ACE
Engineering Academy

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ESE- 2018 (Prelims) - Offline Test Series Test-3

CIVIL ENGINEERING

SUBJECT: FLUID MECHANICS & OPEN CHANEL FLOW, HYDRAULIC MACHINES & HYDRO POWER, SURVEYING AND GEOLOGY

SOLUTIONS

01. Ans: (d) **02. Ans: (c)**

03. Ans: (d)

Sol: Number of photographs required

$$N = \frac{A}{a}$$

$$a = (1-0.6)(1-0.2)\frac{0.25\times 0.25}{\left(\frac{1}{10000}\right)^2} = 2\text{ km}^2$$

$$N = \frac{500}{2} = 250\ \text{No's}$$

04. Ans: (d) **05. Ans: (a)** **06. Ans: (a)**

07. Ans: (d) **08. Ans: (d)** **09. Ans: (b)**

10. Ans: (d)

11. Ans: (a)

Sol: $h = 0.06735\ d^2$;

$d = 10$ km

Total distance = 2 d = 20 km

12. Ans: (a)

Sol:

T.B = MB ± Declination

$= 8^o5' + 2^o$

T.B = $10^o5'$

Using present magnetic declination

$10^o5' = MB + 11^o5'$

$MB = -1^o = 360^o - 1^o = 359^o$

13. Ans: (b)

Sol:

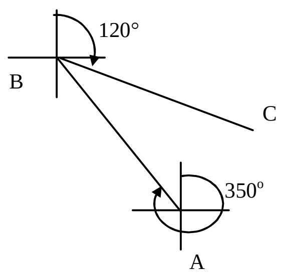
$l = 0.025$ 'S' Cosecα

$= 0.025 \times 10 \times \text{cosec } 30^o$

$l = 0.5$ m

14. Ans: (c)

Sol:



$\angle B$ = F.B of BA – FB of BC

$= (350^o - 180^o) - 120^o$

$= 50^o$

15. Ans: (b)

Sol:

Station	B.S	I.S	F.S	Rise	Fall	R.L
1	2.15					450.000
2	1.645		1.65	0.500		450.500
3		2.345			0.7	449.800
4	Y		1.965	0.38		450.180
5	Z		1.825			

16. Ans: (c)

Sol:

Station	B.S	I.S	F.S	Remarks
1	0.695			B.S
2		1.525		I.S
3	0.635		2.395	Change point
4	0.125		0.805	Change point
5			0.325	

17. Ans: (c)

Sol:

In case of hill, higher values inside and lower values outside, vice versa in a depression

18. Ans: (b)

Sol: $k = \frac{f}{i} = \frac{240}{1.2} \Rightarrow 200$

$C = f + d = 21 + 24 = 45$ cm = 0.45 m

19. Ans: (b)

Sol: $L = R\tan\frac{\theta}{2} \Rightarrow L = 800 \times \tan 30^o$

$= \frac{800}{\sqrt{3}}$ 'm'

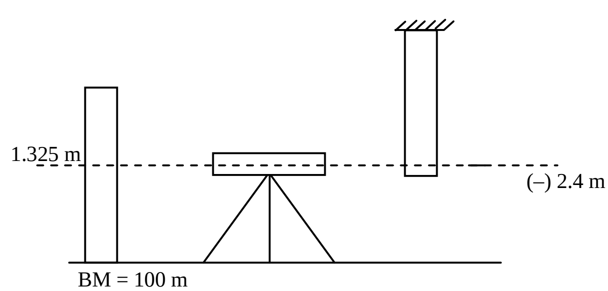
20. Ans: (b)

Sol: Add equations i..e

$6A = 182^o1'55''$

$A = 30^o20'19.17''$

21. Ans: (b)



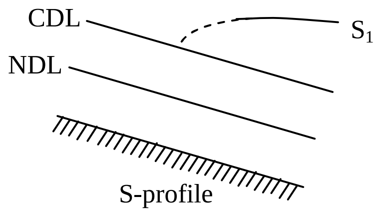
RL of bottom of chajja

= [100 + 1.325] –(–2.4)

= 103.725 m

22. Ans: (c)

Sol:



- There are four falling water surface profiles (M_2, S_2, H_2 and A_2)
  According to open channel flow by Dr. Chow, C_2 profile is a straight line with downward slope. So, statement 2 is wrong.
- All profiles meet critical depth line normally. So, statement 3 is wrong.
- The flow profiles are not properly defined near bed i.e. $y \to 0$. So, statement 4 is wrong.

23. Ans: (c)

Sol: $F = \dfrac{V}{\sqrt{gy}} = 2.5$

$V = 2.5\sqrt{gy}$

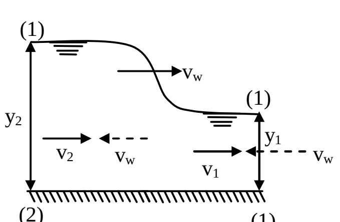
Specific energy, $E = y + \dfrac{V^2}{2g}$

$= 0.8 + \dfrac{2.5^2 \times g \times 0.8}{2 \times g}$

$= 3.3$ m

24. Ans: (b)

Sol:



The given surge is positive surge. v_w is the applied absolute velocity of surge in opposite direction to make it equivalent steady flow

Then by continuity equation

$y_2 (v_2 - v_w) = y_1 (v_1 - v_w)$

25. Ans: (c)

Sol: $V = C\sqrt{RS}$

$1.23 = C\sqrt{RS}$

$\tau = \gamma RS$

$1 = 9810$ RS

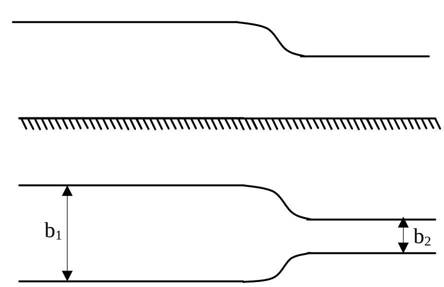
$RS = \dfrac{1}{9810} = 10^{-4}$

$\therefore 1.23 = C\sqrt{10^{-4}}$

$\Rightarrow C = 123$

26. Ans: (d)

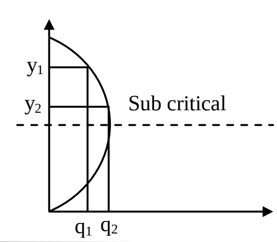
Sol: Assume channel bottom is horizontal



$q_1 = \dfrac{Q}{b_1}$ $\qquad q_2 = \dfrac{Q}{b_2}$

$b_2 < b_1$

$q_2 > q_1$



For $q_2 > q_1 \Rightarrow y_2 < y_1 \Rightarrow$ depth decreases

$Q = AV = b_1y_1 \times V = b_2y_2 \times V$

If the depth decreases and to maintain the same discharge, velocity is to be increased.

27. Ans: (a)

Sol: $\frac{y_2}{y_1} = 9.0$

$y_1 = 0.5,\ y_2 = 4.5$

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

$$= \frac{4^3}{4 \times 0.5 \times 4.5} = 7.1\,\text{Nm/N}$$

28. Ans: (d)

Sol: $\frac{u_{max}}{V_{avg}} = \frac{3.17}{2.6} = 1.219$

$$\frac{U_{max}}{V_{avg}} = 1.43\sqrt{f} + 1$$

$\Rightarrow f = 0.0235$

29. Ans: (c)

Sol: $y_c = \left(\frac{q^2}{g}\right)^{1/3}$

$q = \frac{6}{2} = 3\ \text{m}^3\text{/s}$ per m width of the channel

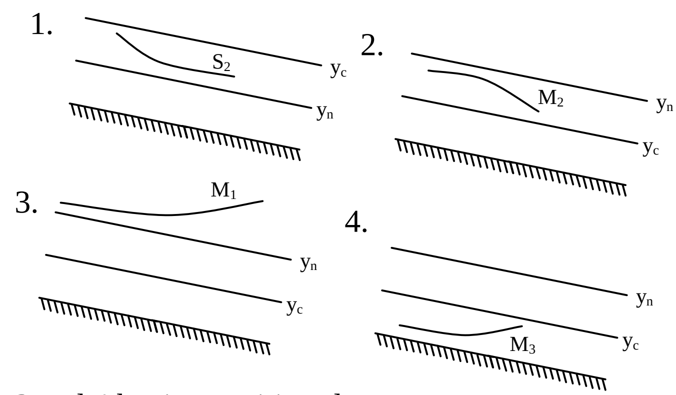
$$y_c = \left(\frac{3^2}{10}\right)^{1/3} = \left(\frac{9}{10}\right)^{1/3} = (0.9)^{1/3} = 0.97$$

30. Ans: (b)

Sol: $b = \frac{2y}{\sqrt{3}} \Rightarrow \frac{b}{y} = \frac{2}{\sqrt{3}} = 1.155$

31. Ans: (d)

Sol:



3 and 4 having positive slopes

32. Ans: (d)

Sol: $\eta = \frac{P_w}{P_s}$

$$P_w = \frac{500 \times 25}{1000} = 125\,\text{kW}$$

$P_s = 150$ kW

$$\therefore\ n = \frac{125}{150} \times 100 = 83.3\% \simeq 83\%$$

33. Ans: (a)

Sol: Using energy equation

$$\frac{V^2}{2g} = H + 0.1\frac{V^2}{2g}$$

$$H = 0.9\frac{V^2}{2g} = 0.9 \times \frac{20^2}{2 \times 9.81} = 18.35\,\text{m}$$

34. Ans: (d)

Sol:

$F = \rho A\,(V-u)^2$

$= 1000 \times 0.002\,(20-10)^2$

$F = 200$ N

35. Ans: (d)

Sol: $N_s = \frac{N\sqrt{P}}{H^{5/4}} = \frac{450\sqrt{8100}}{81^{5/4}} = 166.676$ (Francis)

36. Ans: (a)

Sol: $\sigma = \frac{H_{atm} - H_L - H_V - Z}{H_{working\,head}}$

$0.1 = \frac{10.2 - 0 - 1.5 - Z}{45}$

$\Rightarrow Z = 4.2$ m

37. Ans: (d)

Sol: $\frac{P}{N^3 D^5} = \text{Const}$

$P \propto N^3$

$\frac{1000}{900^3} = \frac{P}{2700^3} \Rightarrow P = 27000$ W

$= 27$ kW

38. Ans: (c)

Sol: $N_s = \frac{N\sqrt{P}}{H^{5/4}} = \frac{T^{-1}\left(MLT^{-2}LT^{-1}\right)^{1/2}}{L^{5/4}}$

$N_s = M^{1/2}L^{-1/4}\,T^{-5/2}$

39. Ans: (b)

Sol: Sphere is acted by form & friction drag both & terminal velocity is maximum velocity.

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40. Ans: (b)

41. Ans: (d)

Sol: Vol. of balloon

$= \frac{75\,\text{kg}}{(1.25 - 0.75)\text{kg/m}^3} = 150\text{ m}^3$

42. Ans: (d)

Sol: $P_p = \rho_1 g h_1 + \rho g h_2$

$= 1000 \times 10 \times 0.8 + 1600 \times 10 \times 1$

$= 24000$ Pa

$P_p = 24$ kPa

$= \frac{24}{1.6 \times 10} = 1.5$ m of immissible liquid

43. Ans: (a)

Sol: It comes back to its original position after slight disturbances.

44. Ans: (b)

Sol: Flow takes place from zone of lower pressure to that of higher pressure.

45. Ans: (c)

46. Ans: (b)

Sol: $y_1V_1 = y_2V_2$

$2 \times 2 = 1 \times V_2$

$V_2 = 4$ m/sec

47. Ans: (b)

Sol: $u = \frac{\log x}{y}$ $\quad V = \frac{-\log y}{x}$

$u = \frac{\partial\psi}{\partial y}$ and $v = \frac{-\partial\psi}{\partial x}$

On integration, $\int\partial\psi = \int u\,dy$

$\Rightarrow \psi = \log x \log y$.

48. Ans: (b)

Sol: Re ≤ 2000

$$\frac{VD}{\nu} \le 2000$$

$$\frac{V\times 0.1}{1.2\times 10^{-4}} \le 2000$$

$\Rightarrow$ V = 2.4 m/s

$$Q = \frac{\pi}{4}\times 0.1^2 \times 2.4 = 6\pi\times 10^{-3} = 6\pi\ l/s$$

49. Ans: (a)

Sol: External mouthpiece = C_d = 0.855

Orifice C_d = 0.6 to 0.65

Bell-mouthed orifice C_d = 0.707

Bordas mouth piece running free C_d = 0.5

50. Ans: (c)

Sol: $y_p = \bar{y} + \frac{I_{xx}}{A\bar{y}}$ $\quad\quad \bar{y} = 2 + \frac{3}{2} = 3.5$ m

$$y_p = 3.5 + \frac{\frac{2.5\times 3^3}{12}}{2.5\times 3\times 3.5}$$

y_p = 3.714 m

51. Ans: (b)

Sol: Potential flow describes the velocity field as the gradient of scalar.

52. Ans: (c)

Sol: Bothm overall efficiency and the output of the turbine can be improved by placing a draft tube at the exit of the turbine.

53. Ans: (c)

Sol: $(Fr)_m = (F_r)_P$

$$V_r = \sqrt{Lr_v}$$

$$Q_r = \frac{Q_m}{Q_p} = V_r.A_r = \sqrt{L_{rv}}.L_{rH}.L_{rV}$$

$$Q_r = L_{rH}.L_{rv}^{1.5} = \frac{1}{500}\times\left(\frac{1}{100}\right)^{1.5}$$

Q_P = 500 × 100 ×10×0.2

= 100000 m^3/s

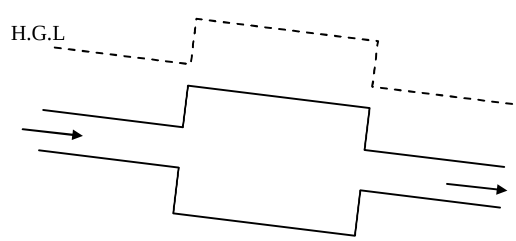
54. Ans: (b)

55. Ans: (c)

Sol:

- In pipe flow, Hydraulic and energy gradient lines will coincide only when velocity is zero, meaning no flow. Therefore 'statement 1' is wrong.
- Piezometric head = $\frac{p}{\gamma} + z$
- In ideal fluids, losses are zero. Hence, total energy remains constant.

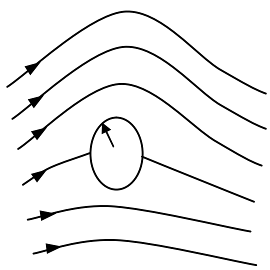
$\Rightarrow$ Total energy line/ energy gradient line is always horizontal



- Assume pipes of different diameter are connected in series as follows. If the diameter of pipe increases, velocity decreases and pressure increases. If the diameter of pipe decreases, velocity increases and pressure decreases. Hence, Hydraulic gradient line may rise or may fall in the direction of flow. If the pipe is of constant diameter, H.G.L will have down ward slope.

56. Ans: (a)

Sol:



Flow pattern over a rotating cylinder

Velocity in upper half of the cylinder is more than lower half.

⇒ Pressure will be opposite.

⇒ Due to difference in pressure, Lift occurs from high pressure to low pressure.

57. Ans: (c)

Sol: $Re = \frac{\rho VD}{\mu} = \frac{VD}{\nu} = \frac{10\times10\times10^{-2}}{10^{-4}} = 10^4$

$Re > 2000 \Rightarrow$ Flow is turbulent

For smooth pipe:

$\therefore\ f = \frac{0.316}{Re^{1/4}} = \frac{0.316}{(10^4)^{1/4}} = 0.0316$

58. Ans: (c)

Sol: $H_L = \frac{fLV^2}{2gD} = \frac{64}{\left(\frac{\rho VD}{\mu}\right)} \times \frac{LV^2}{2gD} = \frac{32\mu VL}{\rho gD^2}$

59. Ans: (b)

Sol: $\tau = \frac{8\mu\overline{V}}{D} = \frac{8\times1.5\times2}{10\times10^{-2}} = 240\,\text{Pa}$

60. Ans: (b)

Sol: $\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + Z_B$

$Z_A = Z_B$ & $V_A = 0$

$\therefore\ \frac{P_A}{\rho g} = \frac{P_B}{\rho g} + \frac{V_B^2}{2g}$

$\Rightarrow P_B < P_A$

61. Ans: (a) **62. Ans: (b)** **63. Ans: (a)**

64. Ans: (d)

Sol: $h^* = \bar{h} + \frac{I_G \sin^2\theta}{A\bar{h}}$

Centre of area of immersed surface lies above the centre of pressure and is independent of the fluid properties.

65. Ans: (d)

66. Ans: (b)

Sol: The correct reason is to trip the boundary at low Reynold's number. This low Reynold's number is main advantage as if the Reynold number is high it may actually increase the drag coefficient.

67. Ans: (d)

Sol: When a thin flat plate is hold parallel to a fluid stream, viscous drag will be maximum.

68. Ans: (a)

69. Ans: (a)

Sol: Q = AV

$Q = AC\sqrt{RS}$

$Q = by_c.C.\sqrt{RS}$

$q = y_c.C.\sqrt{RS}$

$\left(\because \text{discharge per unit width} = q = \frac{Q}{b}\right)$

$q^2 = y_c^2 C^2 y_c S$ $(\because$ For wide rectangular channel $(R = y))$

$q^2 = C^2.y_c^3 S$

$y_c^3 = \frac{q^2}{C^2 S}$ ---------------(1)

For rectangular channel critical depth

$y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}}$

$y_c^3 = \frac{q^2}{g}$ -----------------(2)

from (1) and (2)

$\frac{q^2}{g} = \frac{q^2}{C^2 S}$

$\therefore\ g = C^2 S \Rightarrow S = \frac{1}{\frac{C^2}{g}}$

i.e., 1 in $\frac{c^2}{g}$

70. Ans: (d) **71. Ans: (c)**

72. Ans: (a)

Reciprocal levelling is necessary to carry levelling across a river, valley or any obstacle requiring a long sight between two points so situated that no place for the level can be found from which the lengths of foresight and back sight will be even approximately equal, special method i.e. reciprocal levelling must be used to obtain accuracy and to eliminate the following.

1. Error in instrument adjustment
2. Combined effect of earth's curvature and the refraction of the atmosphere.
3. Variation in the average refraction

73. Ans: (d)

Sol: In most of the problems involving flow of liquid, compressibility can be neglected since bulk modulus is very high and change of density with increase of pressure is very small but for water hammer problems there is huge increase of pressure due to sudden closure of valves in pipe lines.

74. Ans: (a)

75. Ans: (a)

Sol:

Normal depth depends upon channel cross-section and slope. Critical depth upon discharge.