providing cutoff in earth dam?

1. To reduce uplift pressure.
2. To reduce loss of stored water.
3. To support the dam.

(a) 1 and 2 (b) 1 only
(c) 2 and 3 (d) All of the above

486. (a)

Q.487 The Muskingham method of flood routing is a

(a) form of hydraulic routing of a flood
(b) complete numerical solution of St. Venant's equations
(c) hydrological channel routing method
(d) None of these

487. (c)

However, in channel routing the storage is a function of both outflow and inflow discharge and hence a different routing method is needed. From muskingum method of hydrological channel routing, storage is given by

$$S = k\left[xI^m + (1-x)Q^m\right]$$

Q.488 A temporary coffer dam is to be built to protect the 5 year construction activity for a major cross valley dam. If the coffer dam is designed to withstand the 20 year flood, the risk that the structure will be toppled over by flood in the third year exactly is

(a) 3.43% (b) 4.51%
(c) 5.36% (d) 3.86%

488. (b)

Probability of occurrence, $P = \frac{1}{T} = \frac{1}{20}$

Probability of non occurrence $= 1 - \frac{1}{20} = \frac{19}{20}$

∴ Risk that the structure will be toppled over by flood in exactly third year

$$= \frac{19}{20} \times \frac{19}{20} \times \frac{1}{20}$$

$$= 0.0451 = 4.51\%$$

Q.489 In the Muskingham method of channel routing, the routing equation is written as

$$Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$$

If the coefficient $k = 12\ h$ and $x = 0.15$ and the time step for routing $\Delta t = 4h$, the coefficients C_0 and C_2 are respectively

(a) 0.016, 0.572 (b) 0.016, 0.672
(c) 0.312, 0.672 (d) 0.312, 0.572

489. (b)

$$C_0 = \frac{-kx + 0.5\Delta t}{k(1-x) + 0.5\Delta t} = \frac{0.2}{12.2} = 0.016$$

$$C_2 = \frac{k(1-x) - 0.5\Delta t}{k(1-x) + 0.5\Delta t} = \frac{8.2}{12.2} = 0.672$$

Q.490 The normal annual rainfall at stations A, B and C are 170.6, 180.3 and 165.3 cm respectively. In 1993, station B was inoperative and recorded rainfall at stations A and C of 153.0 and 145.1 cm respectively. The annual rainfall at B in that year could be estimated as

(a) 152 cm
(b) 153.8 cm
(c) 149.05 cm
(d) 142.3 cm

490. (c)

Normal annual rainfall at station B (N_B) = 180.3 cm

$$1.1 \times N_B = 1.1 \times 180.3 = 198.33 \text{ cm}$$

$$0.9 \times N_B = 0.9 \times 180.3 = 162.27 \text{ cm} \quad \text{...(i)}$$

Let annual rainfall at station A and C are P_A and P_C respectively.

From (i), N_B differs from N_A and N_C by 10% or less

Then value of P_B is calculated as

$$P_B = \frac{153 + 145.1}{2} = 149.05 \text{ cm}$$

Q.491 During a particular stage of the growth of a crop, consumptive use of water is 3 mm/day. If the amount of water available in the soil is 25% of 80 mm depth of water, what is the frequency of irrigation?

(a) 12 days
(b) 19 days
(c) 20 days
(d) 24 days

491. (c)

$$\text{Water available to the soil} = \frac{25}{100} \times 80 = 20 \text{ mm}$$

Additional water required = 80 – 20 = 60 mm

$$\therefore \quad \text{Frequency of irrigation} = \frac{60}{3} = 20 \text{ days}$$

Thus the crop should be irrigated after every 20 days

Q.492 A lift irrigation scheme using a discharge of 100 m^3/hr is planned to raise a crop with an average delta of 0.4 m. Intensity of irrigation is 50%. Assuming 3600 hours of working of the tubewell for a year, the culturable command area is

(a) 90 ha
(b) 40 ha
(c) 180 ha
(d) 220 ha

492. (c)

By applying mass conservation,

$$0.4 \times 0.5 \times A = 3600 \times 100$$

$$\Rightarrow \quad A = 1800000 \text{ m}^2$$

$$\Rightarrow \quad A = 180 \text{ ha}$$

Q.493 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A. Double mass curve technique
B. Hyetograph
C. Mass curve of a storm
D. Iso-pluvial map

List-II

1. Plot of accumulated precipitation against time in chronological order
2. Estimation of missing rainfall data
3. Checking the consistency of rainfall records
4. Plot of intensity of rainfall against time
5. Lines of equal depth of rainfall of given duration and frequency

Codes:

	A	B	C	D
(a)	4	1	3	5
(b)	2	4	1	5
(c)	3	4	1	5
(d)	3	5	4	2

493. (c)

Q.494 The base width of a solid gravity dam is 24 m. The material of the dam has a specific gravity of 2.6 and the dam is designed as an elementary profile ignoring uplift. What is the approximate allowable height of the dam?

(a) 16 m
(b) 38.7 m
(c) 87.4 m
(d) 95.8 m

494. (b)

For elementary profile, $B = \dfrac{H}{\sqrt{S_C - C}}$

When uplift is ignored, $C = 0$

$$\therefore \quad B = \frac{H}{\sqrt{S_C}}$$

$$\Rightarrow \quad H = 24 \times \sqrt{2.6} = 38.7 \text{ m}$$

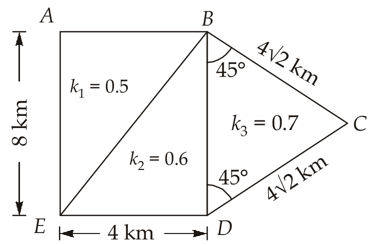
Q.495 The construction of impounding reservoir is required when

(a) average annual flow in the stream is lower than average demand.
(b) the rate flow in the stream, in dry season is more than the demand .
(c) the rate of flow in the stream, in dry season is less than the demand.
(d) the rate of flow in the stream is equal to the demand.

495. (c)

Impounding reservoirs can store water during high flow and utilize the same during lean flow period (i.e. when flow in the stream is less than the demand).

Q.496 For the catchment area shown below with their respective runoff coefficients, the average runoff coefficient for the catchment will be



(a) 0.55
(b) 0.60
(c) 0.65
(d) 0.70

496. (b)

$$Ar(\Delta ABE) = \frac{1}{2}\times 4\times 8 = 16\text{ km}^2$$

$$Ar(\Delta BDE) = \frac{1}{2}\times 4\times 8 = 16\text{ km}^2$$

$$Ar(\Delta BCD) = \frac{1}{2}\times 2\times\left(4\sqrt{2}\cos 45°\right)\times 4\sqrt{2}\sin 45° = 16\text{ km}^2$$

Average runoff coefficient,

$$k' = \frac{0.5\times 16 + 0.6\times 16 + 0.7\times 16}{16+16+16} = 0.60$$

Direction: The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

Q.497 Statement (I): An air vessel is fitted with a reciprocating pump to obtain a continuous supply of liquid at a uniform rate.

Statement (II): When the air vessel is fitted to the delivery pipe, during the first half of delivery stroke, the piston moves with retardation and during the second half, the piston moves with acceleration.

497. (c)

When the air vessel is fitted to the delivery pipe, during the first half of delivery stroke, the piston moves with acceleration and forces and water into the delivery pipe with a velocity more than the mean velocity. The quantity of water in excess of the mean discharge will flow into the air vessel. This will compress the air inside the vessel. During the second half of the delivery stroke, the piston moves with retardation and the velocity of water in the delivery pipe will be less than the mean velocity. The water already stored into the air vessel will start flowing into the delivery pipe and the velocity of flow in the delivery pipe will become equal to the mean velocity. Hence, the rate of flow of water will be uniform.

Q.498 **Statement (I):** At the critical state of flow, the specific force is a minimum for the given discharge.
Statement (II): For a minimum value of specific force, the first derivative of force with respect to depth should be unity.

498. **(c)**

Q.499 **Statement (I):** Weir is always aligned at right angle to direction of current.
Statement (II): This construction ensures lesser length of weir, better discharging capacity.

499. **(d)**
Sometimes weir may be aligned at an oblique angle to the direction of the river current.

Q.500 **Statement (I):** In an irrigation system having regime canals, the silt excluders and silt ejectors are designed to allow sediment in the canal consistent with the regime requirement.
Statement (II): Imbalance in the sediment load of a canal system causes aggradation and degradation problems in the system.

500. **(a)**

■■■■