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ESE-2021 PRELIMINARY EXAMINATION

QUESTIONS WITH DETAILED SOLUTIONS

CIVIL ENGINEERING

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CIVIL ENGINEERING

SUBJECTWISE WEIGHTAGE

S.No.	Name of the Subject	No. of Questions	
01	Building Materials	13	
02	Solid Mechanics	14	
03	Structural Analysis	06	
04	Design of Steel structures	13	
05	Design of Concrete & Masonry Structures	15	
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14	Transportation Engineering (Highways, Railways, Airports, Harbours & Tunnels)	12	
	Total No. of Questions150		



ESE - 2021 Preliminary Examination

CIVIL ENGINEERING

SET - A

- 01. A network of pipes conveying water to a city has the following specifications. The diameter of a main pipe is 30 cm and it branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the main pipe is 2.5 m/s and the average velocity in the 20 cm pipe is measured as 2 m/s, what is the velocity in the 15 cm pipe ?
 - (a) 8.84 m/s (b) 7.44 m/s (c) 5.84 m/s (d) 6.44 m/s

01. Ans: (d) Sol:



Given:

$$\begin{split} & D_1 = 30 \text{ cm} \text{ ; } V_1 = 2.5 \text{ m/s} \\ & D_2 = 20 \text{ cm} \text{ ; } V_2 = 2 \text{ m/s} \\ & D_3 = 15 \text{ cm} \text{ ; } V_3 = ? \\ & \text{By continuity equation:-} \\ & A_1 V_1 = A_2 V_2 + A_3 V_3 \end{split}$$

 $D_1^2 \cdot V_1 = D_2^2 V_2 + D_3^2 \cdot V_3$

$$V_{3} = \frac{D_{1}^{2} \cdot V_{1} - D_{2}^{2} \cdot V_{2}}{D_{3}^{2}}$$
$$= \frac{(900 \times 2.5) - (400 \times 2)}{225}$$

= 6.44 m/s

02. A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 r.p.m. The vanes are curved back to an angle of 30° with the periphery. The impeller diameter is 300 mm and the outlet width is 50 mm. What is the tangential velocity of impeller at outlet ?

(a) 15.7 m/s	(b) 13.2 m/s
(c) 9.7 m/s	(d) 11.2 m/s

02. Ans: (a)

Sol: Tangential velocity of Impeller (U)

$$U = \frac{\pi DN}{60} = \frac{\pi \times 0.3 \times 1000}{60} = 15.7 \text{ m/s}$$

03. A 7.5 cm diameter jet of water strikes a curved plate at its centre with a velocity of 20 m/s. The curved plate is moving with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of 165°. By assuming the plate as smooth, what is the angle made by the relative velocity at the outlet of the plate?

(a) 45° (b) 30° (c) 15° (d) 0°



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Engineering Publications	2 Civil Engineering
 04. A reservoir has a head of 40 m and a channel leading from the reservoir permits a flow rate of 34 m³/s. I the rotational speed of the rotor is 150 r.p.m., what is the power of the turbine ? (Take g = 9.81 m/s²) (a) 14.34 MW (b) 13.34 MW (c) 12.34 MW (d) 11.34 MW 	 6. Full load is supplied by the turbine shaft when the diameter of jet issuing from the nozzle is 150 mm. If the load suddenly drops to 36% of the full load, what diameter of the jet should be attained by regulating the spear rod ? (a) 15 mm (b) 45 mm (c) 90 mm (d) 180 mm
04. Ans: (b) Sol: $H = 40 \text{ m}$ $Q = 34 \text{ m}^{3}/\text{s}$ N = 150 rpm $g = 9.81 \text{ m/s}^{2}$ Power of the turbine = $\dot{m}.g.H = \rho gQH$ $= 1000 \times 9.81 \times 34 \times 40$ $= 13.34 \times 10^{6} \text{ Watt}$ = 13.34 MW	06. Ans: (c) Sol: Load (power delivered) \propto rate of k. E of water issued from Nozzle $P \propto \frac{1}{2} \dot{m} V^2$ $\propto \frac{1}{2} \rho Q V^2$ $\propto \frac{1}{2} \rho A V^3$
 05. A stream function is given by ψ = 3x² - y³. What i the magnitude of velocity components at the point (2, 1) ? (a) 8.52 (b) 9.17 (c) 10.81 (d) 12.37 	$\alpha \frac{1}{2} \rho \frac{\pi}{4} d^2 \cdot V^3$ $p \propto d^2$ $\left(\frac{d_2}{d_1}\right)^2 = \left(\frac{P_1}{P_2}\right)$
05. Ans: (d) Sol: Given: $\psi = 3x^2 - y^3$ V @ 2,1 = ? $u = -\frac{\partial \psi}{\partial y} = +3y^2$	$\left(\frac{d_2}{150}\right)^2 = \left(\frac{0.36P_1}{P_1}\right)$ 1995 $\frac{d_2}{150} = \sqrt{0.36} = 0.6$ $d_2 = 90 \text{ mm}$
$V = \frac{\partial \psi}{\partial x} = 6x$ $\Rightarrow \vec{V} = 3y^2\hat{i} + 6x\hat{j}$ (@ (2,1)	 07. What is the depth of a point below water surface in sea, where pressure intensity is 1.006 MN/m²? (Specific gravity of sea water is 1.025) (a) 60 m (b) 80 m (c) 100 m (d) 120 m
$\vec{\nabla} = 3\hat{i} + 12\hat{j}$ $ \nabla = \sqrt{3^2 + 12^2}$ $= \sqrt{150}$ $= 12.37 \text{ units}$	07. Ans: (c) Sol: P = 1.006 MPa (Given) $\rho = 1025 \text{ kg/m}^3$
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$$\Rightarrow h = \frac{P}{\rho.g}$$

: The options are widely spaced, let us assume g

- = 10 m/s² \Rightarrow h = $\frac{1006000}{1025 \times 9.81}$ =100 m
- 08. Two pressure points in a water pipe are connected to a manometer which has the form of an inverted U-tube. The space above the water in the two limbs of the manometer is filled with toluene (specific gravity is 0.875). If the difference of level of water columns in the two limbs reads 12.0 cm, what is the corresponding difference of pressure (Take g = 9.81m/s²)
 - (a) 110.49 N/m^2 (b) 128.12 N/m^2 (c) 131.34 N/m^2 (d) 147.15 N/m^2

08. Ans: (d) Sol:



$$\begin{split} h &= 12 \ cm \\ P_{_1} - P_{_2} &= ? \\ P_{_1} - \gamma_{\rm w} \left(h' + h\right) &= P_2 - \gamma_{\rm w}.h' - \gamma_{\rm m}.h \end{split}$$

 $\Rightarrow P_1 - P_2 = (\gamma_w - \gamma_m)h$

=9810 (1-0.875) × 0.12 = 147.15 N/m² 09. What is the minimum size of glass tube that can be used to measure water level if the capillary rise in the tube is to be restricted to 2 mm ? (Take surface tension of water in contact with air as 0.073575 N/m)

(a) 1.5 cm	(b) 1.0 cm
(c) 2.5 cm	(d) 2.0 cm

09. Ans: (a)

Sol: Given:

s = 0.073575 N/m

$$\label{eq:gamma} \begin{split} h &= 2 \mbox{ mm} \\ g &= 9810 \mbox{ N/m}^3 \\ \mbox{Assume } \phi \mbox{ (contact angle)} = 0 \end{split}$$

$$\therefore$$
 the fluid is water $d = 2$

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

 $\Rightarrow d = \frac{4\sigma\cos\phi}{\gamma.h}$
= $\frac{4 \times 0.073575}{9810 \times 2 \times 10^{-3}}$ = 1.5 cm

10. A semi-tubular cylinder of 75 mm radius with concave side upstream (drag coefficient = 2.3) is submerged in flowing water of velocity 0.6 m/s. If the cylinder is 7.2 m long and density of water is 1000 kg/m^3 , what is the drag ?

(a) 150 N	(b) 173 N
(c) 955 N	(d) 223 N

10. Ans: (*)

Sol:

Since

 $F_{Drag} = Drag$ force on semi tubular cylinder

$$= C_{D} \cdot \frac{1}{2} \times \rho \cdot A \cdot V^{2}$$

= $C_{D} \times \frac{1}{2} \times \rho \times L \times D \times V^{2}$
= $(2.3) \left(\frac{1}{2}\right) (1000) (7.2) (2 \times 0.075) \times (0.6)^{2}$
= 447 N

Ŕ	ACE Engineering Publications		4		Civil Engineering
11.	A double acting recip area 0.1 m^2 has a stro discharging 2.4 m ³ of through a height of 1 What is the slip of th	procating pump having pistor ke length 0.30 m. The pump is f water per minute at 45 r.p.m 0 m. e pump ?	1 5		$\Rightarrow h_{kerosene} = \frac{1 \times 100}{0.81}$ = 123.5 m of kerosene
	 (a) 0.005 m³/s (c) 0.025 m³/s 	(b) 0.015 m ³ /s (d) 0.035 m ³ /s		13.	A lake has an area of 15 km ² Observation of hydrological variables during a certain year has shown as follows:
11. Sol:	Ans: (a)				Precipitation = 700 mm/year, Average inflow $Q_{in} = 1.4 \text{ m}^{3}/\text{s};$
	Theoretical discharg	e (Double -acts)			Average outflow $Q_{out} = 1.6 \text{ m}^3/\text{s}$. Assume that there is no net water exchange
	$Q_{\rm the} = 2. \left(\frac{\pi}{4} D^2\right) L N(m)$	³ /min)	R1/	۷G	between the lake and the groundwater. What is the evaporation during this year ?
	$Q_{\rm the} = 2 \times (0.1)(0.3)(4$	$5) = 2.7 \mathrm{m^3/min}$			(a) 480 mm (b) 280 mm (c) 380 mm (d) 180 mm
	Actual discharge, Q	$_{1} = 2.4 \text{ m}^{3}/\text{min}$			2
	Slip discharge = 2.7	$-2.4 = 0.3 \text{ m}^3/\text{min}$		13. Sol:	Ans: (b)
	$=\frac{0.3}{60}$ m ³ /sec = 0.005 m	m ³ /sec		~~~~	$A = 15 \text{ km}^2$ $P = 700 \text{ mm/year}$
12.	If pressure head of w	ater is 100 m and specific			$Q_{in} = 1.4 \text{ m}^3/\text{s}$
	gravity of kerosene is	s 0.81, what is the pressure		<	$C_{out} = 1.0 \text{ m}/3$
	head of kerosene?				$\mathbf{L} = :$
	(a) 123.5 m of kerose	ene Sinc	:e 1	99	$P = \pm 700 \text{ mm/year}$ $1.4 \times 365 \times 24 \times 3600 + 2.04226$
	(b) 241.3 m of kerose	ene			$Q_{in} = + \frac{15 \times 10^6}{15 \times 10^6} = + 2.94336 \text{ m}$
	(c) 75.1 m of keroser (d) 52.4 m of keroser	ne All			$Q_{out} = -\frac{2943.36 \text{ mm/year}}{1.6 \times 365 \times 24 \times 3600} = -3.368 \text{ mm}$ = - 3363.84 mm/year
12. Sol:	Ans: (a)				+ P + $Q_{in} - Q_{out} - E = 0$ E = 279.52 \simeq 280 mm
	Given:				
	$h_{water} = 100 \text{ m}$			14.	A bridge has an expected life of 25 years and is
	$S_{kerosene} = 0.81$				designed for a flood magnitude of return period 100
	$h_{kerosene} = ?$				years. What is the risk of this hydrologic design?
	$P_{water} = P_{kerosene}$				(a) $1 - \left(\frac{100}{99}\right)^{25}$ (b) $\left(\frac{99}{100}\right)^{25}$
	$\Longrightarrow S_{water} \times h_{water} = S_{kerose}$	$_{\rm ene} \times {\rm h}_{\rm kerosene}$			(c) $1 - \left(\frac{99}{100}\right)^{25}$ (d) $\left(\frac{100}{99}\right)^{25}$
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n = 25 year T = 100 year $Risk = \phi_1 = ?$ $P = \frac{1}{T} = \frac{1}{100} = 0.01$ q = 1 - P = 1 - 0.1 = 0.99 $q = 1 - \frac{1}{100} = \frac{100 - 1}{100} = \frac{99}{100}$

- 15. In a groundwater field test, a tracer took 8 hours to travel between two observation wells which are 56 m apart. The difference in water table elevations in these wells was 0.70 m. The volume of the void of the aquifer is 30% of the total volume of the aquifer. What is the hydraulic conductivity of the aquifer, if the dynamic viscosity of water is $0.995 \times 10^{-3} \text{ Ns/}$ $m^2?$
 - (a) 4.664 cm/s(c) 2.664 mm/s

(b) 3.664 cm/hr (d) 1.664 cm/hr

15. Ans: (a)

Sol:

T = 8 hours L = 56 m $h_{c} = 0.7 \text{ m}$ n = 30%k = ? $V_s = \frac{DIST}{TIME} = \frac{56}{8} = 7 \text{ m/hour}$ $V_s = \frac{V}{n}$ $7 = \frac{V}{0.3}$ V = 2.1 m/hour $2.1 = k \times \frac{0.7}{56}$ k = 168 m/hourk = 4.67 cm/sec

- 16. Consider the following statements regarding channel routing :
 - 1. In channel routing, the flood hydrograph at various sections of the reach is predicted by considering a channel reach and an input hydrograph at the upstream end.
 - 2. As the flood wave moves down the river, the shape of the wave does not change.
 - Flood waves passing down a river have their 3. peaks attenuated due to friction.
 - 4. The addition of lateral inflows can cause an increase of attenuation.

Which of the above statements are not correct?

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

16. Ans: (d)

Sol:

Since

As the wave moves down the river, the shape i. of the wave gets modified due to various factors, such as channel storage, resistance lateral addition or withdrawal of flows etc.

The addition of lateral inflow can cause a ii. reduction of attenuation.

- 1995 17. Consider the following statements related to water logging control :
 - It is evident that water logging can be 1. controlled only if the quantity of water into the soil below is checked and reduced.
 - 2. Attempts should be made to reduce the seepage of water from the canals and water courses.
 - 3. The entire irrigable land should receive canal water in all seasons. Which of the above statements are correct?
 - (b) 2 and 3 only (a) 1 and 2 only (a)
 - (c) 1 and 3 only (d) 1, 2 and 3

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17. Sol:	Ans: (a)		Volume removed = AI = 12×10^4
	water logging control methods		$= 3000 \text{ m}^{3}$
	• Lining of canals and water courses	•	****
	• Quantity of water into the soil below is checked	20.	What is the hydrauli
	and reduced.		carrying a discharge
	• Intensity of irrigation is to be reduced		method ? (Assume silt
	• Only a small portion of land should receive		(a) 1.44 m
	canal water in one particular season.		(c) 3.14 m
	• Seepage from canals must be down.		
	• By optimum use of water	20.	Ans: (a)
	• By efficient drainage system etc.	Sol:	
	NEER	INC	Lacey's
18.	If wheat requires 7.5 cm of water after every 28		f = 1.0
	days and the base period for wheat is 140 days,		$Q = 27 \text{ m}^{3}/\text{s}$
	what is the value of delta for wheat?		R = ?
	(a) 7.5 cm (b) 27.5 cm		2
	(c) 37.5 cm (d) 17.5 cm		$R = 2.5 \frac{V^2}{f}$
18. Sol:	Ans: (c)		$=\frac{2.5}{f} \left(\frac{Q f^2}{140}\right)^{2/6}$
501.	d = 75 cm		$-2.5(Qf^2)^{1/3}$
	$u_w = 7.5 \text{ cm}$		$- f (\overline{140})$
	number of waterings $-\frac{1}{28}$	\langle	$(2.5(27)^{1/3}-1.44)$
	$D = d_w(\text{number of waternigs})$		$-\frac{1}{1}(\frac{140}{140}) - 1.44 \text{ m}$
	= 7.5 × 5 = 57.5 cm Since	199	5
19.	A tile drainage system draining 12 hectares, flows at	21. (Consider the following
	a design capacity for two days, following a storm. If		water in canals :
	the system is designed using a drainage coefficient		1. The water lost
	of 1.25 cm, how much of water will be removed		very small, as co
	during this period ?		seepage in certair

2.

19. Ans: (c)

(a) 1500 m³

(c) 3000 m³

Sol:

 $D_{c} = 1.25 \text{ cm} = 1.25 \times 10^{-2} \text{ m/day}$ $A = 12 ha = 12 \times 10^4 m^2$ t = 2 days

(b) 4500 m³

(d) 3500 m³

 $D_c t$ $\times 1.25 \times 10^{-2} \times 2$

ic radius of a stable canal of 27 m³/s using Lacey's factor is 1.0)

	,
(a) 1.44 m	(b) 2.67 m
(c) 3.14 m	(d) 4.28 m

Sol:
Lacey's

$$f = 1.0$$

 $Q = 27 \text{ m}^3/\text{s}$
 $R = ?$
 $R = 2.5 \frac{V^2}{f}$
 $= \frac{2.5}{f} \left(\frac{Qf^2}{140}\right)^{2/6}$
 $= \frac{2.5}{f} \left(\frac{Qf^2}{140}\right)^{1/3}$
 $= \frac{2.5}{1} \left(\frac{27}{140}\right)^{1/3} = 1.44 \text{ m}$

- statements regarding loss of
 - by evaporation is generally ompared to the water lost by seepage in certain channels.
 - In percolation, there exists a zone of continuous saturation from the canal to the water-table and a direct flow is established.
 - 3. In absorption, a small saturated soil zone exists around the canal section and is surrounded by a zone of decreasing saturation.

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Engineering Publications	7	ESE_2021_Questions with Solutions
Which of the above statements are correct? (a) 1 and 2 only (b) 2 and 3 only (c) 1 and 3 only (d) 1, 2 and 3 21. Ans: (d) Sol: Regarding Loss of water in Canals	23.	 Which one of the following conditions is correct for a channel to behave in true regime ? (a) Discharge is non-uniform (b) Flow is non-uniform (c) Silt grade is varying (d) Silt charge is constant
(i) Evanoration: The water lost by evanoration	23	Ans: (d)
is very small as compared to water last by	23. So	. Ans. (u)
seepage		Conditions for true regime
(ii) In percolation there exists a zone of continuous		O is uniform, flow is uniform, silt grade and silt
saturation from the canal to the water table and		change constant, soil is incoherent aluminum.
a direct flow is established.	RIN	
(iii) Almost all the water lost from the canal joins	24.	. What is the delta for a crop when its duty is 864
the ground water reservoir.		hectares/cumec on the field and the base period of
(iv) In absorption, a small saturated soil zone exists		this crop is 120 days?
round the canal section and is surrounded by		(a) 120 cm (b) 140 cm
zone of decreasing saturation.		(c) 160 cm (d) 172 cm
As given in options, 1, 2, 3 are correction		
option (d) is right.	24.	. Ans: (a)
22 The chief aim of river training is	50	$D = \frac{864 \text{ ha}}{\text{summar}}$
(a) to protect water from loss		B = 120 days
(b) bed scouring.		$\mathbf{D} = 2$
(c) to achieve ultimate stability of river with the aid	10	$D = 864 \frac{B}{D}$
of river training measures.	.017	75 D
(d) pitching of banks and provision of launching		$=\frac{864 \times 120}{864}$ = 120 cm
aprons.		
22. Ans: (c)	25.	. Which one of the following is the merit of combined
Sol:		sewer system ?
The chief aim of river training to achieve ultimate		(a) Rain water dilutes the sewage, therefore, it can
stability of river with the aid of river training	,	be easily and economically treated.
measures i.e., river attains a stage of equilibrium		(b) Initial cost is high as compared with separate
i.e., no significant change occurs in its alignment,		(a) If the whole sowers is to be disposed of the
siope, regime etc.		(c) If the whole sewage is to be disposed off by
		pumping, it is unccontinual.

(d) During heavy rains, the overflowing of sewers will endanger the public health.



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25. Ans: (a)

Sol:

Merit of combined system is because of diluting DWF with WWF strength of waste i.e BOD become less to moderate and treatment become simple and easy.

- 26. Which one of the following is a device used for measuring the velocity of flowing water in pipes or open channels ?
 - (a) Pitot tube
 - (c) Venturimeter
- (d) Venturi tube

(b) Piezometer

26. Ans: (a)

- 27. Which one of the following is the process in which ammonia is oxidised to nitrites and then to nitrates by aerobic bacteria ?
 - (a) Nitrification
 - (c) Adsorption
- (b) Denitrification(d) Regeneration

27. Ans: (a)

Sol:

Ammonia is converted to nitrites by nitrosomanas bacteria and then converted to nitrates by nitrobacter bacteria is called nitrification.

- 28. A tank into which raw or partly treated sewage is collected, left to stay, and discharged at such a rate as may be necessary for subsequent treatment, is called
 - (a) Dosing tank
 - (b) Sedimentation tank
 - (c) Skimming tank
 - (d) Settling tank

28. Ans: (a)

Sol:

To feed constant flow of sewage for treatment first sewage is collected in flow equalisation tank if pH adjustment is required then it is put in to neutralisation tank then with the help of dosing tank it is fed to treatment units.

- 29. In the context of sludge conditioning, Elutriation is synonymous to
 - (a) Washing(b) Heating(c) Compacting(d) Filtering

29. Ans: (a)

Sol:

Washing of digested sludge is known as Elutriation.

- 30. Sludge thickening is commonly achieved by the following methods :
 - 1. Gravity thickening
 - 2. Air flotation
 - 3. Centrifugation
 - Which of the above methods are correct?
 - (a) 2 and 3 only(c) 1 and 3 only
- (b) 1 and 2 only (d) 1, 2 and 3

30. Ans: (d) Sol:

The most commonly used thickening process include gravity thickening, dissolved air floatation and rotary drum thickening. Centrifuge thickening also becoming more common.

- 31. Which one of the following is the process whereby chemicals are added to a wastewater resulting in a reduction of the forces tending to keep suspended particles apart?
 - (a) Coagulation (b) Flocculation
 - (c) Clarification (d) Sedimentation



	Engineering Publications	9	ESE_2021_Questions with Solutions
31. Sol:	Ans: (a) Addition of chemicals to water to destabilise colloidal particles is known as coagulation of chemical conditioning of water.		 4. The quantity of nitrogen present in wastewater before the decomposition of organic matter has started, is indicated by (a) Albuminoid Nitrogen (b) Free Ammonia (c) Organic Nitrogen (d) Nitrate Nitrogen
32. 32. Sol:	Which one of the following is a grit-removal universe which also removes silt as well as some organic matter along with grit? (a) Detritus Tank (b) Skimming Tank (c) Detention Tank (d) Suspension Tank Ans: (a)	3 st S 3 R I A	 4. Ans: (b) 501: Nitrogen compounds present in the form or ammonia before bacterial oxidation. 5. Which one of the following is that (low) water content of the soil at which plants can no longer extract sufficient water for their growth ? (a) Wilting point (b) Tail water
501:	Grit is removed by grit chamber Detritus tank is a type of grit chamber.	3	(a) writing point (b) fail water (c) Irrigating head (d) Capillary water
33.	The domestic sewage of a town was tested for total solids and the following results were obtained : Weight of sample of sewage = 1000 gm Weight of solids after evaporation of Liquid = 0.952 gm Weight of dry residue after ignition = 0.516 gm What is the value of volatile solids ? (a) 952 ppm (b) 516 ppm (c) 436 ppm (d) 694 ppm		 By definition option (a) Welting point is correct Welting point is that least WC of soil at which plants can no longer extract sufficient water for their growth. Which one of the following is the advantage of using activated carbon for water treatment? (a) When used in powdered form after computation
33. Sol:	Ans: (c) Volume of sewage sample: Weight of sewage sample/density of sewage sample Density of sewage: Density of water: 1 gm/CC Volume of sewage sample $V = \frac{1000}{1CC} = 1000 \text{ m}\ell$;	 (a) when used in powdered form after coagulation it does not aid in coagulation. (b) It increases the chlorine demand of treated water. (c) It removes organic matter present in water (d) Its overdose is harmful
	Volatile solids: $=\frac{(W_2 - W_3)}{V} = \frac{(0.952 - 0.516)}{1000}$ gm/ml = 0.000436 gm/ml × 1000000 mg/lit or ppm = 436 ppm	3	 Ans: (c) Activated carbon remove soluble organic matter present in water or waste water.
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ţ.	ACE Engineering Publications		10		Civil Engineering
37.	A soil has bulk density content 15%. What is t partially dries to a den void ratio remains unch (a) 10.86% (c) 10.68%	y of 20.1 kN/m ³ and water the water content if the soi sity of 19.4 kN/m ³ and the anged ? (b) 10.76% (d) 10.66%	a 3 1 3 3	9. 9.	A concentrated load of 2000 kN is applied at the ground surface. What is the vertical stress at a point 6 m directly below the load? (a) 16.42 kN/m ² (b) 26.53 kN/m ² (c) 36.12 kN/m ² (d) 40.51 kN/m ² Ans: (b)
Sol:	Ans: (a) Given: $\gamma_1 = 20.1 \text{ kN/m}^3$ $w_1 = 15\%$ Void ratio remain const $\gamma_d \propto \frac{1}{1+e}$; γ_d also c	$\gamma_2 = 19.4 \text{ kN/m}^3$ $w_2 = ?$ ant constant	RIA	901:	Given: Q = 2000 kN z = 6 m $\sigma_z = ?$ Directly below the load r = 0
	$\gamma_{d} = \frac{\gamma}{1 + w} \Rightarrow \gamma \propto 1 + w$ $\frac{1 + w_{2}}{1 + w_{1}} = \frac{\gamma_{2}}{\gamma_{1}}$ $\frac{1 + w_{2}}{1 + 0.15} = \frac{19.4}{20.1}$ $w_{2} = 10.99\%$	€ ENGIN	4	·0.	$\therefore \sigma_z = \frac{3}{2\pi} \times \frac{\alpha}{z^2}$ $\sigma_z = 0.4778 \times \frac{2000}{6^2}$ $\sigma_z = 26.54 \text{ kN/m}^2$ Which one of the following is a characteristic of local shear failure?
38.	Nearest answer is 10.86 A fine grained soil is fo 90% and a plasticity ind content is 28%. What is (a) -0.34 (c) -0.24	und to have a liquid limit of dex of 50. The natural water the liquidity index ? (b) $- 0.14$ (d) $- 2.40$	f te 1	99	 (a) Failure pattern is not clearly defined (b) Failure surfaces reach ground surfaces. (c) There is no bulging of soil around the foot (d) Failure is not sudden and there is no tilting footing Ans: (d)
38. Sol:	Ans: (c) $w_L = 90\%$ $I_p = 50\%$ w = 28% $I_p = w_L - w_p$ $50 = 90 - w_p$ $\therefore w_p = 40\%$ $I_L = \frac{w - w_P}{I_P}$ $I_L = \frac{28 - 40}{50}$ $I_L = -0.24$		8	501:	 In local shear failure, plastic equilibrium develops only in part of the soil below the footing, failure surface do not reach the ground and only slight heaving occur. It is a well defined and not sudden failure with no tilting of footing.
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Engineering Publications	11	ESE_2021_Questions with Solutions
41. A sample of silty clay has a volume of 14.88 cr a total mass of 28.81 gm, a dry mass of 24.83 and a specific gravity of solids 2.7. What is the v	m ³ , gm oid	$\frac{160}{1.75} = K \times \frac{30}{15} \times \frac{\pi}{4} \times 10^2$
ratio?		$\mathbf{K} = 0.58 \text{ cm/min}$
(a) 0.412 (b) 0.521		$K = 0.58 \times 10^{-2} \times 60 \times 24 \times 365$
(c) 0.618 (d) 0.663		= 3048 m/year
		$\simeq 3060 \text{ m/year}$
41. Ans: (c)		
Sol: Given:	4	43. Which one of the following is the correct assumption
V = 14.88 cc		of Rankine's theory?
m = 28.81 gm		(a) The soil mass in infinite
$m_{d} = 24.83 \text{ gm}$		(b) The soil mass is non homogeneous
G = 2.7	ER!/	(c) The soil mass is cohesive
IGIN		(d) The ground surface is a plane which may be
$\rho_{\rm d} = \frac{G \rho_{\rm w}}{1 + e} \qquad \qquad \rho_{\rm d} = \frac{m_{\rm d}}{V}$		horizontal or inclined
G 0		
$\therefore e = \frac{6 \rho_w}{\rho_d} - 1 = \frac{24.85}{14.88}$		43. Ans: (d)
27×1		Sol: Rankine Assumed ground surface is planar, which
$e = \frac{2.7 \times 1}{1.67} - 1$ $\rho_d = 1.67 \text{ gm/cc}$ e = 0.618		can be horizontal (or) Inclined
		44. If a retaining wall 5 m high is restrained from
42. A constant head permeability test is carried out	on	yielding, what is the at-rest earth pressure per
a cylindrical sample of sand 10 cm diameter a	and	meter length of wall? (Consider the backfill is
15 cm height. 160 cm ³ of water is collected	in	cohesionless soil having $f = 30^{\circ}$ and $g = 18 \text{ kN/m}^3$)
1.75 minutes, under a head of 30 cm. What is	the	(a) 108 kN/m (b) 112.5 kN/m
coefficient of permeability in m/year?	TCEI	(c) 115 kN/m (d) 124 kN/m
(a) 1257 m/year (b) 2111 m/year		
(a) $\frac{1257}{100}$ m/year (b) $\frac{2111}{2322}$ m/year		44 Ans: (b)
(c) 5000 m/year (d) 5552 m/year		Sale Detaining Walls
42. Alls: (c)		Sol: Retaining wan:
		H = 5 m
d = 10 cm		$\phi = 30^{\circ} \Longrightarrow K_{\circ} = 0.5$
L = 15 cm		$\gamma = 18 \text{ kN/m}^3$
V = 160 cc		- 12
t = 1.75 min		$F_{o} = \frac{1}{2} K_{o} \gamma H^{2}$
h = 30 cm		1
K = ?		$=\frac{1}{2}\times0.5\times18\times5^2$
$Q = k_1 A$		
$\frac{\mathbf{v}}{\mathbf{t}} = \mathbf{K} \cdot \frac{\mathbf{n}}{\mathbf{L}} \cdot \frac{\pi}{4} \mathbf{d}^2$		$F_{0} = 112.3 \text{ k/N/m}$
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- 45. Consider the following steps related to construction with the use of geotextiles:
 - 1. Start with an adequate working surface and staging area
 - 2. Lay a geotextile sheet of proper width on the ground surface.
 - 3. Construction equipment must work from the soil backfill and be kept off the unprotected geotextile

Which of the above steps are correct?

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

45. Ans: (d)

- 46. The void ratio of a clay sample is 0.5 and the degree of saturation is 70%. What is the bulk unit weight of the soil? (Assume G = 2.7)
 (a) 10.46 kN/m³
 (b) 14.32 kN/m³
 - (c) 17.77 kN/m^3 (d) 19.95 kN/m^3

46. Ans: (d)

Sol:
$$e = 0.5$$

- $S_{r} = 70\%$ G = 2.7 $\gamma = \left(\frac{G + e.S_{r}}{1 + e}\right)\gamma_{w}$ $= \left(\frac{2.7 + 0.5 \times 0.7}{1 + 0.5}\right) \times 9.81 = 19.95 \text{ kN/m}^{3}$
- 47. What is the coefficient of volume change (using change in void ratio method) for pressure range 100 kN/m² to 200 kN/m²? (Consider $\sigma'_0 = 100$ kN/m², $e_0 = 1.121$, $\sigma' = 200$ kN/m², $e_0 = 0.964$, $\Delta\sigma' = 100$ kN/m² and $\Delta e = -0.157$) (a) 0.25 m²/MN (b) 0.48 m²/MN (c) 0.69 m²/MN (d) 0.74 m²/MN

47. Ans: (d)

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Sol: $\Delta \sigma' = 100 \text{ kN/m}^2$ $\Delta e = 0.157$ $e_o = 1.121$ $\therefore m_v = \frac{\Delta V}{V} \times \frac{1}{\Delta \sigma'}$ $= \frac{\Delta e}{1 + e_o} \times \frac{1}{\Delta \sigma'}$ $\therefore m_v = \frac{0.157}{1 + 1.121} \times \frac{1}{100}$ $m = 0.74 \times 10^{-3} \text{ m}^2/\text{kN}$

 $m_{\rm c} = 0.74 \ {\rm m^2/MN}$

- 48. Which one of the following problems is required to
 - be studied in the design of earth dams?(a) The prediction of the position of the line of
 - (a) The prediction of the position of the line of seepage in the longitudinal section.
 - (b) The computation of seepage loss
 - (c) The seepage line should cut the down-stream slope
 - (d) The seepage loss through the dam should be maximum

48. Ans: (b)

Since

Sol: Water seeping through the body of earth dam (or)through foundation of earth dam is harmful to the stability of dam by causing softening and sloughing of slopes. So, computation of seepage loss should be ensured for safe design of earth dam.

- 49. Which one of the following is *not* an instrument for setting out right angles?
 - (a) Cross staff(b) Site square(c) Prism square(d) Optical staff

49. Ans: (d)

Sol:

Cross staff \Rightarrow 90° offsets (open cross staff) Site square \Rightarrow 90° offsets Prism square \Rightarrow 90° offsets

Engineering Publications	13	ESE_2021_Questions with Solutions
 50. Which one of the following is correct for Prismatic Compass? (a) The graduated ring rotates with line of sight (b) Instrument cannot be used without tripod (c) The graduations are engraved inverted (d) The readings can directly be taken by seeing through the top of the glass. 	c 52.	 The magnetic bearing of a line AB is S28°30′E. What is the true bearing of line AB if the magnetic declination is 7°30′ towards west ? (a) S36°E (b) N21°W (c) S21° E (d) N36°W
50. Ans: (c)	52.	Ans: (a)
 Sol: In a prismatic compass (a) The graduated Al-disc remains freely suspended (b) Tripod is not essential (c) Graduations are inverted (d) Readings are taken w.r.t a prism 51. Magnetic declination at a place is the horizonta angle between (a) the true meridian and the arbitrary meridian. (b) the magnetic meridian and the arbitrary meridian. (c) the true bearing and the magnetic bearing. (d) the true meridian and the magnetic meridian. 51. Ans: (d) Sol: Declination is the horizontal angle between true meridian and Magnetic meridian at a place. 	So R I N 53 Ce 19	 MB = S28°30'E D = 7°30'W MB = 180° -28°30' = 151° 30' D° = 7°30'W TB = MB ± D = 151°30' - 7°30' = 144° = S36°E The Zenith is/are (a) the point on the upper portion of the celestial sphere marked by plumb line above the observer. (b) the point on the lower portion of the celestial sphere marked by plumb line below the observer. (c) the two points in which the Earth's axis of rotation meets the Earth is sphere. (d) the great circle of the Earth, the plane of which is at right angles to the axis of rotation.
MM		

The point on the celestial sphere vertically above the observer's position on earth is known as zenith. The point vertically below the observer's position is known as Nadir.

 \mathbf{D}^0





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- 54. Which one of the statements is *not* correct for remote sensing ?
 - (a) It requires energy source.
 - (b) It requires propagation of energy through atmosphere.
 - (c) It requires energy interaction with the Earth's surface features.
 - (d) It requires absorption of energy by the Earth's surface.

54. Ans: (d)

Sol:

Components of ideal Remote sensing system are

- 1. Uniform energy source
- 2. Non interfering atmosphere
- 3. Unique energy matter interaction
- 4. Series of super sensors
- 5. Real time data handling
- 6. Multiple end users

- 55. Energy in remote sensing deals with which region of electromagnetic spectrum ?
 - (a) Ultraviolet(b) Infrared(c) X-Ray(d) Gamma Ray

55. Ans: (b)

Sol:

Earth's atmoshpere absorbs energy in Gamma rays. X-ray and most of the Ultra violet region. Therefore there regions are not used for remote sensing.

Remote sensing deals with energy in visible, infrared, thermal and microwave regions.

- 56. Consider the following statements related to the classification based upon the object of survey :
 - 1. Archaeological surveys for unearthing relics of antiquity.
 - 2. Geological surveys for determining different strata in the Earth's crust.
 - 3. Mine surveys for exploring mineral wealth such as gold, coal, etc.

Which of the above statements are correct?

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

56. Ans: (d)

Sol:

Since

- Classification based on object
- (a) Mine survey
- (b) Geological survey
- (c) Engineering survey
- (d) Construction survey
- (e) Military survey
- (f) Archaeological survey
- (g) Route survey
- (h) Satellite survey



Engineering Publications	15	ESE_2021_Questions with Solutions
 57. In setting up of plane table at a station P, the corresponding point on the plan was not accurately centered above P. If the displacement of P was 30 cm in a direction at right angles to the ray and scale is 1 cm = 2 m, how much on the plan would be the consequent displacement of point from its true position ? (a) 0.15 mm (b) 6.0 mm (c) 1.5 mm (d) 0.3 mm 	e y) e e	Overlap = 65% (longitudinal) Error in parallax, dp = 0.15 mm Error in elevation dh = ?? Take, h = 0 = Datum scale = $\frac{1}{20,000}$ $\frac{f}{H} = \frac{1}{20000}$ 0.17 m _ 1
57. Ans: (c) Sol:		H = 3400 m
Error due to inaccurate centering $\Rightarrow pp' = qq' = ek$ $e = 30 \text{ cm}$ $k = \frac{1}{200} (\because \text{scale} \Rightarrow 1 \text{ cm} = 2\text{m})$ $\therefore pp' = qq' = \frac{30 \text{ cm}}{200}$ $= 0.15 \text{ cm}$	RU	Equation for parallax $P = \frac{Bf}{H-h}$ $\Rightarrow h = H - \frac{Bf}{p}$ Differentiating,
 = 1.5 mm 58. A photographic survey is carried out to a scale of 1 : 20000. A camera with a wide angle lens of f = 170 mm was used with 25 cm × 25 cm plate size for a net 65% overlap along the line of flight. What is the error in height given by an error of 0.15 mm in measuring the parallax of the point ? (a) 5.15 m (b) 5.27 m (c) 5.83 m (d) 6.45 m 	f re1 s	$dh = 0 + \frac{Bf}{p^2} dp$ (:: H, B and f remains constant) $\Rightarrow dh = \frac{Bf}{p^2} dp$ but $p = \frac{Bf}{H - h}$ $\Rightarrow dh = \frac{Bf}{(-Bf -)^2} dp$
58. Ans: (c) Sol: $S = \frac{1}{20,000}$ f = 170 mm Size of photo = 25 mm × 25 mm		$\left(\frac{BI}{H-h}\right)^{-1}$ $\Rightarrow dh = \frac{(H-h)^2}{Bf} dp$ Also, $B = L = \frac{\ell(1-p_i\%)}{S}$

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Civil Engineering

$$\Rightarrow B = \frac{0.25m(1 - 0.65)}{\frac{1}{20,000}}$$

 \Rightarrow B = 1750 m

- $\Rightarrow dh = \frac{(3400 0)^2}{1750 \times 0.17} \times 0.15 \text{ mm (dP} = 0.15 \text{ mm Given)}$
 - = 5828.57 m = 5.828 m dh = 5.83 m
- 59. What is the aeroplane flying height to obtain the average scale of the photograph equal to $\frac{1}{7200}$? (Ground surface elevations vary from 160 m to 430 m and focal length of the camera lens is 153 mm)

(a) 1021 m	(b) 1145 m
(c) 1284 m	(d)1397 m

59. Ans: (d) Sol:

$$S_{avg} = \frac{1}{7200}$$

 $h = 160 \rightarrow 430 \text{ m}$

 $h_{avg} = \frac{160 + 430}{2} = 295 \text{ m}$

f = 153 mm

$$S_{avg} = \frac{f}{H - h_{avg}}$$

$$\frac{1}{7200} = \frac{0.153 \text{ m}}{\text{H} - 295 \text{ m}} \Rightarrow \text{H} = 1396.6 \text{ m} = 1397 \text{ m}$$

60. Which one of the following conditions shall be fulfilled when a transition curve is inserted between the tangent and circular curve ?

- (a) It should not meet the original straight tangentially.
- (b) It should not meet the circular curve tangentially.
- (c) Its radius at the junction with the circular curve should be the same as that of the circular curve.
- (d) The rate of decrease of curvature along the transition curve should be same as that of increase in superelevation.

60. Ans: (c)

Sol:

Since

Requirements of a transition curve

- 1. It should meet the straight line tangentially
- 2. It should meet the circular curve tangentially i.e., radius at the junction of intersection of transition of circular curves should be equal.
- 3. The rate of application of super elevation should be equal to rate of change of curvature
- 61. Consider the following statements related to road pavements :
- Deflections measured near cracks are normally much lower than the measurements in nondistressed areas .
 - 2. Deflection near measurements longitudinal joints, transverse joints or corners are higher than those measured at mid-slab for concrete pavements.
 - 3. Thermal and moisture gradient in the vertical direction of concrete slabs does not have any influence on deflection measurements.
 - 4. Measurements taken at night or in the early morning are considerably different from those obtained in the afternoon.

Which of the above statements are *not* correct?

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

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61. Ans: (b)

Sol:

Statement -1 is wrong

Deflections measured near cracks are much higher than the deflection at non-distressed areas.

Statement -3 is also wrong

Moisture and thermal gradients change deflection values.

- 62. Which one of the following tunnelling methods is adopted for the situations where the metro alignment passes under residential buildings or a canal ?
 - (a) Earth pressure balance tunneling machine method
 - (b) Tunnel boring machine method
 - (c) Tube tunneling method
 - (d) Driven shield tunneling method

62. Ans: (b)

Sol:

Tunnel boring machine is used in the situations where tunnel alignment passes under residential buildings.

- 63. Consider the following statements related to the advantages of concrete sleepers :
 - 1. Concrete sleepers can generally be mass produced using local resources.
 - 2. Concrete sleepers are not suitable for beater packing.
 - 3. Concrete sleepers have a very long lifespan.
 - 4. Concrete sleepers have no scrap value.

Which of the above statements is/are correct?

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

63. Ans: (b)

Sol:

Advantages:

- 1. High durability and strength.
- 2. Easy production.
- 3. Longer life span.
- 4. Poses no difficulty to track electrification.
- 5. Holds gauge satisfactorily.
- 6.Can be easily mass produced from local resources.

Disadvantages:

- 1.Zero scrape value.
- 2. May loss dimensions during transportation.

3.Pretensioned and prestressed concretes are generally adopted.

Beater Packing

The beater is basically a pick-axe with one of its end blunted into tee shape. The pick end is used for loosening the ballast core while the blunt end is used for driving the ballast under the sleeper.

Disadvantages:

- 1. Highly labourious.
- 2. Packing becomes unsatisfactory under heavier loads.
- 3. The results of beater packing are not consistent.
- 4. Labour output cannot be measured accurately.
- 5. Ballast life is shortened under beater packing.
- 6. Beater packing damages the concrete sleepers.
- 7. Even wooden sleepers have less life with beater packing.
- 64. Which one of the following is *not* the method of tunneling in hard rock ?
 - (a) Full-face heading method
 - (b) Heading and bench method
 - (c) Drift method
 - (d) Shaft method

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TEST WISE STATISTICS:



QUESTION WISE STATISTICS:







Engineering Publications	18	Civil Engineering
64. Ans: (d) Sol:		9. Saves economy as separate infrastructure is not required for two gauges
In hard rock the common tunneling methods are 1. Full face method 2. Heading and benching method		10. No delay for military movements.
3. Drift methodNote: Shaft method is not related in this regard.	6	6. Which one of the following are provided to give access to properties along an important highway with controlled access to expressway or freeway ?
 65. Consider the following statements related to the advantages of uniformity of rail gauges: As transhipping is not required, there breakage of goods. Large sheds to store goods are not required. Labour strikes, etc. do not affect the service and operation of trains. Which of the above statements are correct ? (a) 1 and 2 only (b) 2 and 3 only 	is ERIA ce 6	 (a) Lay-bys (b) Frontage roads (c) Driveways (d) Cycle tracks 66. Ans: (b) 601: Frontage roads are used to give access to properties along an important highway with
 (c) 1 and 3 only (d) 1, 2 and 3 65. Ans: (d) Sol: Gauges to be used in a country should be unifor throughout as far as possible because it will avo many difficulties as compared to non unifor system such as 1. The delay in transshipment in passengers and the system such as 	m id m ce 1	 controlled access to express way (or) freeway. When properly designed traffic signals are used, which one of the following is the advantage of traffic signals ? (a) The signals allow crossing of the heavy traffic flow with safety. (b) The rear-end collision may increase. (c) Improper design and location of signals may

- 2. No breakage of goods.
- 3. Labour expenses in loading and unloading are save.
- 4. Possibility of theft and misplacement are eliminated.
- 5. Large storage facilities for interim storage is not required.
- 6. Labour strikes etc do not effect the timing and operation of trains.
- 7. Surplus wagons of one gauge will remain underused.
- 8. Better utilisation of locomotives.

67. Ans: (a)

Sol:

The most appropriate answer here is (a), It can be chosen by process of elimination The only advantage among the options is to allow crossing of the heavy traffic flow with safety.

(d) Failure of the signal due to electric power

failure may cause confusion to the road users.

Engineering Publications	19		ESE_2021_Questions with Solutions
 68. If the ruling gradient is 1 in 150 on a particular section of broad gauge and at the same time a curve of 4 degree is situated on this ruling gradient, what is the allowable ruling gradient ? (a) 1 in 10 (b) 1 in 72 (c) 1 in 196 (d) 1 in 245 	r 7 e t	70.	What is the minimum stopping sight distance on a -3.5% grade for a design speed of 110 kmph ? (Consider friction coefficient f= 0.28, t = 2:5 sec and G = 0-035) (a) 76.4 m (b) 194.4 m (c) 214.6 m (d) 270.8 m
68. Ans: (c) Sol: G = 1/150 $D^{\circ} = 4^{\circ}$ BG Track Grade Compensation = 0.04% D° $= \frac{0.04}{100} \times 4$ $= \frac{0.16}{100}$ Compensated Gradient = G - GC $= \frac{1}{150} - \frac{0.16}{100} = \frac{1}{197}$	RIA	70. Sol: V <i>G</i> 71.	Ans: (d) $SSD = 0.278 Vt + \frac{V^2}{254(f-G)}$ $= 0.278 \times 110 \times 2.5 + \frac{110^2}{254(0.28 - 0.039)}$ $= 0.278 \times 110 \times 2.5 + \frac{110^2}{254(0.254)}$ $= 76.45 + 194.4$ $= 270.89 m$ The free mean speed on a roadway is found to be
69. What is the value of headlight sight distance for a highway with a design speed of 65 kmph ? (Take f = 0.36 and t = 2.5 sec) (a) 66.5 m (b) 81.3 m (c) 91.4 m (d) 182.8 m 69. Ans: (c) Sol: HSD = SSD = $0.278 \text{ Vt} + \frac{\text{V}^2}{254\text{f}}$ = $0.278(65)(2.5) + \frac{65^2}{256(0.36)}$ = $45.175 + 46.2$ = $91.38 \simeq 91.4 \text{ m}$		99 71. Sol:	80 kmph. Under stopped condition, the average spacing between the vehicles is 6.9 m. What is the capacity flow ? (a) 5800 Vehicles/hour (per lane) (b) 7200 Vehicles/hour (per lane) (c) 1450 Vehicles/hour (per lane) (d) 2900 Vehicles/hour (per lane) Ans: (d) Free mean speed, $V_m = 80$ kmph Jam density, $k_m = \frac{1000}{S} = \frac{1000}{6.9}$ Veh/km Capacity of flow using Greenshield's model $q_m = \frac{V_m.k_m}{4}$
69. Ans: (c) Sol: $HSD = SSD = 0.278 Vt + \frac{V^2}{254f}$ $= 0.278(65)(2.5) + \frac{65^2}{256(0.36)}$ $= 45.175 + 46.2$ $= 91.38 \simeq 91.4 m$	S	71. Sol:	(d) 2900 Vehicles/hour (per lane) Ans: (d) Free mean speed, $V_m = 80$ kmph Jam density, $k_m = \frac{1000}{S} = \frac{1000}{6.9}$ Ve Capacity of flow using Green $q_m = \frac{V_m \cdot k_m}{4}$ $= \frac{80 \times 1000}{4 \times 6.9} = 2898.5$ veh/hr $\simeq 2900$ veh/hr (per lane)

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 72. For a street lighting system, having the following conditions : Street width - 15 m Mounting height = 7.5 m Lamp size = 6000 lumen Laminaire type = II Coefficient of utilization = 0.44 Maintenance factor - 0.8 What is the spacing between lighting units to produce average Lux = 6 ? (a) 18 m (b) 20 m (c) 23 (d) 27 m 73. Ans: (c) Sol: Spacing of lamps = lamp lumen × coef of ulization × ma intenance factor avg lux required × width of road = <u>6000 × 0.44 × 0.8</u> 6 × 15 = 23.4 ≈ 23 m c/c 74. Ans: (c) Sol: Consider the following for the objects of seasoning wood: 1. Reduce its weight Which of the above objects are correct ? (a) 1. 3 and 4 only (c) 1 and 3 only (d) 2, 5 Ans: (d) Sol: Mild Steel is a low carbon steel with carbon content. Thus, mild steel halterses in carbo	Engineering Publications	20) Civil Engineering
 72. Ans: (c) (d) Soundness test (e) Xousion test (f) Xousion test (g) Soundness test (g) Soundness test (g) Soundness test (h) Sol: Coarse aggregates have three strength parameters. 1. Crushing Strength – Aggregate Crushing Value (ACV) test is used to assess the Crushing Strength of coarse aggregates. 2. Toughness – Aggregate Impact Value (AIV) test is used to assess the Toughness of coarse aggregates. 2. Toughness – Aggregate Impact Value (AIV) test is used to assess the Toughness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. 3. Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Coaling test of mild steel ? (a) It has high carbon content. (b) It is tougher than hard steel. (c) It is more elastic than hard steel. (d) It can be forged and welded easily. 75. Ans: (d) 76. Mild Steel is a low carbon steel with carbon content less than 0.25%. For steel, (a) Elasticity, (b) Toughness and (c) Hardness increase with increase in carbon content. Thus, mild steel Because 	 72. For a street lighting system, having the followin conditions : Street width = 15 m Mounting height = 7.5 m Lamp size = 6000 lumen Luminaire type = II Coefficient of utilization = 0.44 Maintenance factor = 0.8 What is the spacing between lighting units produce average Lux = 6 ? (a) 18 m (b) 20 m (c) 23 (d) 27 m 	to	 To improve the strength and workability. To reduce the probabilities of development of shrinkage defects and improve durability of the timber. To reduce the load and crack of timber. To make the timber receptive to finishes like preservatives, paints and varnishes. The hardness of aggregate is tested by (a) Impact test (b) Crushing strength test (a) Approximatest
 Sol: Coarse aggregates have three strength parameters. Implumen × coef of ulization × maint enance factor avg lux required × width of road (ACV) test is used to assess the Crushing Value (ACV) test is used to assess the Crushing Strength of coarse aggregates. Consider the following for the objects of seasoning wood: Reduce the shrinkage and warping after placement in structure Increase its tendency to split and decay Decrease workability Reduce its weight Which of the above objects are correct ? (a) 1, 3 and 4 only (b) 1 and 4 only (c) 1 and 3 only (d) 2, 3 and 4 only Toughness and (c) Hardness increase with carbon content. Initis is called as seasoning. The main objectives of seasoning of timber are as follows: Deep Learn - India's Best Online Coaching Platform for GATE, ESE, and PSUs 	72. Ans: (c) Sol: Spacing of lamps	ERI	(d) Soundness test 74. Ans: (c)
 73. Consider the following for the objects of seasoning wood: Reduce the shrinkage and warping after placement in structure Increase its tendency to split and decay Decrease workability Reduce its weight Which of the above objects are correct ? (a) 1, 3 and 4 only (b) 1 and 4 only (c) 1 and 3 only (d) 2, 3 and 4 only 75. Ans: (d) 75. Ans: (d) 75. Ans: (d) 76. Ans: (d) 76. Ans: (d) 77. Ans: (d) 78. Ans: (b) 79. The main objectives of seasoning of timber are as follows: 75. Ans: (d) 76. Ans: (d) 77. Ans: (d) 78. Ans: (d) 79. Mild Steel is a low carbon steel with carbon content less than 0.25%. For steel, (a) Elasticity, (b) 79. Toughness and (c) Hardness increase with increase in carbon content. Thus, mild steel has less elasticity and less toughness compared to hard steel. Because 	$= \frac{\text{lamp lumen} \times \text{coef of ulization} \times \text{ma intenance factor}}{\text{avg lux required} \times \text{width of road}}$ $= \frac{6000 \times 0.44 \times 0.8}{6 \times 15}$ $= 23.4 \simeq 23 \text{ m c/c}$	<u>or</u>	 Sol: Coarse aggregates have three strength parameters. 1. Crushing Strength – Aggregate Crushing Value (ACV) test is used to assess the Crushing Strength of coarse aggregates. 2. Toughness – Aggregate Impact Value (AIV) test is used to assess the Toughness of coarse aggregates
 73. Ans: (b) Sol: Reducing the moisture content in timber to desired limits is called as seasoning. The main objectives of seasoning of timber are as follows: 75. Ans: (d) Sol: Mild Steel is a low carbon steel with carbon content less than 0.25%. For steel, (a) Elasticity, (b) Toughness and (c) Hardness increase with increase in carbon content. Thus, mild steel has less elasticity and less toughness compared to hard steel. Because 	 73. Consider the following for the objects of seasonin wood: 1. Reduce the shrinkage and warping aft placement in structure 2. Increase its tendency to split and decay 3. Decrease workability 4. Reduce its weight Which of the above objects are correct ? (a) 1, 3 and 4 only (b) 1 and 4 only (c) 1 and 3 only (d) 2, 3 and 4 only 	er ce 1	 Hardness – Aggregate Abrasion Value (AAV) test is used to assess the Hardness of coarse aggregates. Which one of the following statements is correct in respect of mild steel ? (a) It has high carbon content. (b) It is tougher than hard steel. (c) It is more elastic than hard steel. (d) It can be forged and welded easily.
Deep Learn - India's Best Online Coaching Platform for GATE, ESE, and PSUs Enjoy a smooth online learning experience in various languages at your convenience	73. Ans: (b)Sol: Reducing the moisture content in timber to desired limits is called as seasoning. The main objectives of seasoning of timber are a follows:	ed as	 75. Ans: (d) Sol: Mild Steel is a low carbon steel with carbon content less than 0.25%. For steel, (a) Elasticity, (b) Toughness and (c) Hardness increase with increase in carbon content. Thus, mild steel has less elasticity and less toughness compared to hard steel. Because
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of low carbon content, Mild steel has high ductility and malleability which makes forging and welding easy.

- 76. The chemical composition 'Silicates of iron and alumina' is found in which one of the following minerals ?
 - (a) Garnet (b) Serpentine
 - (c) Olivine (d) Calcite

76. Ans: (a)

- **Sol:** Garnets are silicates having the general formula $X_3Y_2(SiO_4)_3$. The X is usually occupied by divalent cations (Ca, Mg, Fe, Mn)²⁺ and the Y by trivalent cations (Al, Fe, Cr)³⁺. Thus, Silicates of Iron and Alumina can be found in Garnet mineral.
- 77. The drawback of electric seasoning of timber
 (a) Checks
 (b) Splitting
 (c) Cracks
 (d) Reduced Strength

77. Ans: (b)

- **Sol:** In Electrical Seasoning method, timber gets seasoned due to the heat generated by the electricity as it flows through the timber. However, the drawback is that the wood may split.
- 78. Which one of the following is a product obtained by distilling tar and is used largely as an effective preservative for wood ?
 - (a) Creosote (b) Solignum
 - (c) Coal tar (d) Wax polish

78. Ans: (a)

Sol: Creosote oil is a chemical obtained by the distillation of tar and it is used largely as an effective preservative for wood.

- 79. Pozzolanas are
 - (a) argillaceous materials
 - (b) calcareous materials
 - (c) accelerators
 - (d) siliceous materials

79. Ans: (d)

- **Sol:** Pozzolana is a natural siliceous or siliceousaluminous material.
- 80. For better chemical resistance, proportion of which one of the following compounds in cement clinker shall be increased ?
 - (a) Tricalcium Silicate
 - (b) Dicalcium Silicate
 - (c) Tetracalcium Aluminate
 - (d) Tetracalcium Aluminoferrite

80. Ans: (b)

1995

- **Sol:** Increase in the proportion of Di-Calcium Silicate decreases the production of Ca(OH)₂, which is a very strong base. Thus, increase in Di-Calcium Silicate improves the chemical resistance of the cement.
- 81. The finishing coat in X-ray room walls is done preferably with
 - (a) Barium plaster
 - (b) Cement plaster
 - (c) Gypsum
 - (d) Plaster of Paris

81. Ans: (a)

Sol: Barium plaster is used as a finishing coat in X-ray room walls to ensure harmful radiation ray does not leak outside of the room more than allowable dose.



- 82. The most suitable type of cement for mass concreting works is
 - (a) Rapid Hardening Cement
 - (b) High Alumina Cement
 - (c) Low Heat Portland Cement
 - (d) Quick Setting Cement

82. Ans: (c)

- **Sol:** For mass concreting works, cement which produces less heat of hydration is preferred. Among the given options, Low Heat Portland Cement has the least heat of hydrations.
- 83. Which one of the non-destructive tests can be performed on fresh concrete ?
 - (a) Ultrasonic test
- (b) Penetration test

(c) Core test

(d) Hammer test

83. Ans: (a)

- **Sol:** Among the given options, Ultrasonic test is the only test which can also be performed on fresh concrete because this test can be done without disturbing the fresh concrete sample. All the other tests mentioned in the options cannot be performed without disturbing the fresh concrete sample.
- 84. In a concrete mix, for given cement content and workability, higher proportion of fine aggregate will be required if
 - (a) maximum size of aggregate is large.
 - (b) maximum size of aggregate is small.
 - (c) rounded aggregate is used.
 - (d) all in aggregate is used.

84. Ans: (b)

Sol: For a given cement content and workability, smaller maximum size of coarse aggregate would require greater fine aggregate content to fill the voids and maintain the cohesiveness of concrete mix.

- 85. A central steel rod 18 mm diameter passes through a copper sleeve with 24 mm inside and 39 mm outside diameter. It is provided with nuts and washers at each end and the nuts are tightened until a stress of 10 N/mm² is set up in the steel. Then, the stress developed in copper tube is
 - (a) 29.1 N/mm², Compressive
 - (b) 3.4 N/mm², Compressive
 - (c) 3.4 N/mm², Tensile
 - (d) 29.1 N/mm², Tensile

85. Ans: (b)

Sol:



When the nuts are tightened, tube will be under compression and rod will be under tension

Tension load on steel rod = compressive load on 'cu' tube

$$\sigma_{s} \cdot A_{s} = \sigma_{cu} A_{cu}$$

$$10 \times \frac{\pi}{4} d_{s}^{2} = \sigma_{cu} \times \frac{\pi}{4} (D_{cu}^{2} - d_{cu}^{2})$$

$$10 \times \frac{\pi}{4} \times 18^{2} = \sigma_{cu} \times \frac{\pi}{4} (39^{2} - 24^{2})$$

$$\sigma_{cu} = \frac{10 \times 18^{2}}{39^{2} - 24^{2}} = 3.428 \text{ MPa (Comp.)}$$

86. A 2m long alloy bar of 1500 mm cross-sectional area hangs vertically and has a collar securely fixed at its lower end. What is the stress induced in the bar when a weight of 2 kN falls from a height of 100 mm on the collar ? (Take E = 120 GPa) (a) 126 5 MPa (b) 158 3 MPa

(a) 120.5 WII a	(b) 150.5 WII a
(c) 161.2 MPa	(d) 181.3 MPa





87. Normal stresses of 126 MN/m² (Tensile) and 94 MN/m² (Compressive) are acting at a point in an elastic material at right angles to each other. If the maximum principal stress is limited to 146 MN/m², the shear stress that may be allowed at that point in the same plane is

(a) 170 MN/m²
(b) 89 MN/m²

(d) 96 MN/m²

87. Ans: (c) Sol:

(c) 69 MN/m^2



88. A plane element in a body is subjected to a tensile stress of 100 MPa and shear stress of 25 MPa. What is the normal stress on a plane inclined at 15° with the tensile stress ?

(a) -5.8 MPa	(b) – 4.8 MPa
(c) – 3.8 MPa	(d) –2:8 MPa

88. Ans: (a) Sol:







- $\sigma_{x} = 100 \text{ MPa} \qquad \sigma_{y} = 0$ $\tau_{xy} = 25 \text{ MPa}$ $\theta = (-) 75^{\circ}$ $\therefore \sigma_{75^{\circ}} = \frac{\sigma_{x} + \sigma_{y}}{2} (+) \frac{\sigma_{x} - \sigma_{y}}{2} \cos 2\theta (+) \tau_{xy} \sin 2\theta$ $= \frac{100 + 0}{2} + \frac{100 - 0}{2} \cos (-150^{\circ}) + 25 \sin (-150)$ = 50 - 43.3 - 12.5 = 50 - 55.8= (-) 5.8 MPa
- 89. A load of 2100 N is dropped axially on a closedcoiled helical spring from a height of 240 mm. The spring has 22 coils each of n diameter 180 mm and wire diameter is 25 mm. If modulus of rigidity C = 84000 N/mm² and amount of compression δ = 255 mm, what is the maximum shear stress produced in the spring ?
 - (a) 156 N/mm² (b) 346 N/mm² (c) 239 N/mm² (d) 123 N/mm²

89. Ans: (c)

Sol: Given:

$$\begin{split} P &= 2100 \text{ N}, \text{ h} = 240, \delta = 255 \\ \tau_{max} &= \frac{8 \text{wD}}{\pi d^3} \end{split}$$

here,

w = gradual applied load D = mean diameter = 180 mm

d = wire diameter = 25 mm

here the given load is impact load

so we need to find equivalent gradual applied load (w) which will produce same effect as provided by the given falling load of 2100 N

work done by the falling load = work done by w $P(h+\delta) = \frac{1}{2} w \delta$

 $2100(240 + 255) = \frac{1}{2} \text{w} \times 255$ w = 8152 $\tau_{\text{max}} = \frac{8 \text{wD}}{\pi d^3} = \frac{8 \times 8152 \times 180}{\pi (25)^3} = 239 \text{ MPa}$ 90. An I-section purlin of span 4 m is subjected to a total uniformly distributed load of 5 kN. The purlin will be designed for maximum bending moment of (a) 2000 Nm
(b) 20 kNm
(c) 2500 Nm
(d) 25 kNm

90. Ans: (a)

91. A 1.4 m long laminated carriage spring hay leaves of 100 mm width and 10 mm thickness. The spring has to absorb 125 N-m of energy when straightened, without exceeding the bending stress of 160 MPa. What is the number of leaves ? (Take the elastic modulus of material of spring as 200 GPa)

(a) 11 (b) 9 (c) 7 (d) 5

91. Ans: (b)
Sol: L = 1.4 m = 1400 mm
b = 100 mm
t = 10 mm
U = 125 N-m = 125 × 10³ N-mm
(s_b)_{max} = 160 MPa
E = 200 × 10³ MPa n = ?
Strain Energy stored in laminated spring is given by
U =
$$\frac{(\sigma_{bend})^2}{6E} \times (\frac{nbLt}{2})$$

 $125 \times 10^3 = \frac{160^2}{6 \times 200 \times 10^3} \times \frac{n \times 100 \times 1400 \times 10}{2}$
n = 8.37 ~ 9

92. A wooden floor is required to carry a load of 12 kN/m² and is to be supported by wooden joists of 120 mm × 250 mm in section over a span of 4 m. If the bending stress in these wooden joists is not to exceed 8 MPa, what is the spacing of the joists ?
(a) 256 mm (b) 218 mm

(a) 550 mm	(0) 518 mm
(c) 432 mm	(d) 417 mm

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92. Ans: (d)

Sol:



C = Centre to centre distance between two joist load on each joist = $w_0 = 12C \text{ kN/m}$

Max B.M in joist =
$$\frac{W_o L^2}{8} = \frac{(12C) \times (4 \times 10^3)^2}{8}$$

 $(\sigma_{\rm b})_{\rm max} = \frac{B.M_{\rm max}}{\tau_{\rm N,A}}$

 $8 = \frac{(12C)(4 \times 10^3)^2}{8 \times \frac{120 \times 250^2}{6}}$

$$\Rightarrow$$
 C = 0.41666 m = 416.667 mm \simeq 417 mm

93. A motor driving a solid circular shaft transmits 30 kW at 500 r.p.m. What is the torque activity on the shaft, if allowable shear stress is 42 MPa?

(b) 573 Nm

(a) 427 Nm

(c) 180 Nm (d) 219 Nm

93. Ans: (b)

Sol:

$$\begin{split} P &= 30 \times \ 10^3 \ watts \\ N &= 500 \ rpm \\ \tau_{allow} &= 42 \ MPa \end{split}$$

$$P = \frac{2\pi NT}{60}$$

$$30 \times 10^3 = \frac{2\pi \times 500 \times \mathrm{T}}{60}$$

$$T = \frac{1800}{\pi} = 572.95 \text{ N} - \text{m} \approx 573 \text{ N} - \text{m}$$

94. An open-coiled helical spring of wire diameter 12 mm, mean coil radius 84 mm, helix angle 60° carries an axial load of 480 N. What is the twisting moment?

(a) 10.22 Nm	(b) 20.16 Nm
(c) 14.24 Nm	(d) 24.11 Nm

94. Ans: (b)

Sol:

d = 12 mm R = 84 mm $\alpha = 60^{\circ} \quad W = 480 \text{ N}$ $T.M = WR \cos \alpha$ $= 480 \times 84 \times \cos 60^{\circ}$ = 20160 N-mm = 20.16 N-m

- 95. The stresses at a point of a machine component are 150 MPa and 50 MPa, both tensile. What is the intensity of normal stress on a plane inclined at an angle of 30 with the axis of major tensile stress ?(a) 25 MPa(b) 50 MPa
 - (c) 75 MPa

(d) 100 MPa

95. Ans: (c)

Sol:

Since





$$\sigma_{x} = 150 \text{ MPa}$$

$$\sigma_{y} = 50 \text{ MPa}$$

$$\theta = -60^{\circ} \qquad 0$$

$$\sigma_{60^{\circ}} = \frac{\sigma_{x} + \sigma_{y}}{2} + \frac{\sigma_{x} - \sigma_{y}}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$= \frac{150 + 50}{2} + \frac{150 - 50}{2} \cos(-120^{\circ})$$

= 100 - 25 = 75 MPa

- 96. In case of lintel design, the load enclosed in an equilateral triangle is fully transferred to the lintel provided the height of wall above lintel is
 - (a) not less than 1:25 times the height of the equilateral triangle.
 - (b) less than twice the height of the equilateral triangle.
 - (c) less than 1.25 times the height of the equilateral triangle.
 - (d) greater than twice the height of the equilateral triangle

96. Ans: (a) Sol:



In case of lentel design, the load transfer from masonary above lentel is 1.25 times the height of imaginary triangle.

- 97. Consider the following statements for Euler's equation to find critical load of a column :
 - 1. Critical load of a column is proportional to the flexural rigidity.
 - 2. Critical load of a column depends upon yield stress.
 - 3. Critical load of a column is inversely proportional to the length of column.
 - 4. Critical load of a column is inversely proportional to the square of the length of column.

Which of the above statements are correct?

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

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

97. Ans: (b)

Sol:

$$\hat{P}_{B} = \frac{\pi^2 E I_{min}}{\sigma^2}$$

$$l_{e}^{2}$$

 $\hat{P}_{B} \propto EI_{min}$ and $\hat{P}_{B} \propto \frac{1}{c^{2}}$

98. A steel plate 120 mm wide and 20 mm thick is bent into a circular are of radius 10 m. What is the maximum stress produced and the bending moment which can produce this stress respectively ? (Take E = 200 GPa)

(a) 100 MPa, 32 kN-m (b) 200 MPa, 160 N-mm (c) 200 MPa, 1600 N-m (d) 20 MPa, 160 kN-m

98. Ans: (c)

Sol:



b=120 mm





		27	ESE_2021_Questions with Solutions
	$E = 200 \times 10^3 \text{ MPa}$		100. Consider the following statements :
	$y_{max} = \frac{t}{2} = \frac{20}{2} = 10 \text{ mm}$		Moment Area Method proves advantageous in analyzing 1. cantilever beams.
	From bending equation,		 symmetrically loaded simply supported beams. fixed beams
	$\frac{(\sigma_{\rm bend})_{\rm max}}{y_{\rm max}} = \frac{E}{R}$		 4. continuous beams.
	$(\sigma_{\text{bend}})_{\text{max}} = \frac{E}{R} \times y_{\text{max}} = \frac{200 \times 10^3}{10,000} \times 10$		Which of the above statements are correct ?(a) 1, 2 and 4 only(b) 3 and 4 only(c) 1, 2 and 2 anly(d) 1 and 2 anly
	$\therefore (\sigma_{\text{bend}})_{\text{max}} = 200 \text{ MPa}$		(c) 1, 2 and 3 only (d) 1 and 2 only
	and $B.M = (\sigma_{bend}) \times Z_{N.A}$		100. Ans: (c)
	$=(\sigma_{bend}).\frac{bt^2}{6}$		101. Consider the following statements regarding continuous beam :
	$= 200 \times \frac{120 \times 20^2}{6} = 1600000 \text{ N} - \text{mm}$		1. A beam is said to be a continuous beam if it is supported on more than two supports.
	= 1600 N-m		 A continuous beam is a statically indeterminate structure. The degree of indeterminacy depends upon the
99.	Consider the following statements regarding	g	number of supports and also on the nature of the supports.
	1. Point of contraflexure is the point where	e	Which of the above statements are correct ?
	bending moment changes its sign . Since	ce 1	(a) 1 and 2 only (b) 2 and 3 only
	2. Shear force is the rate of change of bending moment	g	(c) 1, 2 and 3 (d) 1 and 3 only
	3. For bending moment to be the maximum o	r	101. Ans: (c)
	4. Rate of change of loading is equal to sheat	r	Sol:
	Which of the above statements are correct ?		
	(a) 2 and 3 only (b) 1 and 4 only		<u> </u>
	(c) 1, 2 and 4 only (d) 1, 2 and 3 only		Statically indeterminate structure
99.	Ans: (d)		

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- 102. In case of flexural tension or flexural compression, the minimum length of the bar which must be embedded in concrete beyond any section to develop its full strength, is termed as
 - (a) Twisted length
 - (b) Flexural length
 - (c) Bond length
 - (d) Development length

102. Ans: (d)

- **Sol:** In case of flexural tension (or) flexural compression, the minimum length of the bar which must be embedded in concrete beyond any section to develop its full strength is termed as development length.
- 103. It is observed experimentally that the amplitude of free vibration of a certain structure modelled as a single degree of freedom system, decreases from 1.0 to 0.4 in 10 cycles. What is the percentage of critical damping ?

(Take In 2 = 0.693 and in 10 = 2.303)

(a) 5.21% (b) 1.46%

(c) 2.37% (d) 3.22%

103. Ans: (b) Sol:

Given $x_0 = 1$ ln(2) = 0.693 $x_{10} = 0.4$ and ln(10) = 2.303

percentage of critical damping = damping factor $(\xi = ?)$

In free damped vibrations ratio of two successive amplitudes remains constant.

So $\frac{\mathbf{x}_0}{\mathbf{x}_1} = \frac{\mathbf{x}_1}{\mathbf{x}_2} = \dots = \frac{\mathbf{x}_9}{\mathbf{x}_{10}}$

given
$$\frac{x_0}{x_1} = \frac{x_0}{x_1} \times \frac{x_1}{x_2} \times \dots \times \frac{x_9}{x_{10}} = \left[\frac{x_0}{x_1}\right]^{10} = \frac{1}{0.4} = \frac{5}{2}$$

logerthermic decrement

$$\delta = \ln \left[\frac{x_0}{x_1} \right] = \frac{1}{10} \ln \left[\frac{5}{2} \right]$$
$$= \frac{1}{10} \ln \left[\frac{5 \times 2}{2 \times 2} \right]$$
$$= \frac{1}{10} [\ln 10 - \ln 2 - \ln 2]$$
$$= \frac{1}{10} [2.303 - 0.639 - 0.693]$$
$$\delta = 0.0917$$

% dampign factor
$$\xi = \frac{\delta}{\sqrt{4\pi^2 + \delta^2}} \times 100\%$$

 $\xi = \frac{0.0917}{\sqrt{4\pi^2 + (0.0917)^2}} \times 100\% = 1.46\%$

104. The ultimate tensile strain in steel is in the range of
(a) 0.012 - 0.020
(b) 0.0012 - 0.0020
(c) 0.12 - 0.20
(d) 0.00012 - 0.00020

104. Ans: (c)

Since

Sol: For mild steel, Tensile strain at plastic point 10 to 15%

= 0.1 to 0.15

Tensile strain at fracture point 25%

= 0.2 to 0.3

Hence, most approximate option is (c)

- 105. Consider the following statements regarding statically determinate structures :
 - 1. Conditions of equilibrium are sufficient to fully analyse the structure.
 - 2. The bending moment at a section or the force in any member is independent of the material of the components of the structure.
 - 3. The bending moment at a section or the force in any member is independent of the crosssectional areas of the components.

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Which of the above statements are correct?

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

105. Ans: (c)

Sol:

- Bending moment or shear force at any section is independent of the material property of the structure.
- The bending moment or shear force at any section is independent of the cross section or moment of inertia.
- 106. A cantilever beam of 4 m span carries a UDL of 3 kN/m over its entire span and a point load of 3 kN at the free end. If the same beam is simply supported at two ends, what point load at the centre should it carry to have same deflection as the cantilever? (a) 60 kN (b) 120 kN
 - (c) 160 kN

(d) 210 kN

106. Ans: (b)

Sol:

Deflection in cantilever with UDL and point load = Deflection in simply supported beam with central point load.



- 107. A beam AB of span 5 m fixed at both ends carries a UDL of 12 kN/m over the whole span. If the right end B settles down by 12 mm, what are the end moments for the beam ? (Take $EI = 15000 \text{ kNm}^2$)
 - (a) $M_a = 68-2$ kNm (hogging) and $M_{\rm h} = 18.2 \text{ kNm} (\text{sagging})$
 - (b) $M_{a} = 18.2$ kNm (hogging) and $M_{\rm h} = 68.2 \text{ kNm} (\text{sagging})$
 - (c) $M_{2} = 68.2$ kNm (hogging) and $M_{\rm h} = 68.2 \text{ kNm} (\text{sagging})$
 - (d) $M_a = 18.2$ kNm (hogging) and
 - $M_{\rm b} = 18.2$ kNm (sagging)

107. Ans: (a)

Sol:



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108. A cable is suspended between two points, 75 m apart horizontally with its left end lower than the right end by 10 m. The cable supports a UDL of 5 kN/m along the horizontal span. What is the horizontal tension in the cable if central sag is 7.5 m? (a) 385.13 kN (b) 468.75 kN (c) 145.15 kN (d) 528.62 kN 108. Ans: (b) Sol: 108. Ans: (b) Sol: 109. Ans: (c) Sol: Steel Member have high strength per unit weight. Therefore, a steel member of a small section which has little self-weight is able to resist heavy loads. The high strength-oweight ratio is the most important property for the construction of long- span bridges, tall buildings and for buildings on soil with relatively low bearing capacities. 110. For a laced column, the minimum width of the lacing bars when using 20 mm ominal diameter rivets is (a) 65 mm (d) 50 mm (e) 55 mm (d) 50 mm 110. Ans: (b) Sol: Width of lacing $\leq 3 \times$ norminal diameter of rivets $3 \times 20 = 60$ mm 111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 129. K/m, inclusive of its own weight. 111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 129. K/m, inclusive of its own weight. 111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 129. K/m, inclusive of its own weight. 111. Ans: (b) Sol: M = ft $z_m = \frac{M}{g}$ $z_m = \frac{M}{g}$ $z_m = \frac{M}{g}$ $z_m = \frac{M}{g}$ $z_m = \frac{M}{g}$ Net with $z = 100 \times g^2 - 60^{-7.5} \times N-m$ $f = permissible bending stress = 0.66 f_y (As per WSM)$	Engineering Publications	30	Civil Engineering
110. For a laced column, the minimum width of the lacing bars when using 20 mm nominal diameter rivets is (a) 65 mm (b) 60 mm (c) 55 mm - (d) 50 mm (c) 55 mm - (d) 50 mm (l) 50! Width of lacing $x 3 \times nominal diameter of rivets 3 \times 20 = 60 \text{ mm}110. Ans: (b) Sol: Width of lacing x 3 \times nominal diameter of rivets 3 \times 20 = 60 \text{ mm}111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 kN/m, inclusive of its own weight.109. Consider the following statements related to merits of construction in structural steel :1. Structural steel has high strength per unit weight as compared to RCC.2. The steel members are slender or small in size as compared to RCC.3. The steel structures are useful in construction of tall buildings, long-span bridges and airplane hangars.VERPDeep Learn - India's Best Online Consting Platform for GATE, ESE, and PSUsExternDeep Learn - India's Best Online Consting Platform for GATE, ESE, and PSUsExtern$	 108. A cable is suspended between two points, 75 m apart horizontally with its left end lower than the right end by 10 m. The cable supports a UDL or 5 kN/m along the horizontal span. What is the horizontal tension in the cable if central sag is 7.5 m? (a) 385.13 kN (b) 468.75 kN (c) 145.15 kN (d) 528.62 kN 108. Ans: (b) Sol:		 Which of the above statements are correct ? (a) 1 and 2 only (b) 2 and 3 only (c) 1, 2 and 3 (d) 1 and 3 only 109. Ans: (c) Sol: Steel Member have high strength per unit weight. Therefore, a steel member of a small section which has little self-weight is able to resist heavy loads. The high strength-to-weight ratio is the most important property for the construction of long-span bridges, tall buildings and for buildings on soil with relatively low bearing capacities.
W SM) W SM Deep Learn - India's Best Online Coaching Platform for GATE, ESE, and PSUs Enjoy a smooth online learning experience in various languages at your convenience	 5 kN/m 5 m 6 m 7 m 9 m<!--</td--><td></td><td>110. For a laced column, the minimum width of the lacing bars when using 20 mm nominal diameter rivets is (a) 65 mm (b) 60 mm (c) 55 mm (d) 50 mm 110. Ans: (b) Sol: Width of lacing \lt 3× nominal diameter of rivets 3 × 20 = 60 mm 111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 kN/m, inclusive of its own weight. What is the section modulus of the beam, if $f_y = 250$ N/mm and $E = 2 \times 10^5$ N/mm² (Assume width of support is 200 mm) (a) 2612 × 10³ mm (b) 3682 × 10³ mm (c) 4682 × 10³ mm (d) 5124 × 10³ mm 111. Ans: (b) Sol: M = f z $z_{req} = \frac{M}{f}$ $M = \frac{w\ell^2}{8} = \frac{60 \times 9^2}{8} = 607.5$ kN-m f = permissible bending stress = 0.66 f_y (As per</td>		110. For a laced column, the minimum width of the lacing bars when using 20 mm nominal diameter rivets is (a) 65 mm (b) 60 mm (c) 55 mm (d) 50 mm 110. Ans: (b) Sol: Width of lacing \lt 3× nominal diameter of rivets 3 × 20 = 60 mm 111. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 kN/m, inclusive of its own weight. What is the section modulus of the beam, if $f_y = 250$ N/mm and $E = 2 \times 10^5$ N/mm ² (Assume width of support is 200 mm) (a) 2612 × 10 ³ mm (b) 3682 × 10 ³ mm (c) 4682 × 10 ³ mm (d) 5124 × 10 ³ mm 111. Ans: (b) Sol: M = f z $z_{req} = \frac{M}{f}$ $M = \frac{w\ell^2}{8} = \frac{60 \times 9^2}{8} = 607.5$ kN-m f = permissible bending stress = 0.66 f _y (As per
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 $\therefore z_{req} = \frac{607.5 \times 10^6}{0.66 \times 250} = 3681.8 \times 10^3 \text{ mm}^3$ $\simeq 3682 \times 10^3 \text{ mm}^3$

- 112. Consider the following statements related to batten plates :
 - 1. These normally consist of flat plates, connecting the components of the built-up columns in two parallel planes.
 - 2. These are used for triaxial loading.
 - 3. The design of battened columns and the design of battens are usually governed by IS code requirements.

Which of the above statements are correct?

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

112. Ans: (a)

- 113. Consider the following statements related to design of tension member with single structural shapes and plates :
 - 1. The common single structural shapes are angle sections, tee sections and channel sections.
 - 2. Single angles are not used for bracing, for light truss tension members.
 - 3. Occasionally, I sections are also used as tension members as they have more rigidity.

Which of the above statements are correct?

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

113. Ans: (a)

- 114. Consider the following statements regarding the advantages of a good organization :1. It increases cooperation and a feeling of freedom.2. It prevents duplication of work.
 - 3. It makes communication easier.
 - 4. It increases the likelihood of run-arounds.
 - Which of the above statements are correct?
 - (a) 1, 2 and 3 only (b) 2, 3 and 4 only
 - (c) 1, 3 and 4 only (d)1, 2 and 4 only

114. Ans: (a)

115. For design of a roof truss, if the design wind velocity is 20 m/s, what is the design wind pressure?

(a) 400 N/m^2 (b) 240 N/m^2 (c) 40 N/m^2 (d) 200 N/m^2

115. Ans: (b)

Sol: Design wind pressure = $0.6 V_{z}^{2}$

 $= 0.6 \times 20^2$ = 240 N/m²

where $v_z = design wind velocity$

116. Consider the following statements :

- 1. The working stress design is based on explicit consideration of the various conditions under which the structure may cease to fulfill its intended function.
 - 2. In case of working stress design, structure will directly take into consideration the various relevant modes of failure.
 - 3. In working stress method, regulatory bodies or classification societies usually specify the value of the allowable stress as some fraction of the mechanical properties of materials.

Which of the above statements is/are correct?

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

116. Ans: (d)



Civil Engineering

- 117. Consider the following statements regarding the working stress design method :
 - 1. Working stress design is based on the elastic theory.
 - 2. The working stress in the member should be less than the permissible stress .
 - 3. The permissible stress is the ratio of the factor of safety to the yield stress.
 - 4. The permissible stresses for fasteners are usually based on the ultimate strength of the connection.

Which of the above statements is/are not correct?

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

117. Ans: (b)

- 118. A steel cantilever beam is proposed to build into a concrete wall at one end and other end is free. It supports a dead load of 20 kN/m and a live load of 10 kN/m. The length of the beam is 5 m. What are the shear force and bending moment respectively ? (Take yield strength of steel as 250 N/mm²)
 - (a) 225 kN and 562.5 kNm
 - (b) 22.5 kN and 56.25 kNm
 - (c) 225 kN and 56.25 kNm
 - (d) 22.5 kN and 562.5 kNm

118. Ans: (a)

Sol: Factored load = $1.5 \times (20 + 10) = 45 \text{ kN/m}$ S.F = wL = $45 \times 5 = 225 \text{ kN}$

B.M =
$$\frac{wL^2}{2} = \frac{45 \times 5^2}{2} = 562.5$$
 kN-m

- 119. Consider the following for local section :
 - 1. Local section failure is usually encountered in the case of short stocky beam-columns with relatively smaller axial compression ratio and in reverse beam-columns bent curvature.

- 2. The strength of end section reached under combined axial force and bending, governs the failure.
- 3. The strength of the section may be governed by plastic buckling of plate elements in the case of plastic, compact and semi-compact sections.

Which of the above statements are correct?

(a) 1 and 2 only

(c) 1, 2 and 3

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

119. Ans: (a)

- 120. A tension member of a roof truss carries a factored load of 430 kN. By considering the strength in yield, what is the gross area required to carry this load ? (Consider Fe 250 grade steel)
 - (a) 1892 mm²
 (c) 1903 mm²

(b)1978 mm² (d) 2150 mm²

120. Ans: (a)

Since

- **Sol:** Considering yielding failure
- Design tensile strength in gross section Yielding $T_{dg} = \frac{A_g f_y}{\gamma_{mo}}$

$$\mathbf{A}_{\mathrm{g.reg}} = \frac{\mathbf{T}_{\mathrm{dg}}}{\left(\frac{\mathbf{f}_{\mathrm{y}}}{\gamma_{\mathrm{mo}}}\right)}$$

The member should be designed to resist Factored load of 430 kN

 $T_{dg} = 430 \text{ kN}$

$$A_{g,req} = \frac{430 \times 10^3}{\left(\frac{250}{1.1}\right)} = 1892 \text{ mm}^2$$



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- 121. Stirrup area in excess of that required for shear and torsion is provided along each terminated bar over a distance from the cut-off point equal to
 - (a) three-fourth the effective depth of the member.
 - (b) one-third the effective depth of the member.
 - (c) two-third the effective depth of the member
 - (d) one-fourth the effective depth of the member.

121. Ans: (a)

- **Sol:** As per IS : 456 -2000, clause 26.2.3.2, stirrups area in excess of that required for shear and torsion is provided along each terminated bar over a distance from cut off point equal to three fourths the effective depth of member.
- 122. Which one of the following is not a type of mortar ?
 - (a) Lime surkhi mortar
 - (b) Cement sand mortar
 - (c) Cement stone chips mortar
 - (d) Cement lime mortar

122. Ans: (c)

- **Sol:** Mortar is prepared by mixing binding material with fine aggregate and water. Since stone chips come under the category of coarse aggregate; cement and stone chips cannot form a mortar.
- 123. The grade of concrete and reinforcement are M-20 and Fe-250 respectively. Consider 25 mm diameter bars and Tod is 1.2. What is the development length at support for a simply supported beam of a rectangular section ?

(a) 1133 mm	(b) 1033 mm
(c) 1321 mm	(d) 1232 mm

123. Ans: (a)

Sol: Development length at simple support

$$L_{d} = \frac{\phi \sigma_{st}}{4\tau_{bd}}$$
$$= \frac{25 \times 0.87 \times 250}{4 \times 1.2} = 1133 \text{ mm}$$

- 124. In a singly reinforced beam, for given grade of concrete, permissible bond stress in deformed bars(a) is lesser than that of plain bars.
 - (b) is equal to that of plain bars.
 - (c) may be greater than or smaller than that of plain bars.
 - (d) is greater than that of plain bars.

124. Ans: (d)

Sol:

- As per IS : 456 2000, For deformed bars, the bond stress as compared to mild steel is increased by 60 percent.
- 125. The safe load carried by the helically reinforced column is
 - (a) 1.05 times the load carried by the similar column with ties.
- (b) 2.15 times the load carried by the similar column with ties.
 - (c) 1.15 times the load carried by the similar column with ties.
 - (d) 2.05 times the load carried by the similar column with ties.

125. Ans: (a)

Sol:

The load carrying capacity of helically reinforced is 1.05 times the load carrying capacity of the tied column. It is because of triaxial compression inside the core of helically reinforced column.



- 126. Nominal cover to reinforcement is provided to
 - 1. protect reinforcement against corrosion.
 - 2. provide shear resistance.
 - 3. protect reinforcement against fire.

4. develop sufficient bond strength along surface area of reinforcement bars.

Which of the above statements are correct?

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

126. Ans: (c)

Sol:

The following are functions of nominal cover to the reinforcement.

It will protect the steel against corrosion, fire accidents and adverse environmental effects.

It will help to develop full bond stresses between steel and concrete.

127. In slab design, ratio of maximum diameter of reinforcing bars to the total thickness of slab should not be more than

(a) 1/12 (b) 1/6 (c) 1/8 (d) 1/7

127. Ans: (c) Sol:

As per IS : 456 - 2000, clause 26.5.2.2 The maximum dia of reinforcing bars shall not exceed one eight of the total thickness.

- 128. To prevent cracking of edges, the corners in two way slabs are provided with
 - (a) shear reinforcement
 - (b) torsion reinforcement
 - (c) tensile reinforcement
 - (d) compression reinforcement

128. Ans: (b)

Sol:

In two way slabs, if corners are held down then torsional moment will develop which create cracks at edge of slab. To prevent this, torsion steel shall be provided.

- 129. Critical section for two way shear in case of isolated footing design is at
 - (a) the face of column.
 - (b) effective depth from the face of column.
 - (c) half of the effective depth from the face of column.
 - (d) two-third of the effective depth from the face of column.

129. Ans: (c)

Sol: As per IS : 456 -2000, clause 34.2.4.1 (b) The critical section for two way shear lies at a distance $\frac{d}{2}$ from the face of column.

- 130. Accepted relationship between tread and riser in case of staircase design is
 - (a) Riser \times Tread = 60,000 mm
- 100 (b) $2 \times \text{Riser} + \text{Tread} = 600 \text{ mm}$
 - (c) Riser + Tread = 600 mm
 - (d) $2 \times \text{Tread} + \text{Riser} = 600 \text{ mm}$

130. Ans: (b)

Sol:

Since

In the design of staircases the accepted relationship between riser and tread is $550 \text{ mm} \le 2R + T \le 700 \text{ mm}$

- 131. Loss of pre-stress is *not* directly related to(a) creep of concrete.
 - (b) shrinkage of concrete.
 - (c) grade of concrete.
 - (d) slipping of steel tendons from concrete.





131. Ans: (d)

Sol:

It is assumed that there is perfect bond between concrete and tendon, so there is no chance of slipping of tendon from concrete.

- 132. Which one of the following statements is the disadvantage of post-tensioning method
 - (a) The loss of pre-stress is less as compared to pre-tensioning system.
 - (b) Post-tensioning method is costly as compared to pre-tensioning method.
 - (c) Post-tensioning can be done in factories and at the site also.
 - (d) Post-tensioning method is used for large spans and heavily loaded structures.

132. Ans: (b)

- Sol: The cost of pretensioning system is generally small as compared to the cost of post tensioning system. This is due to larger amount of labour required in placing, stressing and grouting post tensioned tendons and cost of metal sheathing, spacers, special anchorage devices and jacks which are required in post tensioning.
- 133. What is the main limitation of bar chart ?
 - (a) It does not help in material and labour planning.
 - (b) It does not show all the activities of a project.
 - (c) It does not indicate critical activities of a project.
 - (d) Project duration cannot be estimated.

133. Ans: (c)

Sol: Bar chart does not shown (indicate) critical activity.

- 134. Graders are not suitable for
 - (a) levelling of earthwork.
 - (b) cutting ditches.
 - (c) working on steeper slopes.
 - (d) heavy excavation.

134. Ans: (d)

Sol:

Graders are not suitable for heavy excavation, have limited traction on account of rubber tires rather than track chain. Grader does not have dipper to excavate heavy loose material. Its construction features performs grading and leveling. They found in road formation works, create base for paved roads, cutting drainage ditches, create inclines, remove snow, finish grading, mix and spread materials, high bank cutting et.

Heavy excavation needs Power Shovels & Back Hoe etc.

- 135. Line of Balance technique is
 - (a) modified bar chart.
 - (b) planning of repetitive activities of project.
 - (c) modified form of PERT.
 - (d) used for planning milestones of project.

135. Ans: (b)

- **Sol:** Line-of-balance (LOB) technique is suited for planning of repetitive activity of a project.
- 136. Which one of the following statements is not correct in respect of drawing network ?
 - (a) No activity can start until its tail event has occurred.
 - (b) An event cannot occur twice.
 - (c) Length of arrow should be in proportion to the time consumed by that activity,
 - (d) The number of arrows should be equal to the number of activities in the project.

136. Ans: (c)

Sol: Length of arrow has no significance in a networks



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137. A-O-N system of network

- (a) completely eliminates the use of dummy activities.
- (b) requires judicious use of dummy activities.
- (c) does not distinctly show pre-operation and post-operation of the activities.
- (d) is not suitable for projects with large number of activities.

137. Ans: (a)

Sol:

AON diagram does not require dummy activity.

- 138. Which one of the following types of cost-plus contracts allows the amount of the re-reimbursement to increase if the contractor's cost increases ?
 - (a) Cost-plus award fee contract
 - (b) Cost-plus incentive fee contract
 - (c) Cost-plus fixed fee contract
 - (d) Cost-plus percentage fee contract

138. Ans: (d)

- **Sol:** Cost plus percentage rate contract has a provision to allow the extra amount incurred during the project execution. The contractor is paid actual cost of the work plus an agreed percentage to allow the profit.
- 139. Number of bricks required for 15 cu.m of brickwork

is approximately

(a) 6750	(b) 7200
(c) 7500	(d) 6000

139. Ans: (c)

Sol: The nominal size of a brick with mortar is $20 \times 10 \times 10$ cm. Number of bricks required for 1 cubic meter of brick masonry = $\frac{1}{0.2 \times 0.1 \times 0.1} = 500$ bricks. Therefore, the number of bricks required for 15 cubic meters of brick masonry is $15 \times 500 = 7500$ Bricks.

- 140. The plinth area of a building does not include area of
 - (a) the walls at the floor levels.
 - (b) internal shaft for sanitary installations upto 2 sq.m area.
 - (c) lifts.
 - (d) cantilevered porches.

140. Ans: (d)

Sol: Plinth area is calculated by taking the external dimensions of the building at floor level

Excluding:

- (i) Corut yard/open area
- (ii) Cantilever porch
- (iii) Area of lofts
- (iv) Open stair cases
- (v) Architectural features like cornice
- (vi) If shaft opening area $A > 2m^2$
- (vii) Head room at terrace level
- (viii) lift machine room
- (ix) plinth off sets
- (x) Towers projecting above terrace.

Included:

(i) walls of covered area
(ii) Galleries
(iii) Mossaic floor
(iv) greed stair case
(v) supported porch
(vi) If shaft area ≤ 2m²



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141. Which one of the following statements is not correct

- (a) The circulation area of any floor includes entrance halls.
- (b) Floor area of a building includes area of sills of doors and other openings.
- (c) Cube rate estimate of a building is more accurate as compared to plinth area estimate.
- (d) The preliminary estimate for water supply and sewerage project can be prepared on the basis of per head of population served.

141. Ans: (b)

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Sol:

1. Option (b) is not correct statement

Floor area = Plinth area - Wall area other items to be excluded are:

- Openings
- Internal columns (pillage)
- Pilasters (pillar abutting walls) > 300 cm²

2. Option (a) is correct statement

Circulation Area

- Horizontal circulation : Verandahs, balconies, passages
- Vertical circulation : lifts, stair cases entrance halls

3. Option (c) correct statement

Increasing order of accuracy of preliminary methods of elimation is service rate/unit rate method, plinth area method, cube rate method elemental bill method.

4. Option (d) correct statement:

Approximate method of water supples sewage project based on per head of population.

Hospitals / Hotels based on per head.

Restaurants on the basis of tables.

- 142. Consider the following statements regarding the advantages in Line or Military Organization of management technique :
 - 1. The command and control is very effective.
 - 2. It is simple to work and easily understood by the employees.
 - 3. Responsibilities in all levels are definite and fixed.
 - 4. The organization is rigid.

Which of the above statements are correct?

- (a) 1, 2 and 3 only (b) 2, 3 and 4 only (c) 1, 2 and 4 only (d) 1, 3 and 4 only
- 142. Ans: (a)

Sol:

"The organisation is rigid", is the major drawback of line (or) Militany type Organisation

- 143. Project manager rich of the following
 - 1. Project work-breakdown structure verification and the relevance.
 - 2. Risk identification, cost, levels and security
 - 3. Measurements of risk impacts.
 - Select the correct answer using the code given below
 - (a) 1 and 2 only (b) 2 and 3 only (c) 1, 2 and 3 (d) 1 and 3 only

143. Ans: (c)

- 144. Consider the following statements regarding inspection and quality control :
 - 1. Coefficient of variation is a relative measure of dispersion.
 - 2. Standard deviation is the root mean square of the deviation of all the results.
 - 3. Standard deviation is relative measure of dispersion.

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- Lower value of standard deviation indicates 4 low degree of uniformity of observations.
- Which of the above statements are correct? (b) 2 and 3 only
- (a) 1 and 4 only (a)(d) 2 and 4 only
- (c) 1 and 2 only

144. Ans: (c)

Sol:

- Coefficient of variation is a relative measure 1. of dispersion around the mean (correct statement)
- Standard deviation (σ) is known as root-mean 2. square deviation (correct statement)
- Standard deviation is a relative measure of 3. average depression where as coefficient of standard deviation $\left(\frac{\sigma}{\text{mean}}\right)$ is a measure of relative depression.
- Lower value of standard deviation : More 4. uniformity High value of standard deviation : Less Since uniformity

Directions : Each of the next six (06) items const of two statements, one labelled as the 'Statement (I) and the other as 'Statement (II). You are to examine these two statements carefully and select the answer 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 Statement (1)
- (b) Both Statement (1) and Statement((II) are individually true, but Statement (II)is not the correct explanation Statement (I)

- (c) Statement (D) is true, but Statement (II) is false
- (d) Statement (I) is false, but Statement (II) is true
- 145. Statement (I): The theoretical strength of concrete as per Gel-Space ratio theory is less than the actual strength of concrete.

Statement (II) : In the Gel-Space ratio theory, it has bee assumed that the concrete is perfectly homogeneous and flawless.

145. Ans: (d)

- Sol: Gel-space ratio theory assumes that the concrete is perfectly homogeneous and flawless. However, the cement paste in concrete contains many discontinuities such as voids, fissures, bleeding channels, rupture of bond due to drying shrinkage and temperature stresses etc. Because of these flaws and discontinuities, the actual strength of the concrete comes out to be less than the theoretical strength of concrete calculated using gel-space ratio theory.
- 146. Statement (I): Spur length is kept longer than 1-5 to 2 times the depth of flow.

Statement (II) : Shorter spur length in deeper rivers induce swirling motion on both the upstream and downstream sides of the spur.

146. Ans: (a) Sol:

Spurs (also known as spur dikes, groynes or transverse dikes) are generally made of locally available earth material in the form of an embankment constructed transverse to the flow extending from one of the river banks into the river. Spur length is kept longer than 1.5 to 2 times the depth of flow, and is usually restricted to less than 20% of the river width.

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147. **Statement (I):** Both the Empirical formulae given by American Insurance Association and Buston for the determination of fire demand of water are not suitable for Indian conditions.

Statement (II) : Kuichling's formula estimates lesser value of fire water demand.

147. Ans: (d)

Sol:

Kuichlings formula give lesser value of fire demand compared to other empirical formula. For Indian condition as per code GOI formula is used.

148. Statement (I): For the design of slender column, additional moments are required to be considered. Statement (II): Lateral deflection of slender columns, under axial load, is substantial and causes additional moments.

148. Ans: (a)

Sol:

When a short column is loaded even with an axial load, the lateral deflection is either zero (or) very small. In contrast to this when a slender column is loaded even with an axial load, the lateral deflection Δ , measured from the original centre line along its length, becomes appreciable.

This makes axial load eccentric at the central section of the column by a value Δ . subjecting the section to a BM equal to $P_u \Delta$ in addition to axial load.

Hence separate consideration of this additional BM has to be made.

149. **Statement (I):** To achieve maximum value for minimum radius of gyration of compression members, without increasing the area of the section, a number of elements are placed away from the principal axis using suitable lateral systems.

Statement (II) : Batten shall be placed at 40 to 70" to the axis of built-up members.

149. Ans: (c)

Sol: For economical design of heavily loaded long columns the least radius of gyration of column section is increased to maximum $(r_y \ge r_z)$. To achieve this condition the rolled sections are kept away from the centroidal axis of the column and are connected by some connecting system known as Lattice System. So this statement (I) is correct.

Lacing bars, whether is double or single systems, shall be inclined at any angle not less then 40° nor more than 70° to the axis of the built up member. Batten shall be placed in the transverse direction. So statement (II) is incorrect.

150. **Statement (I):** Chain surveying is that type of surveying in which only linear measurements are made in the field.

Statement (II) : Traversing is that type of survey in which a number of connected survey lines from the framework and the directions and lengths of the survey lines are measured with the help of an angle measuring instrument and a tape respectively.

150. Ans: (b) Sol:

Statement I and II are true but statement II is not the correct explanation of statement I.



