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# ESE - 2016

## CIVIL ENGINEERING PAPER - 2 (OBJECTIVE)

## QUESTIONS WITH DETAILED SOLUTIONS

**SET - B**

| NAME OF THE SUBJECT | NO. OF QUESTIONS |
|---|---|
| FLUID MECHANICS & HM | 44 |
| HYDROLOGY | 05 |
| IRRIGATION ENGINEERING | 07 |
| ENVIRONMENTAL ENGINEERING | 21 |

| NAME OF THE SUBJECT | NO. OF QUESTIONS |
|---|---|
| GEOTECHNICAL ENGINEERING | 21 |
| SURVEYING | 12 |
| HIGHWAY ENGINEERING | 08 |
| RAILWAY ENGINEERING | 02 |

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01. A water supply distribution system for an averagely-populated township is to be designed for
(a) Maximum daily demand
(b) Maximum hourly demand and fire demand
(c) Average demand
(d) Maximum daily demand and fire demand, or maximum hourly demand, which ever is higher.

**01. Ans: (d)**

**Sol:** Water distribution system is designed for total demand

Total demand : Coincident draft (or) max hourly demand which ever is greater

Coincident draft : max daily demand + Fire demand

02. A combined sewerage system is more appropriate for developed areas where.
(a) Rainfall occurs for a very few days in a year
(b) Rainfall occurs almost uniformly throughout the year
(c) Air temperatures are nearly uniform throughout the year
(d) Air temperatures through the year include extremes during certain runs of days

**02. Ans: (b)**

**Sol:** Combined system is better work for areas which receive uniform rains throughout

03. The velocity distribution in the boundary layer is given by $\frac{u}{U}=\frac{y}{\delta}$, where u is the velocity at a distance of y from the boundary and u = U at y = δ, δ being boundary layer thickness. Then the value of momentum thickness will be

(a) $\frac{\delta}{2}$ (b) $\frac{\delta}{4}$ (c) $\frac{\delta}{6}$ (d) $\frac{\delta}{8}$

**03. Ans: (c)**

**Sol: Given:**

$$\frac{u}{U}=\frac{y}{\delta}$$

Momentum thickness,

$$\theta=\int_0^\delta \frac{u}{U}\left(1-\frac{u}{U}\right)dy$$

$$=\int_0^\delta \frac{y}{\delta}\left(1-\frac{y}{\delta}\right)dy$$

$$=\left[\frac{y^2}{2\delta}-\frac{y^3}{3\delta^2}\right]_0^\delta$$

$$=\frac{3\delta-2\delta}{6}$$

$$=\frac{\delta}{6}$$

04. 100 $m^3$ of sludge holds a moisture content of 95%. If its moisture content changes to 90%, the volume of this sludge will then be

(a) 40.5 $m^3$ (b) 50 $m^3$
(c) 75 $m^3$ (d) 94.7 $m^3$

**04. Ans: (b)**

**Sol:** $P_1 = 95\%$ , $P_2 = 90\%$

$V_1 = 100\ m^3$

$$V_2 = \frac{(100 - P_1)}{(100 - P_2)} \times V_1$$

$$= \frac{100 - 95}{100 - 90} \times 100 = \frac{5}{10} \times 100 = 50\,m^3$$

05. The design overflow rate of a sedimentation tank is chosen considering
(a) Flow rate through the tank
(b) Diameter of the particle intended to be removed
(c) Volume of the sedimentation tank
(d) Detention time in the tank

**05. Ans: (b)**

**Sol:** Settling velocity ($\nu_s$) $\geq$ Surface over flow rate ($\nu_o$)

$\nu_s \propto d^2$

$\therefore$ Chosen overflow rate depends on "$\nu_s$"

$\nu_s$ depends on particle diameter

06. Consider the following statements in respect of flow equalization in a waste water treatment plant:
1. Biological treatment is enhanced because shock loadings are eliminated or minimized.
2. Flow equalization is an attractive option for upgrading the performance of overloaded treatment plants.
3. Inhibiting substances can be diluted and pH can be stabilized.
4. Thickening performance of primary sedimentation tanks following grit removal is improved.

Which of the above statements are correct?
(a) 1, 2, 3 and 4 (b) 1, 2 and 3 only
(c) 1, 2 and 4 only (d) 3 and 4 only

**06. Ans: (b)**

**Sol:** Flow equalization is method of applying constant "Q" by detaining the flow collected from different time periods.
It reduces shock loadings
It improves performance of treatment plant
Some times it neutralizes pH if treatment plant receives waste water with different pH values.

07. A drain carrying 5 $m^3$/s of wastewater with its BOD of 100 mg/*l* joins a stream carrying 50 $m^3$/s flow with its BOD of 5 mg/*l*. What will be the value of the BOD of the combined flow after complete mixing?
(a) 3.6 mg/*l* (b) 13.6 mg/*l*
(c) 33.6 mg/*l* (d) 53.6 mg/*l*

**07. Ans: (b)**

**Sol:** $Q_w = 5\ m^3/sec$ $Q_s = 50\ m^3/sec$
$y_w = 100\ mg/l$ $y_s = 5\ mg/l$
BOD of the combined flow

$$y_{mix} = \frac{Q_w y_w + Q_s y_s}{Q_w + Q_s}$$

$$y_{mix} = \frac{5 \times 100 + 50 \times 5}{5 + 50} = \frac{500 + 250}{55}$$

$y_{mix} = 13.6\ mg/l$


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08. Consider the following statements in respect of aerated grit chamber:

1. The grit accumulates at the bottom in advancing spiral-flow aeration tanks, locationally preceded by grit chambers, led to the eventual development of aerated grit chambers.
2. The excessive wear on grit handling equipment is a major factor for the popularity of aerated grit chambers.
3. Aerated grit chambers are designed to provide detention period of 1 minute at maximum rate of flow.
4. Diffusers are located at 0.45 m to 0.6 m above the bottom of the chamber.

Which of the above statements are correct?

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

**08. Ans: (d)**

**Sol:** Aerated grit chamber decreases wear and tear. Water DT is 1 to 3 min. Diffusers are located above bottom.

09. The side of a square land was measured as 150 m and is in error by 0.05 m. What is the corresponding error in the computed area of the land?

(a) 5 $m^2$ (b) 10 $m^2$
(c) 15 $m^2$ (d) 20 $m^2$

**09. Ans: (c)**

**Sol:** $A = a^2$

$\delta_A = 2a.\delta_a = 2 \times 150 \times 0.05 = 15 \text{ m}^2$

10. Consider the following statements in respect of anaerobic sludge digester:

1. It is less expensive compared to several other methods available.
2. Processing of separable solids impacts the environment to a minimum.
3. Quantity of separated solids requiring disposal is minimal.
4. Digested sludge is very readily dewaterable.

Which of the above statements are correct?

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

**10. Ans: (a)**

**Sol:**

Anaerobic sludge digester is economical. Disposal becomes simple. Dewatering is easy.

11. Consider the following statements as regards a Septic Tank:

1. The size required is large and uneconomical when serving more than roughly 100 persons.
2. It can remove around 90% of BOD and 80% of suspended solids.
3. As compared to the sludge holding of a plain sedimentation tank, a septic tank can hold about 90% less of sludge volume.
4. Frequent removal of sludge is not required.

Which of the above statements are correct?

(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 1 and 4

**11. Ans: (c)**

**Sol:** Septic tank does not require frequent sludge removal. Volume of sludge produced in septic tank is less compared to settling tank.

Septic tank works best, If no. of users $\leq 300$

12. Sewage sickness relates to

(a) Toxicity of sewage interfering with 'response' to treatment

(b) Destruction of aquatic flora and fauna due to gross pollution of receiving bodies of water by the sewage.

(c) Reduction in the waste purifying capacity of the soil

(d) Clogging of pores in soil due to excessive application of sewage leading to obstruction of land aeration thereby leading to septic conditions in the land

**12. Ans: (d)**

**Sol: Sewage Sickness:**

Continuous application of effluents on same land leads to clogging of pore space result into anaerobic condition, which leads to septicity by releasing of foul gases.

13. The waste water of a certain large colony contains $10^{-5.6}$ mmol/*l* of $OH^-$ ions at 25°C. The pH of this sample is

(a) 8.6 (b) 7.9 (c) 5.4 (d) 4.5

**13. Ans: (c)**

Concentration of $OH^- = 10^{-5.6}$ m.mol/lit

$= 10^{-5.6} \times 10^{-3}$ mol/lit

$= 10^{-8.6}$ mol/lit

$\therefore$ pOH = 8.6

pH = 14 – pOH = 14 – 8.6 = 5.4

14. Consider the relevance of the following features for causing photochemical smog:

1. Air stagnation.
2. Abundant sunlight.
3. High concentration of $NO_X$ in atmosphere.
4. High concentration of $SO_2$ in atmosphere.

Which of the above features are correct?

(a) 1, 2 and 4 only (b) 3 and 4 only

(c) 1, 2 and 3 only (d) 1, 2, 3 and 4

**14. Ans: (c)**

**Sol:** Photochemical Smog

Smoke + fog = Smog

$NO_x$ + Sunlight $\rightarrow$ Photochemically react $\rightarrow$ Smog

15. Consider the following statements related to ecology:

1. All the physical, chemical and biological factors that a species needs in order to live and reproduce is called ecological niche.
2. The boundary zone between two ecosystems is known as ecotone.
3. The forests in the Arctics are known as tundra.

4. A biome usually has a distinct climate and life forms adapted to that climate. Biome is more extensive and complex than an ecosystem.

Which of the above statements are correct?

(a) 1, 2 and 3 only (b) 1, 2 and 4 only

(c) 3 and 4 only (d) 1, 2, 3 and 4

**15. Ans: (d)**

16. Consider the following laws of ecology suggested by Barry Commoner:

1. Everything is connected to every thing else.
2. Everything must go somewhere.
3. Nature knows best.
4. There is no such thing as a free lunch.

Which of the above statements are correct?

(a) 1, 2 and 3 only (b) 1, 2 and 4 only

(c) 3 and 4 only (d) 1, 2, 3 and 4

**16. Ans: (d)**

**Sol:** As per Barry Commoner all 4 laws are given correct.

17. For a hydraulically efficient rectangular channel of bed width 5 m, the hydraulic radius is

(a) 0.5 m (b) 1.25 m

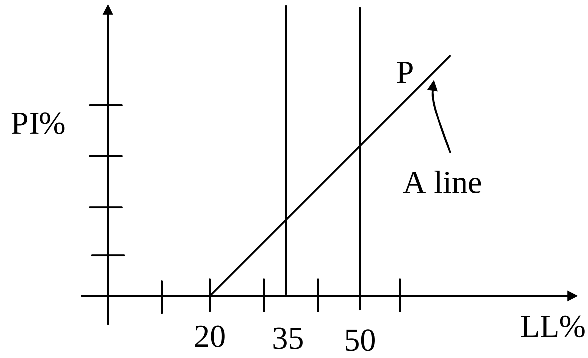
(c) 2.75 m (d) 4.25 m

**17. Ans: (b)**

**Sol:** $R = \frac{y}{2}, y = \frac{B}{2}$

$$\Rightarrow R = \frac{B}{4} = \frac{5}{4} = 1.25\,\text{m}$$

18. The standard plasticity chart by Casagrande to classify fine-grained soils is shown in the figure.




The area marked P represents

(a) Inorganic clays of high plasticity

(b) Organic clays and highly plastic organic silts

(c) Organic and inorganic silts and silt-clays

(d) Clays

**18. Ans: (a)**

19. A soil sample has shrinkage limit of 6%; and the specific gravity of the soil grains is 2.6. The porosity of soil at shrinkage limit is

(a) 7.5% (b) 9.5%

(c) 13.5% (d) 16.5%

**19. Ans: (c)**

**Sol: Given:**

Shrinkage limit, $w_s = 6\%$

G = 2.6

At shrinkage limit, soil is fully saturated

$$e = \frac{wG}{S}$$

$$e = \frac{0.06 \times 2.6}{1} = 0.156$$

Porosity, $n = \frac{e}{1+e}$

$= \frac{0.156}{1.156}$

$= 0.135 = 13.5\%$

20. What is the dry unit weight of a clay soil when the void ratio of a sample thereof is 0.50, the degree of saturation is 70%, and the specific gravity of the soil grains is 2.7? Take the value of $\gamma_w$ to be 9.81 kN/m$^3$.

(a) 13.65 kN/m$^3$ (b) 19.95 kN/m$^3$

(c) 23.65 kN/m$^3$ (d) 29.95 kN/m$^3$

**20. Ans: No Answer (17.66 kN/m$^3$)**

**Sol: Given:**

e = 0.5

S = 0.7

G = 2.7

$\gamma_w = 9.81$ kN/m$^3$

$\gamma = \frac{\gamma_w (G + eS)}{1+e}$

$= \frac{9.81(2.7 + 0.5 \times 0.7)}{1 + 0.5} = 19.95$ kN/m$^3$

Void ratio, $e = \frac{wG}{S}$

$0.5 = \frac{w \times 2.7}{0.7}$

$w = 0.13$

Dry Density, $\gamma_d = \frac{\gamma}{1+w} = \frac{19.95}{1+0.13}$

$= 17.65$ kN/m$^3$

21. Local mean time of a place of longitude of 42°36′ W is 8h 42m 15s AM. The corresponding Greenwich Mean Time is

(a) 10 h 32 m 40 s AM

(b) 11 h 32 m 39 s PM

(c) 0 h 32 m 39 s PM

(d) 11 h 32 m 39 s AM

**21. Ans: (d)**

**Sol:** GMT = LMT ± Longitude

use +, if Longitude is West

−, if Longitude is East

$42°36' = \frac{42°}{15} = 2\text{hr};$

$\frac{12 \times 60 + 36}{15} = 50\,\text{m};$

$\frac{6 \times 60}{15} = 24\text{s}$

∴ GMT = 8h 42 m 15 s + 2h 50m 24s

= 11h 32m 39s (AM)

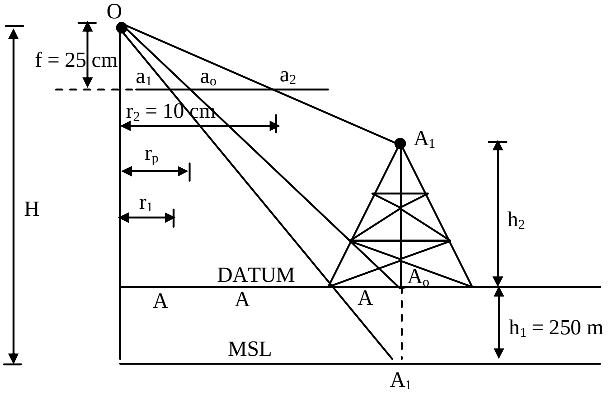
22. A vertical photograph of a flat area having an average elevation of 250 m above mean sea level was taken with a camera of focal length 25 cm. A section line AB 300 m long in the area measures 15 cm on the photograph; a tower BP in the area also appears on the photograph. The distance between images of top and bottom of the tower measures 0.5 cm on the photograph. The distance of the image of the top of the tower is 10 cm. The actual height of the tower is

(a) 10 m (b) 15 m

(c) 20 m (d) 25 m

**22. Ans: (d)**

**Sol:**




**Given:** Relief displacement d = 0.5 cm

$$s = \frac{15}{300} = \frac{25}{(H-h_1)}$$

$$\frac{15}{300} = \frac{25}{(H-250)}$$

$$H = 750\text{ m}$$

$$\therefore \quad d = \frac{r_2 h_2}{(H-h_1)}$$

$$h_2 = \text{Height of tower} = \frac{d(H-h_1)}{r_2}$$

$$= \frac{0.5(750-250)}{10} = 25\,m$$

23. A transportation trip survey was undertaken between private car, and public car transportation. The proportion of those using private cars is 0.45. While using the public transport, the further choices available are Metro Rail and Mono Rail, out of which commuting by a Mono Rail has a proportion of 0.55. In such a situation, the choice of interest in using a Metro Rail, Mono Rail and private car would be , respectively

(a) 0.25, 0.3 and 0.45

(b) 0.45, 0.25 and 0.3

(c) 0.25, 0.45 and 0.3

(d) 0.3, 0.25 and 0.45

**23. Ans: (a)**

**Sol:** Proportion using private cars = 0.45

Proportion using public transport = 0.55

Public transport = metro rail + mono rail

choice of rail = (0.55) (0.55) = 0.3

Choice of rail = 0.45 ×0.55 = 0.25

∴ Total choice as per question

Metro rail = 0.25

Mono rail = 0.3

Private car = 0.45

24. An airfoil of surface area 0.1 $m^2$ is tested for lift L in a wind tunnel. (Conditions can be considered as incompressible flow.) At an angle of attack of $5^o$, with standard air of density 1.22 kg/$m^3$, at a speed of 30 m/sec, the lift is measured to be 3.2 kgf. What is the lift coefficient? For a prototype wing of area 10 $m^2$, what is the approximate lift at an air speed of 160 kmph at the same angle of attack of $5^o$?

(a) 0.572 and 700 kgf

(b) 0.603 and 700 kgf

(c) 0.572 and 570 kgf

(d) 0.603 and 570 kgf

**24. Ans: (a)**

**Sol: Given:**

Airfoil area $A_m = 0.1\ m^2$

Model : wind tunnel

Angle of attack $\alpha_m = 5^o$

$\rho_{air} = 1.22\ kg/m^3$

$V_{air,\ m} = 30\ m/s$

$F_{mL} = 3.2$ kg.f

$C_L = ?$

$Ap = 10\ m^2$

$U_p = 160 \times \frac{5}{18} = 44.45\ m/s$

$\alpha_p = 5^o$

$F_{PL} = ?$

$$F_L = C_L.A.\frac{\rho v^2}{2}$$

$$9.81 \times 3.2 = C_L \times 0.1 \times 1.22 \times \frac{30^2}{2}$$

$$C_L = 0.572$$

$$F_p = 0.572 \times 10 \times 1.22 \times \frac{44.45^2}{2}$$

$$= 6893.9\ N$$

$$= \frac{6893.9}{9.81} \simeq 700\ kg.f$$

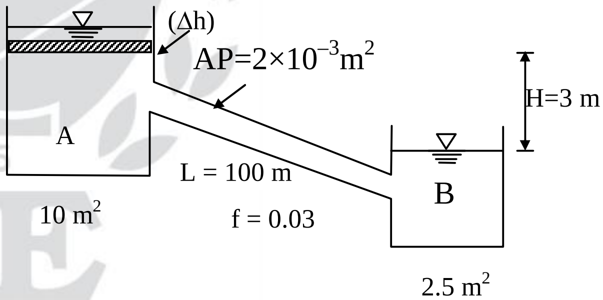
25. Two tanks A and B, of constant cross sectional areas of 10 $m^2$ and 2.5 $m^2$, respectively, are connected by a 5 cm pipe, 100 m long, with f = 0.03. If the initial difference of water levels is 3 m, how long will it take for 2.5 $m^3$ of water to flow from A to B? Considering entry and exit losses, it can be grossly assumed that the flow velocity, in m/s, through the pipe is $1.75\sqrt{h}$, where h is in m, taking g = 10 m/sec$^2$; also, may take area of pipe as $2 \times 10^{-3}\ m^2$.

(a) 535 seconds (b) 516 seconds

(c) 485 seconds (d) 467 seconds

**25. Ans: (d)**

**Sol:**




Pipe must carry 2.5 m3 volume of water to lower tank B whose cross section Area $A_2 = 2.5\ m^2$

$Q_{pipe} = A_2 \times h_2 = 2.5 \times h_2$

$2.5\ m^3 = 2.5 \times h_2$

$\therefore h_2 = 1$ m

$h_f$ = Head lost due to friction (assuming maximum) = $\frac{2}{3} \times h_2 = \frac{2}{3} \times 1 = 0.66$ m where h = 3 – 0.66 = 2.34 m

From Continuity equation, Q = A.V

$$\frac{2.5m^3}{T} = \left(2\times10^{-3}\right)\times1.75\sqrt{h}\,)$$

$$T = \frac{2.5}{(2\times10^{-3})(1.75\times\sqrt{2.34})}$$

T = 467 sec

26. The consistency and flow resistance of a sample of bitumen can be determined through which of the following tests?
(a) Viscosity test (b) Penetration test
(c) Ductility test (d) Softening point test

**26. Ans: (a)**

**Sol:** By using viscosity test consistency and flow resistance can be used

27. A pipe of 324 mm diameter, having friction coefficient as 0.04, connects two reservoirs with 15 m difference in their water levels through a 1500 m long pipe. What will be the discharge through the pipe?
(a) 104 *l*ps (b) 134 *l*ps
(c) 165 *l*ps (d) 196 *l*ps

**27. Ans: (a)**

**Sol:** $h_f = \frac{8f\ell Q^2}{\pi^2 g d^5}$

$$15 = \frac{8\times0.04\times1500\times Q^2}{\pi^2\times9.81\times(0.324)^5}$$

Q = 0.104 $m^3$/s
= 104 *l*ps

28. Flexible concrete is a mix comprising of
(a) Gravel, filler and 30/40 bitumen
(b) Sand, filler and 30/40 bitumen only
(c) Gravel, sand, filler and 60/70 bitumen
(d) Sand, filler and 60/70 bitumen only

**28. Ans: (c)**

**Sol:** Flexible concrete mix is by 60/70 penetration grade bitumen.

29. Consider a soil sample, for which tests yield the following results:

| | |
|---|---|
| Passing 75 micron sieve | 62% |
| Liquid limit | 35% |
| Plasticity Index | 14% |

As per the group index classification of soil, what is the soil condition of the above soil sample?
(a) Poor (b) Fair
(c) Good (d) Excellent

**29. Ans: (b)**

**Sol:** GI = 0.2 a+ 0.005 a.c + 0.01 b.d

a = that part of the % passing 75 μ sieve, greater than 35 and not exceeding 75 (range 1 to 40)
= 62 –35 = 27

b = That part of the % passing 75 μ sieve greater than 15 and not exceeding 55 (range 1 to 40)
= 62 – 15 = 47

But taken as 40

c = That part of the liquid limit greater than 40 and not greater than 60,
(range 1 to 20)

= 1 (since $w_L$ is 35%)

d = that part of PI greater than 10 and not exceeding 30 (range 1 to 20)

= 14 – 10

= 4%

GT = 0.2 × 27 + 0.005 ×27 × 1 + 0.01×40 ×4

= 5.4 + 0.135 + 1.6

= 7.135 say 7

As the GI value is 7, soil is fair to poor but the soil is low compressible or low plastic. Hence it can be classified as fair.

30. Consider the following statements regarding ductility of bitumen:
    1. Ductility is the property which does not permit bitumen to undergo large deformation without breaking.
    2. Bitumens with high ductility are generally adhesive but do not have good cementing properties.
    3. Ductility must be ascertained at two different temperatures in order to pronounce on the suitability of the material

    Which of the above statements is/are correct?

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

**30. Ans: (a)**

**Sol:** 1 – false

Ductility is the property to undergo large deformations.

2 – false

31. A collapsible soil sub-grade sample was tested using standard California Bearing Ratio apparatus; and the observations are given below:

| Sl. No | Load | Penetration |
|---|---|---|
| 1. | 60.55 kg | 2.5 mm |
| 2. | 80.55 kg | 5.0 mm |

Taking the standard assumptions regarding the load penetration curve, CBR value of the sample will be taken as

(a) 3.9 % (b) 4.0 %
(c) 4.4 % (d) 5.5 %

**31. Ans: (c)**

**Sol:** $(\text{CBR})_{2.5} = \dfrac{60.55}{1370}\times 100 = 4.42\%$

$$(\text{CBR})_{5} = \dfrac{80.55}{2055}\times 100 = 3.92\%$$

Use higher value

$\therefore$ $(\text{CBR})_{soil} = 4.42\%$

32. What is the critical thickness of a prestressed concrete pavement (using Westergaard's Corner Load Formula) to support a maximum wheel load of 4200 kg ? Allow 10% for impact. Tyre pressure may be taken as 7 kg/cm$^2$. Assume flexural strength of concrete as 50 kg/cm$^2$, factor of safety as 2, subgrade reaction for plastic mix road as 6 kg/cm$^3$, and modulus of elasticity as $3 \times 10^5$ kg/cm$^2$.

(a) 19.6 cm (b) 21.6 cm
(c) 23.6 cm (d) 25.6 cm

**32. Ans: (d)**

**Sol:** P = 4200 kg

Impact factor = 10%

$t_p = 7\ kg/cm^2$

$\sigma_c = 50\ kg/cm^2$

FS = 2

$K = 6\ kg/cm^3$

$E = 3 \times 10^5\ kg/cm^2$

$$\sigma_c = \frac{3p}{h^2}\left[1-\left(\frac{a\sqrt{2}}{\ell}\right)^{0.6}\right]$$

$$\left(\text{Ignoring}\ \frac{a\sqrt{2}}{\ell}\right)$$

$$50 = \frac{3(4200)}{h^2}$$

$h = 15.87 \times FS$

$h = 31.74$ cm

Highest value given in options is h=25.6 cm

33. At a hydraulic jump, the flow depths are 0.4 m and 5 m at the upstream and downstream, respectively. The channel is wide rectangular. The discharge per unit width is nearly.

(a) $5.8\ m^2/s$ (b) $6.4\ m^2/s$

(c) $7.3\ m^2/s$ (d) $8.3\ m^2/s$

**33. Ans: (c)**

**Sol:** Hydraulic jump

$y_1 = 0.4$ m, $y_2 = 5$ m

wide rectangular

$$\frac{2q^2}{g} = y_1 y_2 (y_1 + y_2)$$

$$q^2 = \frac{9.81}{2} \times 0.4 \times 5(0.4+5)$$

$q = 7.28\ m^3/s/m$

$\simeq 7.3\ m^3/s/m$

34. Overspeed and delay studies on a pre-selected section of a Highway are conducted by

(a) Fast moving car method

(b) Enoscope

(c) Radar

(d) Traffic contours

**34. Ans: (a)**

**Sol:** Speed-delay surveys are done by moving car method.

35. The surface tension of water at 20°C is $75 \times 10^{-3}$ N/m. The difference in water surfaces within and outside an open ended capillary tube of 1 mm internal bore, inserted at the water surface would nearly be

(a) 7 mm (b) 11 mm

(c) 15 mm (d) 19 mm

**35. Ans: (c)**

**Sol:** $\sigma = 75 \times 10^{-3}$ N/m

d = 1 mm

= 0.001 m

$$h = \frac{4\sigma\cos\theta}{\gamma d}$$

$$= \frac{4\sigma \times \cos 0^\circ}{10000 \times 2 \times 10^{-3}}$$

$$= \frac{4 \times 75 \times 10^{-3}}{10000 \times 2 \times 10^{-3}}$$

$$= \frac{300}{2 \times 10^4}$$

$= 15 \times 10^{-3}$ m

= 15 mm

36. Survey of India was publishing toposheets using a scale of
    (a) 1 : 1000 (b) 1 : 5000
    (c) 1 : 10000 (d) 1 : 50000

**36. Ans: (d)**

37. The maximum speed of a train on B.G track having a curvature of $3^o$ and a cant of 10 cm with allowable cant deficiency of 76 mm, for conditions obtaining in India, is
    (a) 87.6 km/h (b) 99.6 km/h
    (c) 76.6 km/h (d) 65.6 km/h

**37. Ans: (a)**

**Sol:**

Radius of curve, $R = \frac{1720}{D^o} = \frac{1720}{3}$

$= 573.33$ m

$$e = \frac{GV^2}{127R}$$

$$0.176 = \frac{1.676 \times V^2}{127 \times 573}$$

$V = \sqrt{7642}$

= 87.4 kmph

38. The gradient for a B.G railway line such that the grade resistance together with curve resistance due to a $4^o$ curve which will be equivalent to a simple ruling gradient of 1 in 150 is
    (a) 1 : 180 (b) 1 : 200
    (c) 1 : 300 (d) 1 : 400

**38. Ans: (b)**

**Sol:**

$$\frac{W}{150} = \frac{W}{x} + 0.0004W \times 4^o$$

$$\frac{1}{150} = \frac{1}{x} + \frac{4 \times 4}{10^4}$$

$$\frac{1}{150} - \frac{16}{10^4} = \frac{1}{x}$$

$$0.0067 - 0.0016 = \frac{1}{x}$$

$$0.005 = \frac{1}{x}$$

x = 200

39. A Pelton wheel works under a head of 400 m. Friction 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) 71 m/s
    (c) 65 m/s (d) 56 m/s

**39. Ans: (a)**

**Sol:** H = 400 m pelton wheel

$h_L$ = 10%

$H_{net} = 400 - 400 \times 0.1$

$= 360$ m

$C_v = 0.98$ , $g = 10\ m/s^2$

$$V = C_v\sqrt{2gH_{net}}$$
$$= 0.98\ \sqrt{2\times10\times360}$$
$$= 0.98 \times 60\ \sqrt{2}$$
$$= 83.14\ m/s$$

40. The value of porosity of a soil sample in which the total volume of soil grains is equal to twice the total volume of voids would be

(a) 30 % (b) 40 %

(c) 50 % (d) 60 %

**40. Ans: (a)**

**Sol: Given:** $V_s = 2V_v$

$$n = \frac{V_v}{V} = \frac{V_v}{V_v + V_s}$$
$$= \frac{V_V}{V_V + 2V_V} = \frac{1}{3} = 0.333$$
$$e = \frac{V_V}{V_S} = \frac{V_V}{2V} = 0.5$$
$$n = \frac{e}{1+e} = \frac{0.5}{1+0.5}$$
$$= \frac{1}{3} = 0.33$$

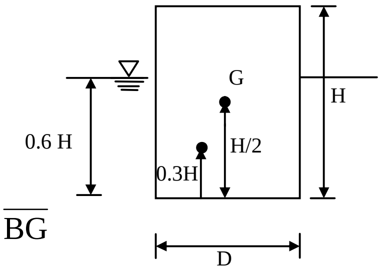
41. A solid cylinder of length H, diameter D and of relative density S floats in neutral equilibrium in water with its axis vertical. What is the ratio of H to D if S = 0.6?

(a) 0.86 (b) 0.72

(c) 0.52 (d) 0.46

**41. Ans: (b)**

**Sol:**




$$GM = \frac{I}{V} - \overline{BG}$$
$$= \frac{\pi D^4}{64}\times\frac{4}{\pi D^2\times0.6H} - \left(\frac{H}{2} - \frac{0.6H}{2}\right)$$
$$0 = \frac{D^2}{16\times0.6H} - 0.2H$$
$$\frac{D^2}{16\times0.6H} = 0.2H$$
$$D^2 = 1.92\ H^2$$
$$\frac{H}{D} = \sqrt{\frac{1}{1.92}} = 0.72$$

42. In a two-dimensional flow, with its stream function $\psi = 2xy$, The velocity at a point (3, 4) is

(a) 12.0 units (b) 10.0 units

(c) 8.0 units (d) 6.0 units

**42. Ans: (b)**

**Sol:** $\psi = 2xy$

$$v = \frac{\partial\Psi}{\partial x} = 2y$$
$$\left(\frac{\partial\Psi}{\partial x}\right)_{(3,4)} = 2\times4 = 8$$
$$u = \frac{\partial\Psi}{\partial y} = 2x$$
$$\left(\frac{\partial\Psi}{\partial y}\right)_{(3,4)} = 2\times3 = 6$$
$$\therefore v = \sqrt{8^2 + 6^2} = 10\ m/s$$

# ESE 2015

## RANKERS

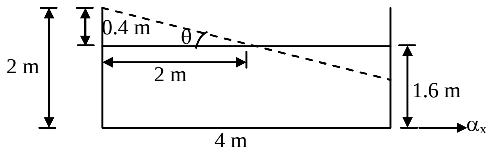

## CONTRIBUTION OF ACE IN THE SUCCESS OF ESE TOPPERS

43. An open rectangular tank of dimensions 4 m × 3 m × 2 m contains water to a height of 1.6 m. It is then accelerated along the longer side. What is the maximum acceleration possible without spilling the water? If this acceleration is then increased by 10%, what amount of water will be spilt off?

(a) 1.472 $m/s^2$ and 0.48 $m^3$
(b) 1.962 $m/s^2$ and 0.48 $m^3$
(c) 1.472 $m/s^2$ and 0.52 $m^3$
(d) 1.962 $m/s^2$ and 0.52 $m^3$

**43. Ans: (b)**

**Sol:**



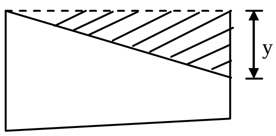

$$\tan\theta = \frac{0.4}{2} = \frac{\alpha_x}{g}$$

$$\alpha_{x_1} = \frac{0.4}{2}\times 9.81$$

$$= 1.962\ m/s^2$$

$$\alpha_{x_2} = 1.1\times 1.962 = 2.16\ m/s^2$$

$$\tan\theta = \frac{\alpha_{x_2}}{g} = \frac{2.16}{9.81} = \frac{y}{4}$$




$$y = \frac{2.16}{9.81}\times 4$$

$$= 0.88\ m$$

Empty volume $= \frac{1}{2}\times 0.88\times 4\times 3 = 5.28\ m^3$

Net volume = 4 × 3 × 2 – 5.28

= 18.72 $m^3$

Original volume = 4 × 3 × 1.6 = 19.2 $m^3$

Sill = 19.2 – 18.72 = 0.48 $m^3$

44. In a laminar flow between two fixed plates held parallel to each other at a distance d, the shear stress is

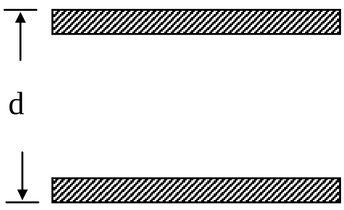
1. Maximum at plane $\frac{d}{2}$ away from each plate and zero at the plate boundaries.
2. Zero throughout the passage.
3. Maximum at the plate boundaries and zero at a plate $\frac{d}{2}$ away from each plate.

Which of the above statements is/are correct?

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

**44. Ans: (b)**

**Sol:**




45. While conducting the flow measurement using a triangular notch, an error of +2% in head over the notch is observed. The percentage error in the computed discharge would be

(a) + 7% (b) – 3%
(c) + 5% (d) – 4%

**45. Ans: (c)**

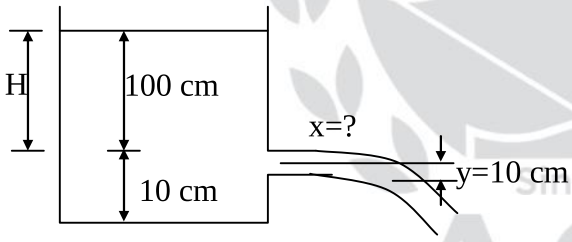
**Sol:** $2 = \frac{2}{5}\left(\frac{dQ}{Q}\right)$

$$\left(\frac{dQ}{Q}\right) = 5$$

46. An orifice is located in the side of a tank with its centre 10 cm above the base of the tank. The constant water level is 1.0 m above the centre of orifice. The coefficient of velocity is 0.98. On the issuing jet, the horizontal distance from the vena-contracta to where the jet is 10 cm below vena-contracta is
(a) 1.62 m (b) 1.00 m
(c) 0.62 m (d) 0.32 m

**46. Ans: (c)**

**Sol:**




$C_v = 0.98$

$$C_v = \sqrt{\frac{x^2}{4Hy}}$$

$$0.98 = \sqrt{\frac{x^2}{4 \times 100 \times 10}}$$

$x = 0.98 \times 10 \times 2\sqrt{10}$

$= 61.98$ cm

$= 0.62$ m

47. The velocity of water at the outer edge of a 60 cm diameter whirlpool, where the water level is horizontal is 2.5 m/s. The velocity of water at a level where the diameter of the whirlpool is 15 cm, is
(a) 1 m/s (b) 5 m/s
(c) 8 m/s (d) 10 m/s

**47. Ans: (d)**

**Sol:** $v_1 r_1 = v_2 r_2$

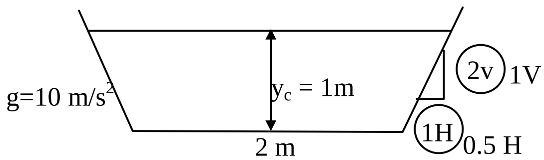
$2.5 \times 30 = v_2 \times 7.5$

$v_2 = 2.5 \times 4 = 10$ m/s

48. In a trapezoidal channel with bed width of 2m, and side slopes of 2 v on 1 h, critical flow occurs at a depth of 1 m. What will be the quantity of flow and the flow velocity? Take g as 10 m/s$^2$
(a) 7.22 m$^3$/s and 3.10 m/s
(b) 6.82 m$^3$/s and 2.89 m/s
(c) 7.22 m$^3$/s and 2.89 m/s
(d) 6.82 m$^3$/s and 3.10 m/s

**48. Ans: (c)**

**Sol:**




$A = (b + my)(y)$

$= (2 + 0.5 \times 1)(1)$

$= 2.5$ m$^2$

$T = b + 2my$

$= 2 + 2 \times 0.5 \times 1$

$= 3$ m

$$\frac{Q^2}{g}=\frac{A^3}{T}$$

$$\frac{Q^2}{10}=\frac{(2.5)^3}{3}$$

$Q = 7.22\ m^3/s$

$$V=\frac{Q}{A}=\frac{7.22}{2.5} = 2.89\ m/s$$

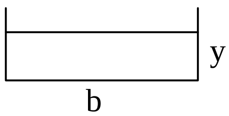
49. A 7.5 m wide rectangular channel conveys 12 $m^3$/s of water with a velocity of 1.5 m/s. The specific energy head of the flow is

(a) 1.18 m (b) 1.78 m

(c) 2.18 m (d) 2.78 m

**49. Ans: (a)**

**Sol:** b = 7.5 m




$Q = 12\ m^3/s$

$V = 1.5\ m/s$

$Q = AV$

$12 = A \times 1.5$

$A = 8\ m^2$

$A = by$

$$\Rightarrow y=\frac{8}{7.5}=1.07m$$

$$E=y+\frac{v^2}{2g}=1.07+\frac{1.5^2}{2\times 9.81}$$

$= 1.07 + 0.115 = 1.185$ m

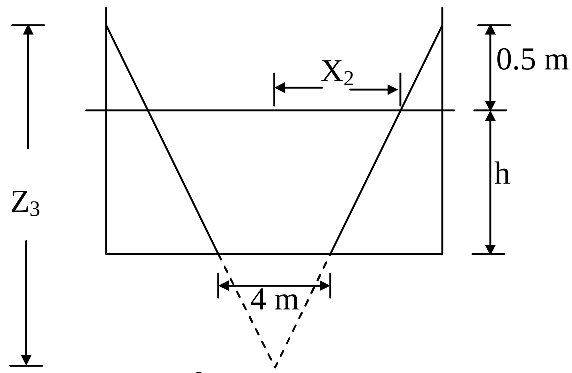
50. A cylindrical vessel with closed bottom and open top is 0.9 m in diameter. What is the rotational speed about its vertical axis(with closed bottom below and open top above) when the contained incompressible fluid will rise 0.5 m at the inner circumference of the vessel and a space of 0.4 m diameter at the bottom will have no fluid thereon? Take g = 10 $m/s^2$.

(a) 650 rpm (b) 600 rpm

(c) 580 rpm (d) 470 rpm

**50. Ans: No Answer (122 rpm)**

**Sol:**




$g = 10\ m/s^2$

N = ?

$\omega = 2\pi N/60$

$$y_1=\frac{\omega^2\times 0.2^2}{2\times 9.81}$$

$y_1 = \omega^2 \times 2.04 \times 10^{-3}$

$$(y_1+h+0.5)=\frac{\omega^2\times 0.45^2}{2\times 9.81}$$

$$= 0.0103\ \omega^2$$

$2.04 \times 10^{-3}\ \omega^2 + h + 0.5 = 0.0103\ \omega^2$

$h + 0.5 = 8.26 \times 10^{-3}\ \omega^2$

$$\frac{\pi\times 0.9^2}{4}\times h=\frac{1}{2}(y_1+h+0.5)\times\frac{\pi\times 0.9^2}{4}$$

$2h = y_1 + h + 0.5$

$h = y_1 + 0.5$

$h = 2.04 \times 10^{-3}\ \omega^2 + 0.5$

$2.04 \times 10^{-3}\ \omega^2 + 0.5 + 0.5 = 8.26 \times 10^{-3}\ \omega^2$

$(8.26 - 2.04)\,(10^{-3})\,\omega^2 = 1$

$$\omega^2 = \frac{1000}{6.22} = 160.77$$

$\omega = 12.68$ rad/s

$$\omega = \frac{2\pi N}{60}$$

$$\Rightarrow N = \frac{12.68 \times 60}{2\pi} = 121.09\text{rpm}$$

51. The sequent depth ratio in a hydraulic jump formed in a rectangular horizontal channel is 10. The Froude number of the supercritical flow is

(a) 12.2 (b) 10.4

(c) 7.42 (d) 4.21

**51. Ans: (c)**

**Sol:** $\frac{y_2}{y_1} = 10$

$$\frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8Fr_1^2}\right]$$

$$10 = \frac{1}{2}\left[-1 + \sqrt{1 + 8Fr_1^2}\right]$$

$$20 = -1 + \sqrt{1 + 8Fr_1^2}$$

$$21 = \sqrt{1 + 8Fr_1^2}$$

$$1 + 8\,Fr_1^2 = 441$$

$$8Fr_1^2 = 440$$

$$Fr_1^2 = 55$$

$$Fr_1 = 7.42$$

52. A fluid flow is described by a velocity field $\bar{U} = 4x^2 i - 5x^2 y j + 1\,k$

What is the absolute velocity (in magnitude) at the point (2, 2, 1)?

(a) $\sqrt{1802}$ (b) $\sqrt{1828}$

(c) $\sqrt{1840}$ (d) $\sqrt{1857}$

**52. Ans: (d)**

**Sol:** $\bar{U} = 4x^2.i - 5x^2y.j + 1.k$

$u = 4x^2 = 4 \times 4 = 16$

$v = -5x^2y$

$= -5 \times 4 \times 2$

$= -40$

$w = 1$

$$\therefore |v| = \sqrt{16^2 + 40^2 + 1}$$

$$= \sqrt{1857}$$

53. A partially open sluice gate discharges water at 6 m/s with a depth of 40 cm in a rectangular horizontal channel of width 5 m. What would be the post-jump depth of flow on the downstream of the gate by taking g as 10 m/s$^2$?

(a) 1.51 m (b) 1.70 m

(c) 1.85 m (d) 1.95 m

**53. Ans: (a)**

**Sol:** $V_1 = 6$ m/s

$y_1 = 40$ cm

$b = 5$ m $\quad g = 10$ m/s$^2$

$y_2 = ?$

$$F_{r1} = \frac{V_1}{\sqrt{gy_1}} = \frac{6}{\sqrt{10 \times 0.4}} = 3$$

$$y_2 = \frac{y_1}{2}\left[-1+\sqrt{1+8Fr_1^2}\right]$$

$$= \frac{0.4}{2}\left[-1+\sqrt{1+8\times 3^2}\right] = 1.51 \text{ m}$$

54. What is the maximum power available at the downstream end of a pipeline 3 km long, 20 cm is diameter, if water enters at the upstream end at a pressure of 720 m of water, with taking pipe friction coefficient as 0.03 and g as 10 m/s$^2$?

(a) 770 mhp (b) 740 mhp

(c) 700 mhp (d) 660 mhp

**54. Ans: (d)**

**Sol:** $P = \frac{2}{3}\gamma QH$

$$\frac{8f\ell Q^2}{\pi^2 g d^5} = \frac{720}{3}$$

$$\frac{8\times 0.03\times 3000\times Q^2}{\pi^2\times 10\times 0.2^5} = \frac{720}{3}$$

$\Rightarrow Q = 0.102 \text{ m}^3/\text{s}$

$$\text{Power, } P = \frac{2}{3}\gamma.Q.H$$

$$= \frac{2}{3}\times\frac{10000\times 0.102\times 720}{735}$$

$\simeq 666$ mhp

55. In the design of pipeline the usual practice is to assume that due to aging of pipelines:

1. The effective roughness increases linearly with time.
2. The friction factor increases linearly with time.
3. The flow through the pipe becomes linearly lesser with time.

Which of the above statements is/are correct?

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

(c) 2 only (d) 1 only

**55. Ans: (d)**

56. Consider the following statements:

1. In flow through hydro-dynamically smooth pipes, the friction factor $f$ is always a constant.
2. In flow through hydro-dynamically smooth pipes, the friction factor $f$ is always a function of the flow Reynolds number.
3. In a fully developed rough turbulent pipe flow, the friction factor $f$ is a function of relative roughness only.
4. In a fully developed rough turbulent pipe flow, the friction factor $f$ is a function of the flow Reynolds number and relative roughness.

Which of the above statements are correct?

(a) 1 and 3 (b) 2 and 3

(c) 2 and 4 (d) 1 and 4

**56. Ans: (b)**

# BSNL - JTO

Bharat Sanchar Nigam Limited (BSNL) may soon announce Junior Telecom Officer (JTO) Recruitment Notification to recruit more than 2500 Junior Telecom Officers.

**Name of The Post :** JTO - Telecom

**Educational Qualification :** Bachelor Degree in Engineering (Telecom/ Electronics / Radio/ Computer/ Electrical/ IT/ Instrumentation)

**Selection Procedure :** Written Examination

## PAPER PATTERN

| S.No. | Section | Subjects | No of Q's | Total marks |
|---|---|---|---|---|
| 1. | Section - 1 | Engineering - 1 | 50 | 100 |
| 2. | Section - 2 | Engineering - 2 | 50 | 100 |
| 3. | Section - 3 | General Ability | 20 | 40 |

## PAPER STRUCTURE

| | | |
|---|---|---|
| 1. | Total marks | 240 |
| 2. | Total Number Questions | 120 |
| 3. | Time Allowed | 3 Hours = 180 Minutes |
| 4. | Medium of Examination | English |
| 5. | Negative Marketing | Yes (25%) |
| 6. | Type of Questions | Objective type |

## SYLLABUS

**SECTION - 1 :** Materials and Components, Physical Electronics, Electron Devices and ICs, Network theory, Electromagnetic Theory, Electronic Measurements and Instrumentation, Power Electronics

**SECTION - 2 :** Analog Electronic Circuits, Digital Electronic Circuits, Control Systems, Communication systems, Microwave Engineering, Computer Engineering, Microprocessors

**SECTION - 3 :** General ability test (General Knowledge, Current Affairs, General English)

(based on the previous exam papers)

**ACE Engineering academy offers exclusive regular coaching for BSNL JTO exam.**

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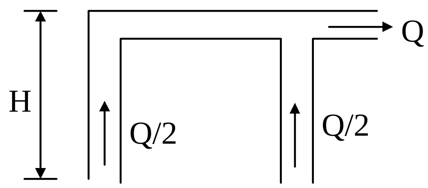
57. Two identical centrifugal pumps are connected in parallel to a common delivery pipe of a system. The pump curve of each of the pumps is represented by $H = 20 - 60Q^2$ where H is manometric head of the pump and Q is the discharge of the pump. The head loss equation when two such fully-similar pumps jointly deliver the same discharge Q will be

(a) $H = 40 - 15Q^2$ (b) $H = 20 - 60Q^2$

(c) $H = 40 - 60Q^2$ (d) $H = 20 - 15Q^2$

**57. Ans: (d)**

**Sol:**




$$H = 20 - 60 \times \left(\frac{Q}{2}\right)^2$$

$$H = 20 - 15\,Q^2$$

58. A line source of strength 15 π m/s is situated within a uniform stream flowing at −12 m/s (i.e., right to left). At a distance of 0.6 m downstream from the source is an equal sink. How far will the stagnation points be from the nearest source/sink?

(a) 0.38 m (b) 0.46 m

(c) 0.52 m (d) 0.58 m

**58. Ans: (a)**

**Sol:** Stagnation point,

$$x = -\frac{\text{Volumetric flow}}{2\pi U_o}$$

Given line source of strength = 15 π

$$\frac{\overset{*}{V}}{L} = 15\pi$$

$$\overset{*}{V} = 15\,\pi \times \text{width}$$

$$\overset{*}{V} = 15\,\pi \times 0.6$$

$$x = \frac{-15\pi \times 0.6}{2\pi \times (-12)}$$

$$x = 0.375 \text{ m} \simeq 0.38 \text{ m}$$

59. At the point of operation with maximum efficiency, a turbine indicated unit power of 12 units and unit speed of 98 units and operates with 3300 kgf/s of flow. What are the speed in rpm and the specific speed of the machine respectively when its design head is 8.5 m?

(a) 285 rpm and 339 (b) 270 rpm and 360

(c) 285 rpm and 360 (d) 270 rpm and 339

**59. Ans: (a)**

**Sol:** $P_u = 12$

$N_u = 98$

$W = 3300$ kgf/sec

$N = ?$

$N_s = ?$

$H = 8.5$ m

$$N_s = N_u\sqrt{P_u}$$

$= 98\sqrt{12}$

$N_s = 339$

$$N_u = \frac{N}{\sqrt{H}}$$

$$98 = \frac{N}{\sqrt{8.5}}$$

N = 285 rpm

60. A hydraulic turbine develops 8000 kW when running at 300 rpm under a head of 45 m. The speed of the same turbine under a head of 60 m is
(a) 224.4 rpm (b) 346.4 rpm
(c) 424.8 rpm (d) 485.8 rpm

**60. Ans: (b)**

**Sol:** $N_u = \frac{N}{\sqrt{H}}$

$$\frac{N_1}{\sqrt{H_1}} = \frac{N_2}{\sqrt{H_2}}$$

$$N_2 = N_1 \times \sqrt{\frac{H_2}{H_1}}$$

$$= 300 \times \sqrt{\frac{60}{45}}$$

= 346.4 rpm

61. Consider the following statements:
1. In an Impulse turbine, the pressure of the flowing water remains unchanged and is equal to atmospheric pressure.
2. In Impulse turbines, the water impinges on the buckets with 'pressure energy'.
3. In a Reaction turbine, the pressure of the flowing water remains unchanged and is equal to atmospheric pressure.

Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

**61. Ans: (a)**

62. A Pelton wheel with single jet rotates at 600 rpm. The velocity of the jet from the nozzle is 100 m/s. If the ratio of the bucket velocity to jet velocity is 0.44 and the speed ratio is 0.43, what is the coefficient of velocity of the nozzle?
(a) 0.817 (b) 0.882
(c) 0.913 (d) 0.977

**62. Ans: (d)**

**Sol:** N = 600 rpm

v = 100 m/s

$$\frac{U}{C_v\sqrt{2gH}} = \frac{U}{V_1} = 0.44 \qquad \text{….(1)}$$

$$\frac{U}{\sqrt{2gH}} = 0.43 \qquad \text{……(2)}$$

$$C_v = \frac{0.43}{0.44} = 0.977$$

**Directions:**

Each of the next **Eighteen (18)** items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

**Codes:**

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **not** the 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

63. **Statement (I):** The shear strain graph for a Newtonian fluid is linear.

**Statement (II):** The coefficient of viscocity $\mu$ of the fluid is not a constant.

**63. Ans: (c)**

64. **Statement (1):** Reynolds number must be the same for model and the prototype when both are tested as immersed in a subsonic flow.

**Statement (II):** A model should be geometrically similar to the prototype.

**64. Ans: (b)**

65. **Statement (I):** The ogee spillway is a control weir having an S-shaped crest profile which provides a high discharge coefficient without causing cavitations.

**Statement (II):** The crest profile of ogee spillway conforms to the lower nappe of flow over a ventilated sharp-crested weir and ensures a constant discharge coefficient for all heads.

**65. Ans: (c)**

66. **Statement (I):** In open channel flow, the maximum velocity does not occur on the free surface.

**Statement (II):** There is wind drag on the free surface of an open channel.

**66. Ans: (c)**

**Sol:** The maximum velocity of the cross-section occurs at a certain distance below the free surface. This dip of the maximum velocity point, giving surface velocities which are less than the maximum velocity, is due to secondary currents and is a function of the aspect ratio (ratio of depth to width) of the channel. Thus, for a deep narrow channel, the location of the maximum velocity point will be much lower from the water surface than for a wider channel of the same depth. This characteristic location of the maximum velocity point below the surface has nothing to do with the wind shear on the free surface.

**(Reference Flow in open channels Book by K. Subramanya)**

67. **Statement (I):** The deeper a lake, the lesser the evaporation in summer and the more in winter.

**Statement (II):** Heat storage in water bodies affects seasonal evaporation.

**67. Ans: (a)**

**Sol:** Evaporation for deep water bodies

Summer evaporation less and winter evaporation more.

68. **Statement (I):** Flow over sharp-crested weirs, standing wave flumes and abrupt free overfalls at ends of long straight channels are examples of rapidly varied flow.

**Statement (II):** The above-listed flows are all essentially local phenomena and can be utilized for flow measurement in open channels.

**68. Ans: (b)**

69. **Statement (I):** Negative skin friction will act on the piles of a group in filled-up reclaimed soils or peat soil.

**Statement (II):** The filled-up or peat soils are not fully consolidated but start consolidating under their own overburden pressure, developing a drag on the surface of the piles.

**69. Ans: (a)**

70. **Statement (I):** The possibility of quicksand condition occurring is more on the downstream of a weir on a permeable foundation than on the upstream end with an upward component of seepage velocity.

**Statement (II):** Seepage lines end with an upward component of seepage velocity at the downstream reaches of such a weir.

**70. Ans: (a)**

71. **Statement (I):** Multistage centrifugal pumps are used to produce very high delivery heads.

**Statement (II):** Roto-dynamix pumps must have to be centrifugal rather than centripetal, from the very basic principles of hydrodynamics. Also, the stages are in series.

**71. Ans: (a)**

72. **Statement (I):** The speed of a hydraulic turbine has to be maintained constant irrespective of the load on the machine for keeping the electrical power generation frequency constant.

**Statement (II):** Governing of hydraulic turbines can be done by controlling the discharge through the turbines by adjusting the spear valve in Pelton turbines and the wicket in Francis or Kaplan turbines.

**72. Ans: (a)**

**Note:** If statement (I) and Statement (II) are reversed, the answer would be (a)

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73. **Statement (I):** A channel in alluvium running with constant discharge and constant sediment charge will first form its flow section and then its final longitudinal slope.

**Statement (II):** If a channel in alluvium has a section too small for a given discharge and slope steeper than required, degradation and aggradation happen and then the flow section attains final regime.

**73. Ans: (d)**

74. **Statement (I):** The shear stress exerted by the stream flow on the bed is responsible for the movement of bed sediment particles.

**Statement (II):** The sediment will move when the shear stress crosses a threshold limit designated as a critical shear stress $\tau_C$.

**74. Ans: (a)**

75. **Statement (I):** The trap efficiency of reservoir increases with age as the reservoir capacity is reduced by sediment accumulation.

**Statement (II):** The trap efficiency is a function of the ratio of reservoir capacity to the total inflow. A small reservoir on a large stream has a low trap efficiency.

**75. Ans: (d)**

76. **Statement (I):** Recarbonation of water softened by lime-soda process results in increased hardness of the water.

**Statement (II):** Suspended solids, like $CaSO_4$ and $MgSO_4$, which have not settled in the sedimentation tank, get dissolved due to passage of $CO_2$.

**76. Ans: (a)**

**Sol:** Recarbonation is carried out to dissolve precipitates formed during lime-soda process. Precipitates which remain pushed back to dissolve form it slightly increase hardness.

77. **Statement (I):** Pipes carrying water are anchored at bends and other points of unbalanced thrusts.

**Statement (II):** Pipes are anchored by firmly embedding in massive blocks of concrete or masonry to counter side thrusts due to hydrodynamic forces exerted on the joints.

**77. Ans: (a)**

78. **Statement (I):** Aerobic condition in composting of refuse can be confirmed by temperature measurements.

**Statement (II):** Aerobic reactions are exothermic.

**78. Ans: (a)**

**Sol:** Aerobic compositing release heat, therefore it is exothermic.

Measure of performance of aerobic composting is temperature.

79. **Statement (I):** For a given soil, optimum moisture content increases with the increase in compactive effort.

**Statement (II):** Higher the compactive effort, higher is the dry density at the same moisture content.

**79. Ans: (d)**

80. **Statement (I):** Rate of settlement of a consolidating layer depends upon its coefficient of consolidation, which is directly proportional to the permeability and number of drainage paths available.

**Statement (II):** The excess hydrostatic pore pressure is relieved fast in soil of higher permeability, in turn, depending on the number of drainage paths available in the consolidating layer.

**80. Ans: (a)**

81. In a single-acting reciprocating pump, the acceleration head at the beginning of the suction stroke is 3.5 m. If the pump is 1.5 m below the water level in the supply reservoir, the pressure head at the cylinder at that instant, considering the atmospheric pressure as 10.0 m is

(a) 2 m (abs) (b) 4 m (abs)

(c) 8 m (abs) (d) 16 m (abs)

**81. Ans: (c)**

**Sol:** $h_{a_s} = 3.5\text{m}$

$H_s = 1.5$ m

$H_{atm} = 10$ m

$P_c = ?$

$P_c = H_{atm} + H_s - h_{a_s}$

$= 10 + 1.5 - 3.5$

$= 8$ m (Abs)

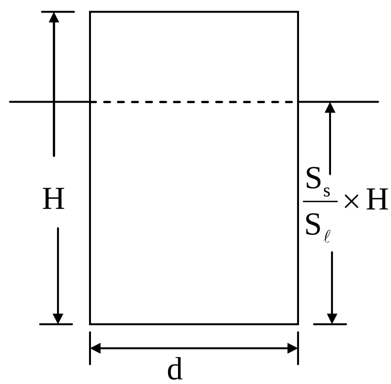
82. A solid cylinder of circular section of diameter d is of material with specific gravity $S_s$. This floats in a liquid of specific gravity $S_l$. What is the maximum length of the cylinder if equilibrium is to be stable with the cylinder axis vertical?

(a) $\dfrac{dS_s}{2\sqrt{S_s(S_\ell - S_s)}}$ (b) $\dfrac{dS_\ell}{\sqrt{8S_s(S_\ell - S_s)}}$

(c) $\dfrac{dS_\ell}{\sqrt{2S_s(S_\ell - S_s)}}$ (d) $\dfrac{d}{\sqrt{8(S_\ell - S_s)}}$

**82. Ans: (b)**

**Sol:**




$$GM = \frac{I}{V} - B\overline{S}$$

$$\frac{\pi d^4}{64}\times\frac{4}{\pi d^2}\frac{S_\ell}{S_s \times H} - \left(\frac{H}{2} - \frac{S_s H}{2S_\ell}\right) = 0$$

$$\frac{d^2 S_\ell}{16 S_s . H} = \frac{H}{2}\left[1 - \frac{S_S}{S_\ell}\right]$$

$$H^2 = \frac{d^2.S_\ell \times S_\ell}{8S_s(S_\ell - S_s)}$$

$$= \frac{d^2 S_\ell^2}{8S_s(S_\ell - S_s)}$$

$$H = \frac{d.S_\ell}{\sqrt{8S_s(S_\ell - S_s)}}$$

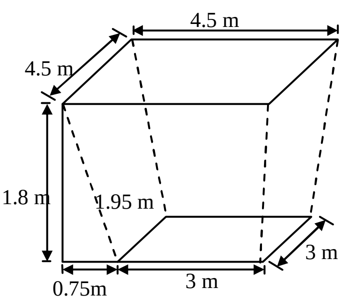
83. A tank is 1.8 m deep and square length of 4.5 m at the top and square length of 3 m at the bottom. The four sides are plane and each has the same trapezoidal shape. The tank is completely full of oil weighing 936 kg/m$^3$. What is the resultant pressure on each side?

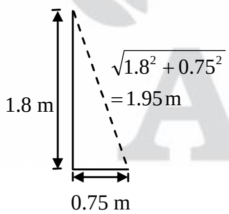
(a) 5750 kgf (b) 5500 kgf

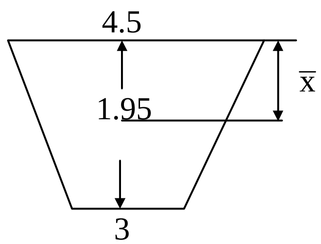
(c) 5250 kgf (d) 5140 kgf

**83. Ans: (a)**

**Sol:**




$$\bar{x} = \left(\frac{4.5 + 2\times 3}{4.5 + 3}\right)\frac{1.95}{3} = 0.84\,\text{m}$$

$F = \rho\, A\, \bar{x}$

$$= 936 \times \left(\frac{4.5+3}{2}\right)(1.95)\times 0.84$$

= 5750 kg (f)

84. Over a basin of area 333 km$^2$, there was a storm for 6 h with a uniform intensity of 2 cm/h. The observed runoff was 20 × 10$^6$ m$^3$. The average rate of infiltration for the basin was

(a) 5 mm/h (b) 10 mm/h

(c) 20 mm/h (d) 40 mm/h

**84. Ans: (b)**

**Sol:** i = 2 cm/hr $\quad$ t = $t_e$ = 6 hr

P = $P_e$ = 2 × 6 = 12 cm

$$\text{Runoff 'R'} = \frac{\text{Volume of runoff}}{\text{Catchment area}}$$

$$= \frac{20\times 10^6}{333\times 10^6}\times 100 = 6\,\text{cm}$$

$$\phi_{\text{Index}} = \frac{P_e - R}{t_e}$$

$$= \frac{12-6}{6} = \frac{6}{6} = 1\ \text{cm/hr}$$

= 10 mm/hr

85. International Traffic Intelligent Survey Data are related with

(a) Origin and destination studies

(b) Speed and delay studies

(c) Classified traffic volume studies

(d) Accident profiling studies

**85. Ans: (a)**

86. A peak flow of a flood hydrograph due to a six-hour storm is 470 $m^3/s$. The corresponding average depth of rainfall is 8 cm. Assume an infiltration loss of 0.25 cm/hour and a constant base flow of 15 $m^3/s$. What is the peak discharge of 6 hour unit hydrograph for this catchment?

(a) 60 $m^3/s$ (b) 70 $m^3/s$
(c) 80 $m^3/s$ (d) 90 $m^3/s$

**86. Ans: (b)**

**Sol:** Peak flow of 6 hr FHG = 470 $m^3$/sec

$\phi_{Index}$ = 0.25 cm/hr

$P = P_e = 8$ cm $\quad t = t_e = 6$ hr

$$\phi_{Index} = \frac{P_e - R}{t_e}$$

$$0.25 = \frac{8-R}{6} \Rightarrow R = 6.5\,\text{cm}$$

Base flow = 15 $m^3$/sec

Peak flow of 6 hr DRH = 470 – 15

= 455 $m^3$/sec

Peak flow of 6 hr UHG

$$= \frac{\text{Peak flow of 6hr DRH}}{R}$$

$$= \frac{455}{6.5} = 70\ m^3/\text{sec}$$

87. A new reservoir has a capacity of 12 $Mm^3$ and its catchment area is 400 $km^2$. The annual sediment yield from this catchment is 0.1 ha. m/$km^2$ and the trap efficiency can be assumed constant at 90%. The number of years it takes for the reservoir to lose 50% of its initial capacity is, nearly

(a) 177 years (b) 77 years
(c) 17 years (d) 7 years

**87. Ans: (c)**

**Sol:** Reservoir capacity = 12 $Mm^3$

Catchment area = 400 $km^2$

Sediment yield 1 yr = 0.1 ha-m/$km^2$

Trap efficiency = 90%

Life of reservoir if 50% is silted = ?

Total sediment yield = 0.1 × 400 = 40 ha-m

$= 40 \times 10^4\ m^3 = 0.4 \times 10^6\ m^3$

$= 0.4\ Mm^3$

Trap Efficiency,

$$\eta = \frac{\text{sediment trapped in reservoir}}{\text{total sediment bloomy in the river}}$$

∴ Sediment deposited in reservoir/yr

= 0.9 × 0.4

= 0.36 $Mm^3$

50% of capacity = 6 $Mm^3$

$0.36\ Mm^3 \rightarrow 1$ yr

$$6\ Mm^3 \rightarrow 6 \times \frac{1}{0.36} = 17\ \text{yr}$$

88. Cavitation is likely to occur if

1. Pressure becomes very high.
2. Temperature becomes low.
3. Pressure at the specific point falls below vapour pressure.
4. Energy is released with the onset of a high intensity wave due to noise and vibration of the machine.

Which of the above statements are correct?

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

**88. Ans: (c)**

**Note:** Francis of statement-4 is improper

89. Which of the following statements are correct as regards aquifer characteristics?
   1. The storage coefficient is the volume of water released from storage from the entire aquifer due to unit depression of peizometric head.
   2. The storage coefficient is the same as the specific yield for water table aquifer.
   3. Both the aquifer constants, viz. storage coefficient *S* and Transmissivity *T* are dimensionless numbers.

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

**89. Ans: (b)**

90. The important parameters describing the performance of a hydraulic machine are:
P the power input, H the head produced across the machine and the efficiency, η. For a given geometrical design of the machine, the performance is characterized by the variables:
H-the head increase across the machine,
ρ- the fluid density, ω-the angular velocity of the rotor, D – the diameter of the rotor,
μ - the fluid viscosity and Q - the flow rate; and both P and η are expressed through these variables. How many non-dimensional parameters are involved herein? Gravitational acceleration g has also to be considered necessarily?
   (a) 7 (b) 6
   (c) 5 (d) 4

**90. Ans: (b)**

**Sol:** P, H, η,ρ, W, D,μ, Q, g

No of π parameters $= n - m$

$= 9 - 3 = 6$

91. What are the values of coefficients a and c if velocity distribution in a laminar boundary layer on a flat plat is:

$$f(n) = \frac{u}{U_o} = a + bn + cn^2 + dn^3$$

Where, $n = \dfrac{y}{\delta}$

   (a) $\frac{1}{2}$ and 1 (b) 0 and 1
   (c) $-\frac{1}{2}$ and 0 (d) 0 and 0

**91. Ans: (d)**

**Sol:** $\dfrac{u}{U_o} = a + bn + cn^2 + dn^3$

At y = 0, u = 0 = $U_o$

$\therefore$ a = 0

$n = \dfrac{y}{\delta}$

At $y = \delta$, $U = U_\infty$, $\dfrac{du}{dy} = 0$

92. The conditions to be satisfied for a channel in 'Regime' as per Lacey are

1. Constant discharge.
2. Silt grade and silt concentration are constant.
3. The channel is flowing in unlimited incoherent alluvium of the same alluvial character as that transported.

Which of the above statements are correct?

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

**92. Ans: (b)**

93. Consider the following statements related to uplift pressure in gravity dams:

1. A drainage gallery reduces the uplift pressure at all levels below the gallery.
2. A drainage gallery below upstream water level reduces the uplift pressure at all levels below the upstream water level.
3. A grout curtain near the heel reduces seepage and uplift pressure everywhere on the gravity dam whatever the upstream water level.

Which of the above statements are correct?

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

**93. Ans: (a)**

94. A barrage on a major river in the Gangetic plains has been designed for a flood discharge 7000 m$^3$/s. It-has been provided with a waterway of 360 m length. The looseness factor of this barrage is

(a) 1.7 (b) 1.1
(c) 0.7 (d) 0.1

**94. Ans: No Answer (0.9)**

**Sol:** Q = 7000 m$^3$/s

Length of waterway provided = 360 m

P = Regime width

$$P = 4.75\sqrt{Q} = 397.41 \text{ m}$$

Looseness factor

$$= \frac{\text{Actual waterway provided}}{\text{computed waterway}}$$

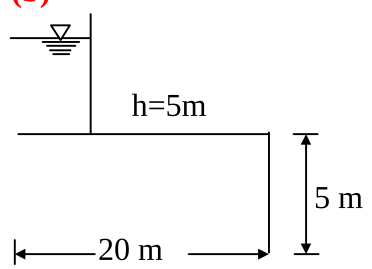
$$= \frac{360}{397.41} = 0.905$$

95. A 20 m long horizontal concrete floor under a barrage on a permeable foundation retains a 5 m head of water and has a 5 m deep downstream end pile. The exit gradient is

(a) 1 in 4 (b) 1 in 5
(c) 1 in 6 (d) 1 in 8

**95. Ans: (b)**

**Sol:**




$$G_E = \frac{H}{d\pi\sqrt{\lambda}} \qquad \lambda = \frac{1+\sqrt{1+\alpha^2}}{2}$$

$$\lambda = \frac{1+\sqrt{1+16}}{2} \qquad \alpha = \frac{b}{d} = \frac{20}{5} = 4$$

$\simeq 2.5$

$$G_E = \frac{5}{5\pi\sqrt{2.5}}$$

$$= \frac{5}{5\pi\sqrt{2.5}} = 0.2$$

$$= \frac{1}{5}$$

96. Electrical conductivity (EC) of water and total dissolved solids (TDS) are relatable as: The value of EC will
(a) Decrease with increase in TDS
(b) Increase with increase in TDS
(c) Decrease initially and then increase with increase in TDS
(d) Increase initially and then decrease with increase in TDS

**96. Ans: (b)**

**Sol:** EC $\propto$ TDS

97. Consider the following properties of fluorine:
1. It is a member of the halogen family.
2. It is a greenish yellow diatomic gas.
3. Chlorine, iodine, bromine and Helium are members of the halogen family.
4. Even fireproof asbestos burns in the ambience of fluorine.

Which of the above are correct?
(a) 1, 2 and 3 only (b) 3 and 4 only
(c) 1, 2 and 4 only (d) 1, 2, 3 and 4

**97. Ans: (c)**

**Sol:** Fluorine, chlorine, Iodine and Bromine only halogen group of chemical
Fluorine is highly reactive

98. The following are certain operating problems of a rapid sand filter:
1. Sand depth should never be depleted by more than 10 cm.
2. Air binding results due to development of negative head and formation of air bubbles in the filter sand.
3. Water softening with lime-soda leads to incrustation of sand.
4. Bumping of filter bed is caused due to negative head.

Which of the above statements are correct?
(a) 1, 2 and 4 only (b) 1, 2 and 3 only
(c) 3 and 4 only (d) 1, 2, 3 and 4

**98. Ans: (d)**

**Sol:** Rapid sand filters often experience air binding problem and also incruster of sand.

99. Consider the following characteristics of E coli bacteria:
1. Gram negative
2. Spore-forming
3. Facultative anaerobic
4. Bacillus

Which of the above are correct?
(a) 1, 2 and 3 only (b) 2 and 4 only
(c) 1, 3 and 4 only (d) 1, 2 3 and 4

**99. Ans: (c)**

**Sol:** E-coli are non spore forming gram negative Bacillus

100. How much bleaching powder is needed to chlorinate 5000 $l$ of water whose chlorine demand is 2 mg/$l$, assuming that the bleaching powder has 25% available chlorine?

(a) 4 g (b) 40 g

(c) 140 g (d) 400 g

**100. Ans: (b)**

**Sol:** Q = 5000 lit

$Cl_2$ demand 2 mg/$l$

$Cl_2$ in BP = 25%

$$\text{B.P dose} = \frac{2}{\frac{25}{100}} = \frac{2\times100}{25} = 8 \text{ mg/lit}$$

Total BP = Q × dose of BP

= 5000 × 8 = 40000 mg

lit × mg/lit = 40 gm

101. Which technique of stabilization for the sub-base is preferred for a heavy plastic soil?

(a) Cement stabilization

(b) Mechanical stabilization

(c) Lime stabilization

(d) Bitumen stabilization

**101. Ans: (c)**

102. A fill having volume of 150000 $m^3$ is to be constructed at a void ratio of 0.8. The borrow pit solid has a void ratio of 1.4. The volume of soil required to be excavated from the borrow pit will be

(a) 150000 $m^3$ (b) 200000 $m^3$

(c) 250000 $m^3$ (d) 300000 $m^3$

**102. Ans: (b)**

**Sol:** $\frac{V_1}{V_2} = \frac{1+e_1}{1+e_2}$

$$\frac{V_1}{15\times10^4} = \frac{1+1.4}{1+0.8} = \frac{2.4}{1.8}$$

$$= \frac{0.4}{0.3}$$

$$= \frac{4}{3}\times15\times10^4$$

$= 20 \times 10^4\ m^3$

103. A channel designed by Lacey's theory has a mean velocity of 1.1 m/s. The silt factor is 1.1. Then hydraulic mean radius will be

(a) 1.13 m (b) 2.27 m

(c) 3.13 m (d) 4.27 m

**103. Ans: No Answer (2.75 m)**

**Sol:** V = 1.1 m/s, f = 1.1 R = ?

$$V = \sqrt{\frac{2}{5}.f.R}$$

$$R = \frac{5}{2}\frac{V^2}{f} = \frac{5}{2}\times1.1\times\frac{1.1}{1.1}$$

= 2.75 m

104. Consider the following assumptions as regards field permeability test:

1. The flow is laminar and Darcy's law is valid.
2. The flow is horizontal and uniform at all points in the vertical section.
3. The velocity of flow is proportional to the 'tangent magnitude' of the hydraulic gradient.

Which of the above assumptions are correct?

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

**104. Ans: (d)**

105. In a three-layered soil system, the thicknesses of the top and bottom layers each are half the thickness of the middle layer. The coefficients of permeability of top and bottom layers each are double the coefficient of permeability *k* of the middle layer. When horizontal flow occurs, the equivalent coefficient of permeability of the system will be

(a) 1.5 k (b) 3.0 k
(c) 4.5 k (d) 6.0 k

**105. Ans: (a)**

**Sol:**

$Z_1 = Z$ $k_1 = 2k$

$Z_2 = 2Z$ $k_2 = k$

$Z_3 = Z$ $k_3 = 2k$

$$K_H = \frac{Z\times 2k + 2Z\times k + Z\times 2k}{Z+2Z+Z}$$

$$= \frac{6Zk}{4Z} = 1.5k$$

106. A uniform collapsible sand stratum, 2.5 m thick, has specific gravity of its sand as 2.65, with a natural void ratio of 0.65. The hydraulic head required to cause quick collapsible sand condition is

(a) 2.50 m (b) 2.75 m
(c) 3.25 m (d) 3.50 m

**106. Ans: (a)**

**Sol:**

G = 2.65, e= 0.65

$$i_c = \frac{G-1}{1+e}$$

$$= \frac{1.65}{1.65} = 1$$

$$i_c = \frac{h}{Z} \qquad h = i_c.Z$$

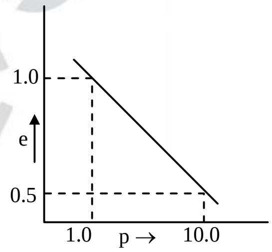
$h = 1 \times 2.5 = 2.5$ m

107. The ratio of dry unit weight to unit weight of water represents

(a) Specific gravity of soil solids
(b) Specific gravity of soil mass
(c) Specific gravity of dry soil
(d) Shrinkage ratio

**107. Ans: (d)**

108.




The virgin compression curve with axes adopted as per convention in this regard for a clay soil is shown in the figure. The compression index of the soil is

(a) 0.25 (b) 0.50
(c) 1.00 (d) 1.25

**108. Ans:(b)**

**Sol:**

$$C_c = \frac{\Delta e}{\log_{10}\frac{\sigma_{f'}}{\sigma_o}}$$

$$= \frac{1-0.5}{\log_{10}\frac{10}{1}} = \frac{0.5}{1} = 0.5$$

109. Proctor's compaction test for the maximum dry density of a certain soil gave the results as : 1.77 gm/cc and OMC 14.44%. The specific gravity of the clay soil grain was 2.66. What was the saturation degree for this soil?

(a) 44% (b) 55% (c) 66% (d) 77%

**109. Ans: (d)**

**Sol:**

$\gamma_d$ = 1.77 g/cc, w = 14.44%, G = 2.66, $S_r$ = ?

$$\gamma_d = \frac{\gamma_w G}{1+e}$$

$$1.77 = \frac{1\times 2.66}{1+e}$$

e = 0.5

$$e = \frac{wG}{S_r}$$

$$S_r = \frac{wG}{e}$$

$$= \frac{0.144\times 2.66}{0.5}$$

= 0.766

= 77%

110. A rigid retaining wall of 6 m height has a saturated backfill of soft clay soil. What is the critical height when the properties of the clay soil are:

$\gamma_{sat}$ = 17.56 kN/m$^3$ and cohesion

C = 18 kN/m$^2$

(a) 1.1 m (b) 2.1 m

(c) 3.1 m (d) 4.1 m

**110. Ans: (d)**

**Sol:**

$$H_c = \frac{4c}{\gamma} = \frac{4\times 18}{17.56} = 4.1\text{m}$$

111. The Engineering News Record Formula,

$Q_a = \frac{Wh}{6(s+0.25)}$, is used for the case of

1. Drop hammer
2. Single-acting hammer
3. Double-acting hammer

Which of the above is/are correct?

(a) 1 only (b) 2 only

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

**111. Ans: (b)**

112. In a certain sea shore, the height of a retaining wall with smooth vertical back is 4.4 m. The foundation is over an expansive collapsible soil and has a horizontal surface at the level of the top of the wall and carries a udl of 197 kPa. The unit weight and angle of internal friction are 19 kN/m$^3$ and 30$^o$, respectively. What is the nearest magnitude

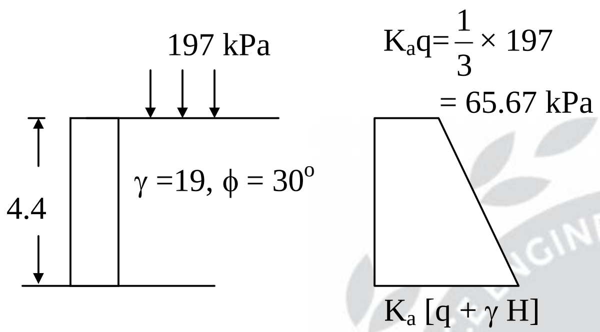
of the total active pressure per metre length of this sea shore wall?

(a) 270 kN/m (b) 360 kN/m

(c) 450 kN/m (d) 640 kN/m

**112. Ans: (b)**

**Sol:**




$K_a\,[q + \gamma H]$

$= \frac{1}{3}[197 + 19 \times 4.4] = 93.53\,\text{kPa}$

$F_a = \frac{65.67 + 93.53}{2} \times 4.4$

= 350 kN/m

113. Which of the following statements are rightly associated with the laws of weights in the theory of errors?

1. If an equation is multiplied by its own weight, then the weight of the resulting equation is equal to the reciprocal of the weight of the original equation.
2. The weight of the algebraic sum of two or more quantities is equal to the reciprocal of the sum of the individual weights.
3. If the quantity of a given weight is multiplied with a factor, then the weight of the resulting quantity is obtained by dividing the original weight by the square root of that factor.
4. If the quantity of a given weight is divided by a factor, then the weight of the resulting quantity is obtained by multiplying the original weight by the square of that factor.

(a) 2 and 3 (b) 2 and 4

(c) 1 and 4 (d) 1 and 3

**113. Ans: (c)**

**Sol:**

2. The weight of the algebraic sum of two or more quantities is equal to the reciprocal of the sum of the **reciprocal** of individual weights.
3. If the quantity of a given weight is multiplied with a factor, then the weight of the resulting quantity is obtained by dividing the original weight by the **square** of that factor.

As statement 2 and 3 are not associated with the laws of weights in the theory of errors so correct option is 'c'

114. Hypotenusal allowance is given by the expression (adopting standard conventions)

(a) (1 – secθ) × measured distance

(b) (1 – cosθ) × measured distance

(c) (secθ – 1) × measured distance

(d) (cosθ –1) × measured distance

**114. Ans: (c)**

115. The clogging of chain rings with mud introduces (with 'error' defined in the standard way):

1. Negative cumulative error
2. Positive cumulative error
3. Compensating error

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

**115. Ans: (b)**

116. The magnetic bearing of a line (on full circle mensuration basis) is 55°30′ and the magnetic declination is 5°30′ East. The true magnetic bearing of the line will be

(a) 61°00′ (b) 55°30′
(c) 40°00′ (d) 50°00′

**116. Ans: (a)**

**Sol:** T.B = M.B ± Declination
use + , for Eastern Declination
−, for Western Declination
= 55°30′ + 5°30′ = 61°00′

117. In any closed traverse, if the survey work is error free, then

1. The algebraic sum of all the latitudes should be equal to zero
2. The algebraic sum of all the departures should be equal to zero
3. The sum of the northings should be equal to the sum of the southings.

Which of the above statements are correct?

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

**117. Ans: (d)**

118. The rise and fall method for obtaining the reduced levels of points provides a check on

1. Foresight
2. Backsight
3. Intermediate sight

Which of the above statements are correct?

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

**118. Ans: (d)**

119. Turning of the theodolite telescope in vertical plane by 180° about the horizontal axis is known as

(a) Setting (b) Centering
(c) Transiting (d) Swinging

**119. Ans: (c)**

120. Which of the following are among the fundamental lines of a theodolite ?

1. The vertical and horizontal axes
2. The lines of collimation and axis of the plate levels
3. The bubble line of the altitude level

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

**120. Ans: (d)**

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