ESE-2017 PRELIMS TEST SERIES

Date: 27th November, 2016

CE–TEST 12 (OBJECTIVE SOLUTION)...

ANSWERS

1.	(a)	28.	(a)	55.	(b)	82.	(d)	109.	(b)	136.	(d)
2.	(b)	29.	(b)	56.	(c)	83.	(b)	110.	(d)	137.	(d)
3.	(d)	30.	(b)	57.	(b)	84.	(b)	111.	(a)	138.	(a)
4.	(b)	31.	(d)	58.	(d)	85.	(a)	112.	(a)	139.	(d)
5.	(d)	32.	(b)	59.	(d)	86.	(c)	113.	(b)	140.	(c)
6.	(b)	33.	(b)	60.	(d)	87.	(c)	114.	(d)	141.	(b)
7.	(b)	34.	(d)	61.	(c)	88.	(d)	115.	(a)	142.	(a)
8.	(d)	35.	(c)	62.	(a)	89.	(d)	116.	(b)	143.	(d)
9.	(c)	36.	(c)	63.	(d)	90.	(b)	117.	(d)	144.	(a)
10.	(a)	37.	(b)	64.	(d)	91.	(c)	118.	(b)	145.	(d)
11.	(c)	38.	(c)	65.	(b)	92.	(c)	119.	(b)	146.	(d)
12.	(b)	39.	(a)	66.	(b)	93.	(b)	120.	(b)	147.	(a)
13.	(a)	40.	(c)	67.	(c)	94.	(c)	121.	(b)	148.	(a)
14.	(b)	41.	(c)	68.	(a)	95.	(b)	122.	(d)	149.	(b)
15.	(d)	42.	(b)	69.	(c)	96.	(d)	123.	(d)	150.	(b)
16.	(b)	43.	(c)	70.	(b)	97.	(d)	124.	(a)	151.	(a)
17.	(d)	44.	(b)	71.	(b)	98.	(a)	125.	(b)	152.	(c)
18.	(c)	45.	(d)	72.	(c)	99.	(d)	126.	(c)	153.	(a)
19.	(d)	46.	(d)	73.	(b)	100.	(a)	127.	(b)	154.	(d)
20.	(c)	47.	(c)	74.	(b)	101.	(c)	128.	(c)	155.	(b)
21.	(b)	48.	(c)	75.	(d)	102.	(d)	129.	(a)	156.	(a)
22.	(b)	49.	(c)	76.	(c)	103.	(b)	130.	(c)	157.	(b)
23.	(b)	50.	(d)	77.	(b)	104.	(b)	131.	(b)	158.	(b)
24.	(a)	51.	(c)	78.	(b)	105.	(a)	132.	(b)	159.	(b)
25.	(b)	52.	(d)	79.	(a)	106.	(c)	133.	(b)	160.	(b)
26.	(d)	53.	(a)	80.	(c)	107.	(b)	134.	(b)		
27.	(b)	54.	(d)	81.	(b)	108.	(b)	135.	(a)		

1. (a) The value of critical velocity ratio is decided arbitrarily since there is no method given for determining its value.

2. (b) Discharge at the field = 0.7 × 16

= 11.2 cumecs

Area = 11.2 × 1500 = 16800.0 ha

$\boxed{A = 16800\ \text{ha}}$

3. (d) According to Lacey's empirical equation

$$R = \frac{5}{2}\left(\frac{v^2}{f}\right) \quad \text{... (i)}$$

$$R = \frac{A}{P} \ \& \ A = \frac{Q}{v}$$

$$\text{Hence, } R = \frac{Q}{V.P} \quad \text{... (ii)}$$

Putting (ii) into (i)

$$\frac{Q}{V.P} = \frac{5}{2}\frac{v^2}{f}$$

$$v = \left(\frac{2}{5}\frac{Qf}{P}\right)^{1/3} \quad \text{... (iii)}$$

Since $P = 4.75\sqrt{Q}$ ... (iv)

Putting (iv) into (iii)

$$v = \left(\frac{\sqrt{Q}f}{11.875}\right)^{1/3} \quad \text{... (iii)}$$

4. (b) The coarse the silt, flatter is the semiellipse.

5. (d) For rice:

$$Q_{Rice} = \frac{1296}{\frac{8.64\times140}{1.4}} = 1.5\ m^3/s$$

For wheat:

$$\text{Area} = 1.5\times\frac{8.64\times90}{0.5}$$

A = 2332.8 ha

6. (b) 5.5 cm

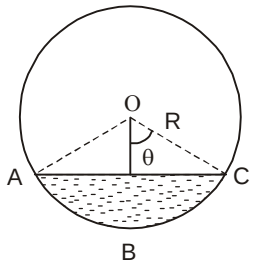
$$\text{Irrigation requirment} = \frac{1}{100}\left(\frac{22-12}{2}\right)\times\frac{15}{10}\times1\text{m}$$

$$\left[= w\times\frac{\gamma_d}{\gamma_w}\times d\right]$$

= 7.5 cm

⇒ Net irrigation requirement = 7.5 – 2 = 5.5 cm

7. (b)



Flow area = Sector ABC

= Area OABC – Area OACO

$$= \theta R^2 - \frac{1}{2}\times2R\sin\theta\times R\cos\theta$$

$$= \theta R^2 - 2R^2\sin\theta\cos\theta$$

$$= R^2\left(\theta - \frac{\sin2\theta}{2}\right)$$

8. (d) $Z_0 = \frac{2c}{\gamma\sqrt{k_A}}, k_A = \frac{1-\sin15}{1+\sin15} = 0.589$

$$Z_o = \frac{2c}{(1.8\times9.81)\text{kN/m}^3\times\sqrt{0.589}} = 0.144c$$

∴ Depth of cut $= \frac{2\times0.144c}{F} = 2Z_0$

[F = FOS = 1

5.5 = 2 × 0.144 C

⇒ C =18.63 kN/m²

9. (c) For sand

C = 0

$$q_{nu} = \left(1+0.3\frac{B}{L}\right)CN_C + q\ (Nq-1) + 0.5\left(1-0.2\frac{B}{L}\right)\gamma BN_y$$

= 0 + 16 × 1.5 × 9.16 + 0.5 × 0.86 × 4 × 16 × 7.44

= 424.6

$$q_{ns} = \frac{q_{nu}}{FOS} = 212.3$$

10. (a)

1. Drains should be laid straight between manholes. All sharp bends, junctions, which tend to become dead ends for collection of sewage solids should be avoided except at manholes.
2. The house sewer should be disconnected from public sewer by the

provision of intercepting trap so as not to allow foul gases from public sewer to enter house sewers.

3. The house sewers should be connected to public sewer keeping the outfall level of house sewer sufficiently higher than the water level of the public sewers to avoid back flow and inefficient building drainage.

11. (c) **Gully Traps-**A gully traps or gully is often provided at the junction of a room or a roof drain and the other drain coming from bath, kitchen etc. The foul sullage from bath will enter through the side inlet (called back inlet) and the unfoul room washing or rain water from roof or courtyard will enter from the top. The rain water pipes or sullage pipes discharging into drains are often connected to them through such trap gully traps may either have the s-trap or the p-trap.

12. (b)

1. Couil is used as a ventilating pipe.
2. Wash basin may either use s-trap or p-trap.
3. Water closet waste is carried through soil pipe.
4. House drainage are connected with municipal sewers by intercepting traps.

13. (a) D = 60 cm = 0.6 m

$$r = \frac{a}{p} = \frac{\pi D^2}{8} \times \frac{2}{\pi D} = \frac{D}{4} = \frac{0.6}{4} = 0.15\,m$$

$$v = 0.625 \text{ m/s} = \frac{1}{0.012}(0.15)^{2/3} S^{1/2}$$

$$\Rightarrow \quad S = \frac{1}{1417}$$

14. (b) The temperature gradient of the standard atmosphere from the mean sea level to the altitude at which the temperature becomes –15.6°C is –0.0065°C per meter.

$\therefore$ Standard temperature at an altitude of 800 m = 15°C – 800×0.0065=9.8°C

15. (d) Runway is usually oriented in the direction of prevailing winds. The wind data i.e. direction, duration and intensity are graphically represented by a diagram called wind rose. It helps in analysing the wind data obtaining the most suitable direction of the runway wind rose diagrams can be plotted in two types as follows:

Type I : Showing direction and duration of wind

Type II : Showing direction, duration and intensity of wind.

16. (b) **Basic Runway Length**

It is the length of runway under the following assumed Conditions at the airport:

- Airport altitude is at sea level.
- Temperature at the airport is standard (15°C).
- Runway is levelled in the longitudinal direction.
- No wind is blowing on runway.
- Aircraft is loaded to its full loading capacity.
- There is no wind blowing enroute to the destination.
- Enroute temperature is standard.

The basic runway length is for mean sea level elevation having standard atmospheric conditions. Necessary corrections are, therefore, applied for any change in elevation, temperature and gradient for the actual site of construction.

(i) **Correction for elevation :** ICAO recommends that the basic runway length should be increased at the rate of 7% per 300 m rise in elevation above MSL.

(ii) **Correction for temperature :** The rise of airport reference temperature has the same effect as that of the increase in elevation. Airport referene temperature is defined as the monthly mean of average daily temperature (Ta) for the hottest month of the year plus one third the difference of this temperature (Ta) and the montly mean of the maximum daily temperature (Tm) for same month of the year. ICAO recommends that the basic runway length after having been corrected for elevation, should be further increased at the rate of 1% for every 1°C rise of airport reference temperature above the standard atmospheric temperature at that elevation. The temperature gradient of the standard atmosphere from the MSL to the altitude at which the temperature

becomes –15.6°C is –0.0065°C per metre. The temperature gradient becomes zero at the elevations above the altitude at which the temperature is 15°C.

(iii) **Check for the total correction for elevation plus temperature :** ICAO further recommends that, if the total correction for elevation plus temperature exceeds 35% of the basic runway length, these corrections should then be further checked up by conducting specific studies at the site by model tests.

(iv) **Correction for gradient :** ICAO does not recommend any specific correction for the gradient. FAA recommends that the runway length after having been corrected for elevation and temperature should be further increased at the rate of 20% for every 1% of effective gradient.

17. (d)

(1) Increasing the path of percolation: The hydraulic gradient (i) depends upon the path of percolation (L). If length of the path is increased, the exit gradient will decrease to safe value.

(2) Reducing the seepage : with reduction in seepage, the chances of seepage through the body of dram is considerably reduced.

(3) Providing drainge filter A drainage filter changes the direction of flow away from the down stream. It prevents the movement of soil particles along with water.

(4) Loaded filter : A loaded filter consists of graded sand and gravels. The function of graded filter is to increase the downward force without increasing the upward seepage force.

18. (c) $\sigma_z = \gamma_z = 16.5\times 2 = 33\,KN/m^2$

$\sigma_x = K_0\sigma_z = 0.5\times 33 = 16.5\,KN/m^2$

19. (d)

$$S_n = \frac{C_m}{\gamma H} = \frac{C}{\gamma H F_C}$$

$F_C = H_c / H$

$$S_n = \frac{C}{\gamma H_C}$$

20. (c)

21. (b)

22. (b) For $C-\phi$ soil active earth pressure

$$P_a = \gamma_2 K_A - 2c\sqrt{K_A}$$

$$K_a = \frac{1-\sin 15^\circ}{1+\sin 15^\circ} = \frac{0.75}{1.25} = 0.6$$

at z = 0

$P_a = -2\times 15\times\sqrt{0.6}$

$= 23.2\,KN/m^2$

23. (b) Changing the width of footing does not affect the bearing capacity of clays.

24. (a) load intensity for 4.5 KN load on 30 cm square plate will be

$$\rho = \frac{4.5}{(0.3)^2} = 50\,KN/m^2$$

Load intensity for 200 KN load on 2m× 2m footing will be

$$\rho' = \frac{200}{4} = 50\,KN/m^2$$

Since load intensity is same so,

$$S_F = S_p \times \left(\frac{B_F(B_p+0.3)}{B_P(B_p+0.3)}\right)^2$$

$$= 12\times\left(\frac{2\times 0.6}{0.3\times 2.3}\right)^2 = 36.3\,mm$$

25. (b)

26. (d)

27. (b)

Bearing capacity,

$$q_{ult} = CN_c + qN_q + \frac{1}{2}B\gamma N_\gamma$$

For cohesive soil, $N_q = 1.0$ and $N_\gamma = 0$

$\therefore\ q_{net,ult} = q_{ult} - q$

$= CN_C = 10\times 5.7 = 57\,KN/m^2$

28. (a)

29. (b)

30. (b)

31. (d)

32. (b)

33. (b)

34. (d)

35. (c) Minimum depth of ballast cushion D in terms of sleeper spacing s and width of sleeper w is given by the equation

$$D = \frac{S-W}{2} = \frac{75-25}{2} = 25 \text{ cm}$$

36. (c)

37. (b)

Field application efficiency

$$= \frac{0.3\times 36\times 10^4}{6\times 6\times 3600}\times 100$$

$$= 83.33\%$$

38. (c)

$$\text{Scour depth} = 1.35\left(\frac{q^2}{f}\right)^{1/3}$$

$$= 1.35\left(\frac{(12)^2}{2.25}\right)^{1/3}$$

$$= 1.35(8^2)^{1/3}$$

$$= 5.4 \text{ m}$$

39. (a)

Capillary water is held by surface tension, so easily available for plant use. Thus, designated as available water.

Gravitational water drains out freely, so not available for plant use.

40. (c)

(i) Wetted perimeter $P = 4.75\sqrt{Q}$

$$\Rightarrow \quad P \propto \sqrt{Q}$$

2. Hydraulic radius, $R = 0.48\left(\frac{Q}{f}\right)^{1/3}$

$$\Rightarrow \quad R \propto Q^{1/3} \quad \text{and} \quad R \propto \frac{1}{f^{1/3}}$$

41. (c) Gross commanded area

= Culturable commanded area + Non-culturable commanded area

42. (b)

CIR = Water required for consumptive use of plant

NIR = CIR + Water for leaching

FIR = NIR + Field losses

GIR = FIR + Canal losses

43. (c) Linear plate method grants an absolute control of running ground water. It is an excellent and positive method of minimizing ground subsidence in urban areas.

44. (b)

45. (d) 'Blow in' method has the advantage of supplying of fresh air right near the working face, but the disadvantage lies in that the four air, smoke and dust slowly, move out, fogging the atmosphere inside the tunnel, especially in long tunnels. 'Blow out' method has special advantage of quick removal of dust and smoke from working face. But the draw back of this method is that the fresh air has to travel a long distance before it reaches the working face and it is quite likely that is may absorb during this time moisture, heat and foul gases of having equipment resulting in an important working condition at face. Both these methods are used in combination to incorporate their advantages.

46. (d)

47. (c) It is given by $n = 1.5\sqrt{F}$

where F is nautical miles and ?? in feet

$$h = 1.5\sqrt{400} = 30 \text{ feet} = 9.144 \text{m}$$

48. (c) Docks or wet docks or tidal basins are enclosed and are shut off by entrances or locks to maintain a uniform level of water and basins are partially enclosed areas of water. Dry docks are repair docks. These are long, excavated chamber having side walls, a semicircular end wall and a floor. A floating dry dock is a floating vessel which can lift a ship out of water and retain it above water by means of its own buoyancy.

49. (c) Method for tunneling in hard rock

50. (d)

51. (c)

52. (d)

53. (a)

54. (d) $\vec{v} = (2ax - by)\hat{i} + (-cx + 3d.y)\hat{j}$

here $u = 2ax - by$ and $v = -cx + 3d.y$

For flow to be irrotational,

$$\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} = 0$$

$\therefore -c + b = 0$ ..... (1)

55. (b)

- **Streamlines:** A streamline is an imaginary curve drawn through a flowing fluid in such a way that the tangent to it at any point gives tha direction of the velocity of flow at that point. Since a streamline is everywhere tangent to the velocity vector, there can be no component of the velocity at right angles to the streamline and hence there can be no flow of fluid across any streamline. In steady flow, since there is no change in direction of the velocity vector at any point, the flow pattern is not changing. But in unsteady flow, since the direction of the velocity vector at any point may change with time, the flow pattern also changes with time. Therefore, for a steady flow the streamline pattern remains the same at different times, but for an unsteady flow, the streamline pattern may changes from time to time.
- **Pathline:** A pathline may be defined as the line traced by a single fluid particle as it moves over a period of time. thus a pathline will show the direction of velocity of the same fluid particle at successive instants of time. In steady flowl the pathlines and streamlines are identical. In unsteady flow, pathlines and streamliines are different.
- **Streak line:** A streakline may be defined as a line that is traced by fluid particles passing through a fixed point in a flow field. In steady flow, a streak-line, a streamline and a pathline are all identical. In unsteady flow, a streak-line at any instant is the locus of end points of particle paths (pathlines) that started at the instant the particle passed through the injection point.
- **Equipotential lines:** It represents a curve for which the velocity potential is same at every point.

56. (c) The fluid motion in which the fluid particles rotate about their own axis is known as rotational flow.

57. (b)

$$u = \frac{/nx}{y} \text{ and } v = -\frac{/ny}{x}$$

$$\because \frac{\partial \Psi}{\partial x} = +v \text{ and } \frac{\partial \Psi}{\partial y} = -u$$

$$\therefore \frac{\partial \Psi}{\partial x} = -\frac{/ny}{x}$$

$$\text{or, } \partial \Psi = -\int \frac{/ny}{x} dx$$

$$\text{or, } \Psi = -/ny./nx + c_1 \quad ...(i)$$

Similarly,

$$\frac{\partial \Psi}{\partial y} = -\frac{/nx}{y}$$

$$\Rightarrow \partial \Psi = -\int \frac{/nx}{y} dy$$

$$\text{or, } \Psi = -/nx./ny + c_2 \quad ...(ii)$$

From (i) and (ii)

$$\Psi = -/ny./nx$$

For Ψ to be existent, the continuity eqn must be satisfied.

$$\therefore \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$\Rightarrow \frac{1}{xy} - \frac{1}{xy} = 0 \Rightarrow$ satisfies the continuity equation.

58. (d)

59. (d)

60. (d)

61. (c) $P = S\rho_w gh$

$100 = 0.8 \times 9.81\ h$

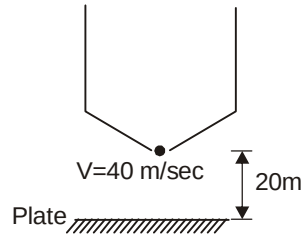
$$h = \frac{100}{0.8 \times 9.81} = 12.74 \text{ m}$$

$v = \sqrt{2gh} = \sqrt{2\times 9.81\times 12.74} = 15.81$ m/s

62. (a) **Manometers:** Manometers are those pressure measuring devices which are based on the principle of balancing the column of liquid by the same or another column of liquid. A piezometer is the simplest form of manometre which can be used for measuring moderate pressure of liquids.

63. (d) The coefficient of discharge of the ventriumeter varies somewhat with the rate of flow, the viscosity of the fluid and the surface roughness, but in general for the fluids of low viscosity a value of about 0.98 is usually adopted for C_d of the venturimeter.

64. (d)



Q = AV

$= 0.5\times 40 = 20\frac{m^3}{sec}$

Force = ρQV

V = velocity of Jet when it strike the plate

So $V^2 = u^2 + 2aS$

$V^2 = 40^2 + 2\times 9.81\times 20$

$V = 44.64\frac{m}{sec}$

So Force = 1000 × 20 × 44.64

= 892.73kN

65. (b) $\frac{F}{L} = \rho\times U\times \Gamma$

Γ = circulation = vorticity × Area

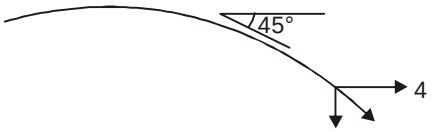
Vorticity = 2 × ω

$\Gamma = 2\times\omega\times\frac{\pi d^2}{4}$

$\frac{F}{L} = 1.236\times 150\times 2\times 300\times\frac{2\pi}{60}\times\frac{\pi\times 2^2}{4}$

$\frac{F}{L} = 36.6$ kN/m

66. (b)



Horizontal velocity

$\Rightarrow \frac{Q}{A} = \frac{0.05}{\frac{\pi}{4}\times(0.1)^2} = 6.366\frac{m}{sec}$

and it would remained constant throughout.

when jet is at 45°

vertical velocity will also be = horizontal velocity $= 6.366\frac{m}{sec}$ resultant velocity

$= \sqrt{2}\times 6.366$ m/sec

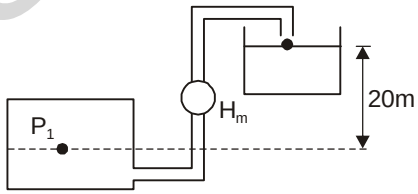
Now by continuity equation

$A_1V_1 = A_2V_2$

$0.05 = \sqrt{2}\times 6.366\times\frac{\pi}{4}\times d^2$

d = 8.4 cm

67. (c)



Power = $\gamma_Q H_m = 15\times 1000\times 0.8$

$\gamma = 10\times 10^3$ N/m³

h = ?

Applying energy equation between bottom tank and top tank.

$\frac{P_1}{\gamma} + 0 + \frac{V^2}{2g} + h_m = 0 + 20 + \frac{V^2}{2g} + 1.5$

$H_m = 20 + 1.5 - \frac{45}{10}$

$H_m = 17$

$Q = \frac{15\times 1000\times 0.8}{10\times 10^3\times 17}\frac{m^3}{sec}$

$Q = 70.5 l/sec$

68. (a)

69. (c) Fresh sewage is alkaline in nature. As the time passes this alkalinity changes to acidity if it is left untreated because of the bacterial action in anerobic or nitrified process.

70. (b) C_6H_6 TOC $= 117 \times \frac{72}{78} = 108$ ppm

$C_6H_{12}O_6$ TOC $= 225 \times \frac{72}{180} = 90$ ppm

$\therefore$ TOC = 180 + 90 = 198 ppm

71. (b) The relative stability checks tells about the stability of sewage thus acting as a check for sewage treatment proces.

To prevent biological action from taking place before the test, for formaldehyde, chloroform or H_2SO_4 which at as preservatives may be added.

The samples are taken from the same depth at different times mixed accordance to the flow rates to form a representive sample.

A representative sample from a point where turbulence is throughly mixing up the sewage is called is called grab sample.

72. (c) $BOD_5 = \frac{(D_i - D_2) - (B_1 - B_2)(1-P)}{P}$

D_1 = DO of diluted sample after dilution (mg/L)

D_2 = DO of diluted sample after 5 days (120 hrs) (mg/l)

B_1 = DO of seeded control sample before incubation (mg/L)

B_2 = DO of seeded control sample after 5 days incumbation (mg/l)

P = Dilution ratio

D_1 = 8 mg/l D_2 = 3 mg/L , $B_1 - B_2$ = 3.0 mg/L $P = \frac{20\text{ m}}{300\text{ m}}$

$$\Rightarrow BOD_5 = \frac{(8-3) - (3.0)\left(1 - \frac{20}{300}\right)}{\frac{20}{300}}$$

$$= \frac{5 - 3.0 \times \frac{280}{300}}{\frac{20}{300}}$$

$$= \frac{5 - 3.0 \times \left(1 - \frac{20}{300}\right)}{\frac{20}{300}}$$

= [5 – 2.8] × 15

= 2.2 × 15 = 33 mg/L

73. (b) In anaerobic reaction, the most part of energy is not used up in reaction, instead, most of the energy is still contain in the end products like CH_4

In anaerobic process, bounded O_2 is removed from the molecules and thus energy released in anaerobic process is less and hence synthesis of new cells is less.

Since new cells are not formed, therefore volume of sludge is grossly reduced due to decomposition of organic matter.

74. (b) The assumptions are

(1) Ample supply of carbon, nitrogen and phosphorous to enable synthesis of new cell.

(2) Sufficient energy available in organic matter.

(3) In organic growth nutrients, such as calcium and iron must be present in necessary amount.

(4) Appropriate growth nutrients are present

(5) Absence of toxic substance such as Cd Pb, Cr, etc.

75. (d) This is a part of sulphur cycle.

The sulphorous organic matter on oxidation produces H_2S gas which on further oxidation changes to sulphur and then to sulphates. Sulphates when consumed by plants become plant protein.

In anaerobic process however the oxidation of H_2S to sulphates becomes impossible and therefore H_2S tends to remain in system causing foul smell and also causing corrsion by forming H_2SO_4.

76. (c)

(a) Pipe main — Designed for maximum daily draft.

(b) Pumps — Required to be kept in reserve so that if one goes out of service, it can be replaced.

(c) Distribution System — Designed for maximum hourly draft of maximum day or coincident draft which includes fire demand.

77. (b) 1, 3, 4

Steel pipes are used for water mains

Wrought iron/G.I. pipes are not used for water mains, which carries raw water which may contain acidic and alkaline impurities & G.I. pipes are adversely affected by them.

Vitrified clay pipes are highly resistent to corrosion and chemically inert, therefore used for carrying sewage.

Due to easy workability wrought iron pipes are used for water distribution inside buildings (service connections).

Asbestos pipes are made of silica and cement under pressure and are highly resistant to corrosion.

78. (b) Sluice valves — Also known as gate valve

— These valves are provided to regulate flow of water through pipe and divide the main line into several section.

— They are usually placed at summits where the pressure is low so that, due to water hammer the pipe does not get bursted.

79. (a) Collar joint is recommended for R.C.C. and asbestos pipe as they have smooth finishing. In spoigot and socket joint, the spoigot is inserted inside the socket with yarn/thread wounded on it.

80. (c) Positive displacement pumps (Rotary pumps or reciprocate pumps) used for very high head and low discharge Rotodynamic pumps (centrifugal pumps) used for high discharge and low heads.

81. (b) Turbidity can never be direct measurement of amount of solid present in the liquid. Even a huge mass of single piece of stone can be present in liquid without causing any or negligible turbidity.

But suspended solid do cause absorbtion or scattering of light which is responsible for turbidity.

82. (d) TDS is responsible for specific conductance of water. But TDS does not has one to one basis relation with specific conductance. Only ionized substances contribute to specific conductance. Organic molecules and compound which dissolve in water do not contribute to the specific conductance.

83. (b) Magnesium carbonate is soluble in water and hence cannot be removed by boiling.

84. (b) Factual

85. (a) $\text{moles } [H^+] = \frac{960}{1000}\times10^{-4} + \frac{4}{1000}\times10^{-3}$

$= 9.6 \times 10^{-5} + 0.4 \times 10^{-5}$

$= 10 \times 10^{-5}$

$= 10^{-4}$ moles

$\therefore \quad = -\log\frac{10^{-4}\times1000}{964} = 3.984$

86. (c) Nitrate concentration is measured by colour formed by sulphonic acid + potassium hydroxide.

Free ammonia and organic ammonia are measured by the amount of gasses which are formed.

87. (c) Aeration removes volatile liquids like phenols and humic acid but the rate of removal is very slow.

Hence, aeration is adopted only when due concentration thus volatile liquids is very high.

Fe and Mn are removed as $Fe(OH)_3 \downarrow$ and $MnO_2 \downarrow$ by aeration.

88. (d) Spry nozzle has highest CO_2 removal efficiency - upto 90% and 99% for H_2S

Cascade aerator is a stepped system working on principal of turbulence.

In diffused air aerator, compressed air is blown into the system. Trickling beds–The stones or cooking coals used are supported on a series of vertically arranged perforated trays.

89. (d) $G = \sqrt{\frac{P}{\mu V}}$

$27 \times 27 = \frac{P}{\mu \times V}$

$\Rightarrow 729 = \frac{21870}{7\times10^{-2}\times V}$

$\Rightarrow \quad V = \frac{30\times100}{7}$

$= 428.8\ m^3.$

90. (b)

S.G.F.	R.G.F.
Effective size :	0.2 –0.3 mm 0.7 –0.8 mm
Depth : 1m	0.6 – 0.7 m
Uniformity : $\simeq$ 5 Coefficient	1 – 2

91. (c) Activated carbon is never added after filtration as it cannot be removed after that.

A.C. decreases the chlorine demand by removing some amount of organic matter.

Removes phenol, taste, colour and odour, excess fluorine, H_2S etc.

92. (c) Tuberculation refers to formation of red ppt of $Fe(OH)_3$. It occurs both alkaline and acidic water.

$$Fe(OH)_2 + \frac{1}{2}O_2 + H_2O \longrightarrow 2Fe(OH)_3$$

(An Alkalinewater)

$$Fe(OH)_2 + 2CO_2 \longrightarrow Fe(HCO_3)_2$$

(An acidic medium)

$$Fe(HCO_3)_2 + O_2 + H_2 \longrightarrow 2Fe(OH)_3 + 4CO_2$$

It causes roughness in pipes thereby decreasing carrying capacity.

93. (b) Hardness = $\left[\frac{120}{20} + \frac{48}{12}\right] \times 50 = 500$ mg/l

Alkalinity = $\left[\frac{60}{30} + \frac{122}{61}\right] \times 50 = 200$ mg/l

Carbonate Hardness = Minimum of {Total Hardness and Alkalinity}

= 200 mg/l.

Non carbonate hardness = 500 – 200 = 300 mg/l.

94. (c) Lime is required for neutralising the carbonate hardness (i.e. alkalinity) plus Mg^{+2}.

= [Meq/l of HCO_3^- + Meq/l of Mg^{+2}] × (Eg weight of CaO)

= (1.6 + 0.8) × 28 = 67.2 mg/l.

lime] required in Kg = $\frac{67.2 \times 10^6 \times 1}{10^6}$

= 67.2 Kg.

95. (b) Population = 70,000

Average consumption = 150 lpd

$\therefore$ Average total consumption = 150 × 70,000

= 10,500,000 lit/day

$\therefore$ Intake load = $\frac{10,500,000}{10^3 \times 10 \times 3600} = 0.29$ m^3/s

96. (d) For 4-1-0 combination MPN = $\frac{94}{0.001} = 94000$

97. (d) TON = $\frac{A+B}{A} = \frac{15+225}{15}$

TON = 16

98. (a) **Tree System :** In this system, there is one main supply pipe, from which originates (generally at right angles) a number of submain pipes. The distribution network can be solved easily and it is possible to easily and accurately calculate the discharges and pressures at different points in the system.

Grid-Iron System : In this system, the mains, submains and branches are all inter-connected with each other. This system requires more length of pipe lines and a larger number of sluice valves (*i.e.* cut off valves).

Circulation System : In this system, a closed ring either circular or rectangular, of the main pipes, is formed around the area to be served.

Radial System : In this system water is supplied through radially laid distribution pipes.

99. (d) Balancing reservoir is provided to meet fluctuating demand with constant rate of supply. The storage capacity of balancing reservoirs is worked out with the help of hydrographs of inflow and outflow by mass curve method. The amount of balancing storage is determined by adding the maximum ordinates between the demand and supply lines.

100. (a)

$\therefore$ Head loss, $h_f = \frac{flv^2}{2gd} = \frac{flQ^2}{12.5d^5}$

$\therefore$ Both pipes are connected in series, the discharge through them will be equal.

$\therefore \quad \frac{h_{f_A}}{h_{f_B}} = \frac{d^2}{(1.2d)^5} = 0.40$

101. (c) Initial D.O = 0.03 × 0.6 + 0.97 × 3

= 2.928 mg/L

D.O of after 5 days = 0.8 mg/L

D.O consumed in 5 days = 2.928 – 0.8

= 2.128 mg/L

BOD_5 = (D.O consumed in 5 days) × dilution factor

$= 2.128 \times \frac{100}{3} = 70.93$ mg/L

102. (d) Average 5 day BOD= 300 mg/l

Average sewage flow = 90 × 10^6 l/day

$\therefore$ Total BOD in sewage = 300×90×10^6 mg/day

= 27000 kg/day

Population equivalent = $\frac{\text{Total 5 day BOD in kg/day}}{0.08}$

Assuming domestic sewage quantity to be 0.08 kg/person/day

$= \frac{27000}{0.08} = 337500$

103. (b) $BOD_5 = L\left[1 - 10^{-K_D \cdot t}\right]$

$K_{D(T)} = K_{D(20)}[1.047]^{T-20}$

$\therefore \quad K_{D(30)} > K_{D(20)}$

104. (b) Due to more water absorption property of bricks, stonework is more water tight than brickwork.

105. (a) Minimum crushing strength of bricks = 3.5 MPa

106. (c) 4th class brick are over burnt & distorted bricks. Their ballast is used for foundation.

107. (b)

108. (b)

109. (b) Burls or excrescence are formed when tree recieves injury in its young age.

110. (d)

111. (a) Steps in air Abel process:

1. Dilute solution of sodium silicate is coated on timber surface.
2. Cream like paste of fat lime is applied.
3. Cone, solution of silicate of soda is applied.

112. (a) Silica increases the resistance to sulphate attack.

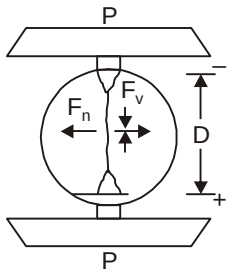
113. (b)

114. (d)

115. (a) Steam curing is recommended for pre cast concrete member.

116. (b)

117. (d) Split tensile strength test $f_n = \frac{2P}{\pi DL}(\text{Tensile})$



118. (b) Concrete stregth increase with rate of loading.

119. (b) Silicon content <0.2% has no appreciable effect on physical properties of steel the elasticity & strength of steel are considerable increased without serious reduction in its ductility.

120.(b) Metered water supply adds cost and decreases demand. Decrease in pressure of distribution reduces loss due to leakage and also reduces the reach of water thus prompting people to save water and use efficiently.

121. (b)

Mild steel cannot be easily hardened and tempered.

122. (d) Distilatiation— Evaporation of water followed by condensation

Electrodialysis— Salt ions are removed from water under the impetus of an electric current the process is specially suited for brackish sea water.

Reverse osmosis — A pressure greater than osmotic pressure is applied, to push out water but not the salts.

Solar evaporation— Leaves salts behind.

Freezing— When water freezes, the ice is theoretically free from saline concentration of water.

123. (d) The annealing increases the ductility and brings back the steel to best physical state to resist fracture under sudden stresses.

124. (a)

125. (b) Sapwood is light in colour and weight. Annular rings of sapwood are less sharply defined than those of heartwood.

126. (c)

127. (b)

128. (c) Sand does not increase the strength of mortar.

129. (a)

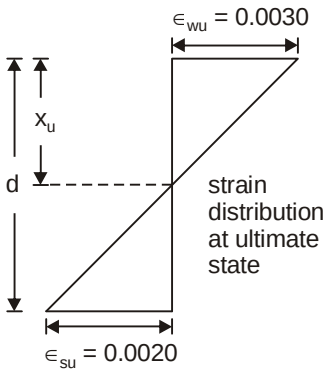
The strong cement mortar (richer mix having less water for definite consistency) are most likely to lead to shrinkage cracks.

130. (c)

131. (b) Salts, after getting dissolved in water, appear in form of whitish crystals on exposed brick surface. This is known as efflorescence.

132. (b) In veneered wall, backing carries all the imposed load.

133. (b)



Limiting depth of neutral axis,

$$x_u = \left(\frac{0.003}{0.003 + 0.002}\right)d$$

$$x_u = 0.60\ d$$

134. (b) Presence of calcium carbonate indicates poor weathering quality of stone.

135. (a) Size of cube is 40mm × 40mm × 40mm.

136. (d) A is false and R is true

Lining of a canal is always beneficial but need not be economical always.

137. (d) A is false and R is true

Canal running on a watershed has a very high command area as it can irrigate areas on both sides.

138. (a) Wheel assembly configuration and layout of different aircrafts are different. The total number of load applications in the entire design life of a highway pavement is known for pavement structural design. In contrast the frequency of aircraft landing on an airport pavement is much less.

139. (d)

140. (c) Ideal fluids are those fluids which have no viscosity and surface tension and they are incompressible. As such for ideal fluids no resistance is encountered as the fluid moves.

- A flow is said to be rotational if the fluid particles whle moving in the

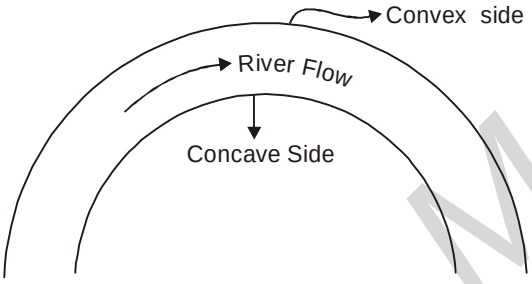
direction of flow rotate about their mass centres. The liquid in the rotating tanks illustrates rotational flow where the velocity of each particle varies directly as the distance from the centre of rotation.

- A flow is said to be irrotational if the fluid particles while moving in the direction of flow do not rotate about their mass centres. It may however be stated that a true irrotational flow exists only in the case of flow of an ideal fluid for which no tangential or shear stresses occur. But theflow of practical fluids, may also be assumed to be irrotational if the viscosity of the fluid has little significance.

141.(b)

142. (a)

143. (d)



144. (a) Manganese precipitates very slowly in pH below 9. The trickling bed aeration process is done only for Fe and Mn. To precipitate Mn quickly and to help in their oxidation, alkaline oxidation agent is added.

145.(d) Pre chlorination in not d one in highly turbid waters because, turbidity tends to shield the micro organism from disinfectant and also tends to carry some of the disinfectant on it self, thereby wasting the whole purpose of pre chlorination.

146.(d) Very high weir loading rate can cause turbulence due to which the settlement of the particles is adversely affected.

Due to turbulence, some of the finer particles at the end of the tank may jump out, which otherwise would have settled.

147.(a)

148. (a)

149. (b) BOD directly gives the amount of biologically active organic matter present in sewage.

150. (b) Both statements are independently correct.

151. (a)

152. (c)

153. (a)

154. (d)

Maximum free fall is 1.5 m

155. (b) Cube strength is more because of more confinement.

156. (a)

157. (b) Both statements are correct.

"Assertion statements" is actually the explaination for the "Reason statements".

158. (b)

Head course should never start with queen's closer it will get displaced therefore queen's closer should be placed just next to quoin header.

159. (b)

160. (b)