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ESE - 2016

CIVIL ENGINEERING PAPER - 1 (OBJECTIVE)

QUESTIONS WITH DETAILED SOLUTIONS

SET - A

NAME OF THE SUBJECT	NO. OF QUESTIONS
BUILDING MATERIALS	12
STRUCTURAL ANALYSIS	11
DESIGN OF STEEL STRUCTURES	09

NAME OF THE SUBJECT	NO. OF QUESTIONS
SOLID MECHANICS	26
DESIGN OF CONCRETE & MASONRY STRUCTURES	33
CONSTRUCTION PRACTICE, PLANNING AND MANAGEMENT	29

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01. Consider the following statements:
1. There will be no defects in select grade timbers.
2. The codal values for strength of grade-II timber without defects may be reduced by 37.5%
3. For timber used as columns, the permissible stress in ungraded timbers is adopted with a multiplying factor of 0.50.
4. In case of wind force and earthquakes a modification factor of 1.33 is adopted.

Which of the above statements are correct?

01. Ans: (b)

02. Consider the following statements regarding timber:
1. The strength of timber increases by Kiln seasoning.
2. Cutting of wood is to be done prior to treatment.
3. Water seasoning is good for prevention of warping.
4. ASCU treatment enhances the strength of wood.

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, 3 and 4

02. Ans: (a)

Sol: ASCU treatment cannot enhance hardness or density of wood. Therefore there is no enhancement to strength.

Statement -4 is false

The only option without (4) is (a)

03. Gase(s) emitted during rotting or decomposition of timber is/are mainly
(a) Methane and Hydrogen
(b) Hydrogen Sulphide
(c) Carbonic acid and Hydrogen
(d) Ammonia

03. Ans: (c)

04. Efflorescence of bricks is due to
(a) Excessive burning of bricks
(b) High silt content in brick clay
(c) High porosity of bricks
(d) Soluble salts present in parent clay

04. Ans: (d)

05. Disintegration of brick masonry walls is primarily due to
1. Efflorescence
2. Magnesium sulphate in bricks
3. Calcined clay admixtures
4. Kankar nodules

Which of the above statements are correct?

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

05. Ans: (d)

06. Consider the following tests:
1. Transverse strength test
2. Water absorption test
3. Impact test
4. Breaking strength test

Which of the above are relevant to testing of tiles?

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

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

06. Ans: (d)

07. Which of the following statements is/are correct regarding the strength of cement?

1. Particle sizes less than 3 μm increase the viscous nature of the cement.
2. Finer particles in cement can be replaced by fly-ash to improve the strength.

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

07. Ans: (c)

08. The constituent compound in Portland cement which reacts immediately with water, and also sets earliest, is

(a) Tricalcium silicate

(b) Dicalcium silicate

(c) Tricalcium aluminate

(d) Tetracalcium aluminoferrite

08. Ans: (c)

Sol: The reaction of pure C_3A with water is very rapid which may lead to a flash set.

(or)

When water is added, C_3A is the first to set and harden.

09. Which of the following statements are correct with regard to cement mortar?

1. Workability of cement mortar can be improved by addition of lime
2. Fly-ash cement is economical in plastering jobs.
3. Addition of saw dust improves workability
4. Sand in mortar can be replaced by finely crushed fire bricks.

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

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

09. Ans: (d)

10. In a concrete mix of proportion 1 : 3 : 6, the actual quantity of sand, which is judged to have undergone 15% bulking, per unit volume of cement, will be

(a) 3.00 (b) 3.45

(c) 4.50 (d) 6.00

10. Ans: (b)

11. The Rheological behaviour of concrete, when represented by shear stress vs rate of shear, is characterized as

(a) $\tau = \tau_0 + \mu.\dot{\gamma}$ (b) $\tau_0 = \tau + \mu.\dot{\gamma}$

(c) $\frac{\tau}{\tau_0} = \mu.\dot{\gamma}$ (d) $\tau = \mu.\dot{\gamma}$

Where:

τ = Shear stress,

τ_0 = (initial) yield value,

μ = at-point plastic viscosity,

$\dot{\gamma}$ = at-point rate of shear.

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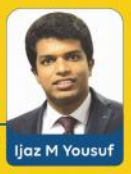
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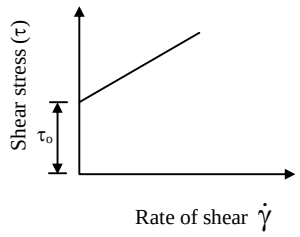
11. Ans: (a)

Sol:



$$\tau = \tau_o + \mu.\dot{\gamma}$$

12. Which method of curing of concrete is recommendable for rapid gain of strength of concrete?

(a) Sprinkling water
(b) Membrane curing
(c) High-pressure steam curing
(d) Infrared radiation curing

12. Ans: (d)

13. Which of the following is appropriate as a simple field method for assessing consistency of concrete?

(a) Compacting factor (b) Slump test
(c) Vee-Bee test (d) Kelly Ball test

13. Ans: (b)

Sol: Slump test is most commonly used method of measuring consistency at site of work or in laboratory.

14. Which of the following are relatable to Autoclaved Aerated Concrete?

1. Light Weight 2. Strong
3. Inorganic 4. Non-toxic

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

14. Ans: (d)

15. The workability of concrete becomes more reliable depending on

1. Aggregate-cement ratio
2. Time of transit
3. Grading of the aggregate

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

15. Ans: (d)

Sol: Workability depends on water content, aggregates type and grading, aggregate/cement ratio, presence of admixtures and fineness of cement.

There are two other factors which affects the workability: Time and temperature.

As aggregate/cement ratio increases, workability reduces.

16. The longitudinal strain of a cylindrical bar of 25 mm diameter and 1.5 m length is found to be 3 times its lateral strain in a tensile test. What is the value of Bulk Modulus by assuming $E = 1\times10^5\ N/mm^2$?

(a) $2\times10^5\ N/mm^2$
(b) $1.1\times10^5\ N/mm^2$
(c) $1\times10^5\ N/mm^2$
(d) $2.1\times10^5\ N/mm^2$

16. Ans: (c)

Sol: **Given:**

d = 25 mm, l = 1.5 m

$\varepsilon_l = 3(\varepsilon_{lat})$

$$\mu = \frac{\varepsilon_{lat}}{\varepsilon_{lon}} = \frac{1}{3}$$

$E = 1\times 10^5$ N/mm^2

$E = 3K(1 - 2\mu)$

$$1\times10^5 = 3K\left(1-2\times\frac{1}{3}\right)$$

$$1\times10^5 = \frac{3}{3}K$$

$K = 1 \times 10^5$

Note: If $\mu = \frac{1}{3}$ K = E

If this point is known answer can be directly picked - up

17. For an elastic material, Poisson's ratio is μ, Modulus of Elasticity is E, Modulus of Rigidity is C and Bulk Modulus is K. μ is expressible in terms of K and C as

(a) $\frac{6K-2C}{3K-2C}$ (b) $\frac{6K+2C}{3K-2C}$

(c) $\frac{3K-2C}{6K+2C}$ (d) $\frac{3K+2C}{6K+2C}$

17. Ans: (c)

Sol: $\mu = \frac{3K-2C}{6K+2C}$

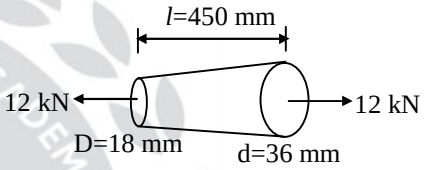
18. A mild steel bar of length 450 mm tapers uniformly. The diameters at the ends are 36 mm and 18 mm, respectively. An axial load of 12 kN is applied on the bar. $E = 2\times10^5\,N/mm^2$. The elongation of the bar will be

(a) $\frac{1}{3\pi}$ mm (b) $\frac{1}{6\pi}$ mm

(c) $\frac{3\pi}{2}$ mm (d) $\frac{2}{3\pi}$ mm

18. Ans: (b)

Sol:



$$\delta\ell = \frac{4P\ell}{\pi E.D.d} = \frac{4\times12\times10^3\times450}{\pi\times2\times10^5\times36\times18}$$

$$= \frac{1}{6\pi}\text{ mm}$$

19. Which of the following statements are correct for stresses acting on mutually perpendicular faces of a plane element?

1. The sum of the normal stresses in mutually perpendicular planes is equal to the sum of the principal stresses.
2. The shearing stresses in two mutually perpendicular planes are equal in magnitude and direction.
3. Maximum shear stress is half of the difference between principal stresses.

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

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

19. Ans: (d)

Sol: 1 – True

2 – False

True statement is the shearing stresses on two mutually perpendicular planes are equal in magnitude and opposite in direction.

The options without -2 is (d)

20. Which of the following statements are correct?

1. Strain in the direction of applied stress is known as longitudinal strain.
2. Tensile stress results in tensile strain in linear and lateral directions
3. Strains in all directions perpendicular to the applied stress are known as lateral strain.
4. Ratio of change in volume to original volume is known as volumetric strain.

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

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

20. Ans: (b)

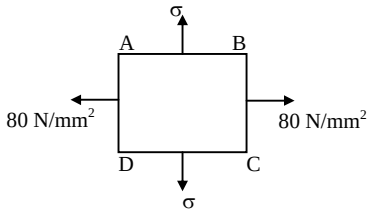
Sol: 1 – True

2 – False

3 – True

4 – True

21. The state of stress on an element is as shown in the figure. If $E = 2 \times 10^5$ N/mm^2 and Poisson's ratio = 0.3, the magnitude of the stress σ for no strain in BC is



(a) 84 N/mm^2 (b) 64 N/mm^2

(c) 34 N/mm^2 (d) 24 N/mm^2

21. Ans: (d)

Sol: Given:

Strain in BC = 0 (i.e $\varepsilon_y = 0$)

$$\varepsilon_y = 0 = \frac{\sigma_y}{E} - \mu\frac{\sigma_x}{E}$$

$$0 = \frac{\sigma}{E} - 0.3\frac{80}{E}$$

$\sigma = 0.3 \times 80 = 24$ MPa

22. In the cross-section of a timber, cambium layer can occur in

(a) Inner Bark and Sap Wood

(b) Pith and Heart Wood

(c) Sap Wood and Heart Wood

(d) Outer Bark and Sap Wood

22. Ans: (a)

Sol: Cambium layer occurs between inner bark and sap wood

23. Consider the following statements:

1. In the infinitesimal strain theory, dilatation is taken as an invariant.
2. Dilatation is not proportional to the algebraic sum of all normal stresses.
3. The shearing modulus is always less than the elastic modulus.

Which of the above statements is/are correct?

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

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

23. Ans: (d)

Sol: 3-True

It is known that shearing modulus is always less than elastic modulus.

Statement-3 is true. The only option with statement 3 is (d).

24. Which one of the following represents 'constitutive relationship'?

(a) Vertical displacements in a structure

(b) Rotational displacements in a structure

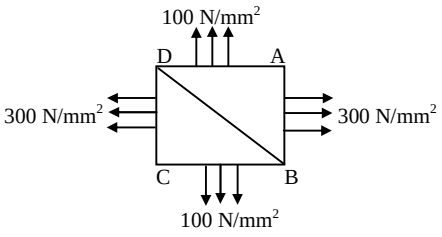
(c) System of forces in equilibrium

(d) Stress-strain behaviour of a material

24. Ans: (d)

Sol: Constitutive relationships are stress-strain behaviour of structures.

25. A square element of a structural part is subjected to biaxial stresses as shown in the figure. On a plane along BD, the intensity of the resultant stress due to these conditions will be



(a) $25\sqrt{5}$ N/mm^2 (b) $50\sqrt{5}$ N/mm^2

(c) $75\sqrt{5}$ N/mm^2 (d) $100\sqrt{5}$ N/mm^2

25. Ans: (d)

Sol: $\sigma_x = 300$ N/mm^2 ; $\sigma_y = 100$ N/mm^2

$$\sigma_{(\theta=45^o)} = \frac{300+100}{2} + \frac{300-100}{2}\cos(90^o)$$

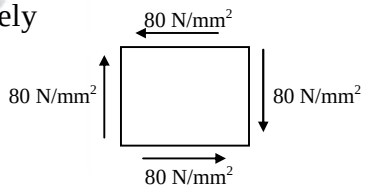
$(\because \cos 90^o = 0)$

$\sigma_{45^\circ} = 200$ MPa

$$\tau_{45^\circ} = \frac{300-100}{2}\sin(90^o) = 100\,\text{MPa}$$

$$\sigma_R = \sqrt{200^2+100^2} = 100\sqrt{5}\,\text{MPa}$$

26. A structural element is subjected to pure shear of 80 N/mm^2, as shown in the figure. The yield stresses both in tension and in compression are 240 N/mm^2. According to the maximum normal stress theory, the factors of safety in tension and compression are, respectively



(a) 2 and 2 (b) 2.5 and 2.5

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

26. Ans: (c)

Sol: $\tau_{max} = 80$ N/mm^2

$\sigma_1 = \sigma_2 = 80$ MPa

Yield stress, $f_y = 240$ MPa

$$\text{Factor of safety, } FS = \frac{f_y}{\sigma_1} = \frac{240}{80} = 3$$

In both tension and in compression FS = 3

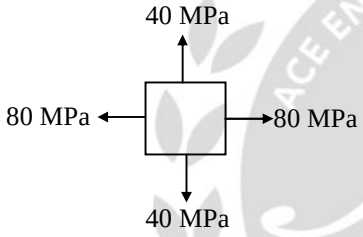
27. Principal stresses at a point are 80 N/mm^2 and 40 N/mm^2, both tensile. The yield stress in simple tension for this material is 200 N/mm^2. The values of factors of safety according to maximum principal stress theory and maximum shear stress theory, respectively, are

(a) 2.5 and 2.5 (b) 2.5 and 5

(c) 5 and 5 (d) 5 and 1.67

27. Ans: (b)

Sol:



f_y = 200 MPa; σ_1 = 80 MPa, σ_2 = 40 MPa

As per maximum principal stress theory

$$\sigma_1 = \frac{f_y}{FS} \Rightarrow FS = \frac{f_y}{\sigma_1} = \frac{200}{80} = 2.5$$

As per maximum shear stress theory

$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2} = \frac{f_y}{2(FS)}$$

$$\frac{80-40}{2} = \frac{200}{2(FS)}$$

$\therefore$ FS = 5

28. The principal stresses at a point are 2σ (tensile) and σ (compressive), and the stress at elastic limit for the material in simple tension is 210 N/mm^2. According to maximum shear strain theory, the value of σ at failure is

(a) 70 N/mm^2 (b) 105 N/mm^2

(c) 140 N/mm^2 (d) 210 N/mm^2

28. Ans: (a)

Sol: As per maximum shear strain energy theory Ans. is 80 MPa

Considering maximum shear strain for failure

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2}$$

Shear strain, $\phi_{max} = \frac{\tau_{max}}{G} \not> \frac{f_y}{2G}$

$$\frac{2\sigma - (-\sigma)}{2G} = \frac{f_y}{2G}$$

$$3\sigma = 210$$

$$\sigma = 70 \text{ MPa}$$

29. A thin steel ruler having its cross-section of 0.0625 cm × 2.5 cm is bent by couples applied at its ends so that its length *l* equal to 25 cm, when bent, as a circular arc, subtends a central angle θ = 60^o. Take E = 2 × 10^6 kg/cm^2. The maximum stress induced in the ruler and the magnitude is

(a) 2618 kg/cm^2 (b) 2512 kg/cm^2

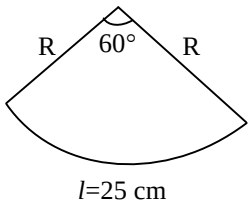
(c) 2406 kg/cm^2 (d) 2301 kg/cm^2

29. Ans: (a)

Sol: l = 25 cm

θ = 60°

E = 2× 10^6 kg/cm^2



l=25 cm

$l = R\theta$

$$25\,\text{cm} = (R)\left(60 \times \frac{\pi}{180}\right)$$

R = 23.87 cm

$$\frac{E}{R} = \frac{f_{max}}{y_{max}}$$

$$\left[\because y_{max} = \frac{\text{thickness}}{2} = \frac{0.0625}{2}\right]$$

$$\frac{2\times10^6}{23.87} = \frac{f_{max}}{\left(\frac{0.0625}{2}\right)}$$

f_{max} = 2618 kg/cm^2

30. Which of the following statements are correct?
    1. Cranes are employable in moving and/or hoisting loads.
    2. With the use of dipper and stick power shovels can be used as hoes.
    3. Overdrive for higher speeds is a facility often used comfortably in the working of a tractor
    4. Clamshells are less desirable than draglines if the material is water-saturated.

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

30. Ans: (a)

Sol: õ Cranes are used to hoist and move loads from one location to another location.

- Dipper stick is a main component of power shove to push excavate in frontal action. It cannot be used in back hoe excavator.
- Over drive gear box mechanism allows the tractor to move at lower speeds leads to fuel economy, lower noise etc.
- Dragline excavator is used when material must be excavated from underwater.
- Clam shell excavator provides the excavate and handle vertically to considerable heights/depths.

Statement (1) and Statement (4) are correct only.

Statement (2) and statement (3) are incorrect.

31. Two similar bars of steel and Aluminium are heated to a same temperature. Forces are applied at the ends of the bars to maintain their lengths unaltered. If the ratio of Young's modulii of Steel and Aluminium is 3, and the ratio of the coefficients of thermal expansion of steel to that of Aluminium is 0.5, what is the stress on the Aluminium bar if the stress on the Steel bar is 100 MPa?

    (a) 16.7 MPa (b) 66.7 MPa
    (c) 136.7 MPa (d) 150.0 MPa

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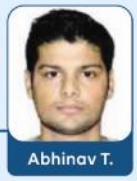
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6 EE Anos Feroz


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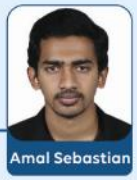
7 EE Amal Sebastian


8 ME Sreenihar


8 EE Sachin


9 E&T Shruthi


9 ME Chaitanya


9 EE Sudhakar


9 EE Vishal rathi


10 CE Aishwarya Alok

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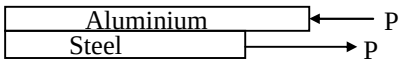
31. Ans: (b)

Sol: $\frac{E_s}{E_a} = 3; \frac{\alpha_S}{\alpha_a} = 0.5$

σ_s = 100 MPa, σ_a = ?



To have no change in length

$\delta l_a = (l\ \alpha\ t)_a = \frac{\sigma_{a\ell}}{E_a}$

$\sigma_S = (E\alpha t)_s \rightarrow (1)$

Similarly $\sigma_a = (E\ \alpha t)_a \rightarrow (2)$

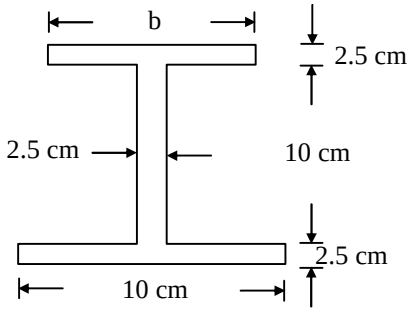
Dividing (2)/(1)

$\frac{\sigma_a}{\sigma_s} = \frac{E_a \alpha_a t}{(E_s)(\alpha_s)(t)}$

$\frac{\sigma_a}{100} = \left(\frac{1}{3}\right)\left(\frac{1}{0.5}\right)$

$\sigma_a = \frac{200}{3} = 66.67$ MPa

32. In order that the extreme fibre stresses in bending will be in th ratio 4 : 3 in the beam shown in the following figure, the width b of the upper flange (b < 10 cm) of the beam section is to be

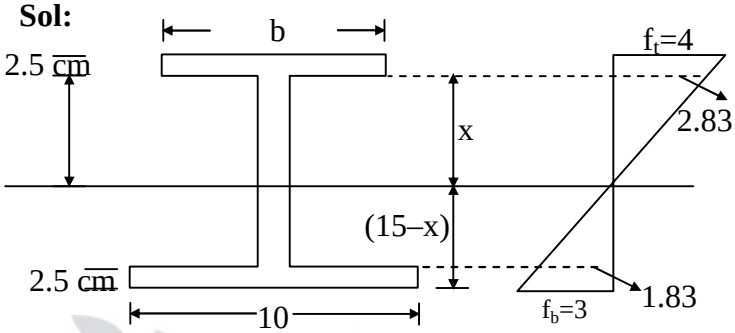


(a) 6.1 cm (b) 6.6 cm

(c) 5.1 cm (d) 5.6 cm

32. Ans: (d)

Sol:



$\frac{f_t}{f_b} = \frac{4}{3} = \frac{x}{(15-x)}$

4(15–x) = 3(x)

60 – 4x = 3x

7x = 60

x = 8.57 cm

(15–x) = 6.43

Compressive force = Tensile force

$b \times 2.5\left[\frac{4+2.83}{2}\right] + \frac{2.83}{2}[6.07 \times 2.5]$

$= 10 \times 2.5\left[\frac{3+1.83}{2}\right] + \left[\frac{1.83}{2}\right][3.93 \times 2.5]$

$= \frac{60.375 + 8.989 - 12.12}{8.53}$

b = 5.609 cm

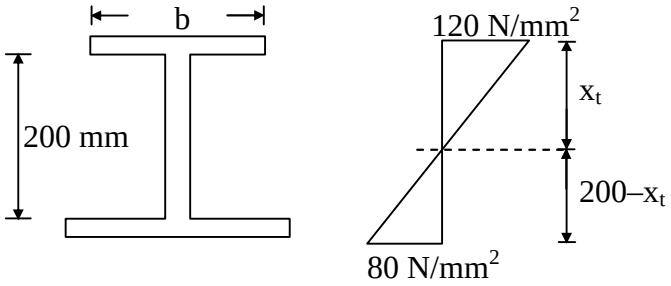
33. A structural steel beam has an unsymmetrical I-cross-section. The overall depth of the beam is 200 mm. The flange stresses at the top and bottom are 120 N/mm^2 and 80 N/mm^2, respectively. The depth of the neutral axis from the top of the beam will be

(a) 120 mm (b) 100 mm

(c) 80 mm (d) 60 mm

33. Ans: (a)

Sol:



Let x_t – Depth of N.A from top

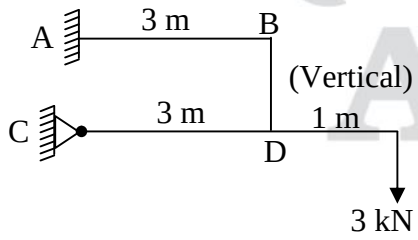
$$\frac{120}{x_t} = \frac{80}{200 - x_t}$$

$600 - 3x_t = 2x_t$

$5x_t = 600$

$$\Rightarrow x_t = \frac{600}{5} = 120 \text{ mm}$$

34. The bending moment at A for the beam shown below (with BD being a rigid bar) is

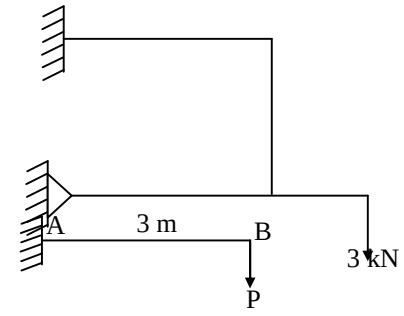


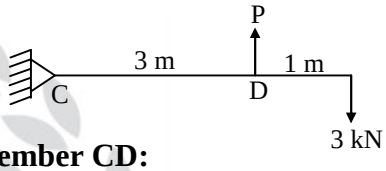
(a) Zero (b) 12 kN-m

(c) 8 kN-m (d) 6 kN-m

34. Ans: (b)

Sol:





On member CD:

$\sum M_c = 0$

$3(4) = P(3)$

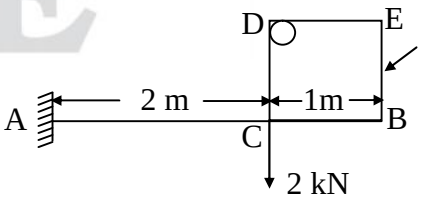
$P = 4$ kN

On member AB:

$M_A = P(3)$

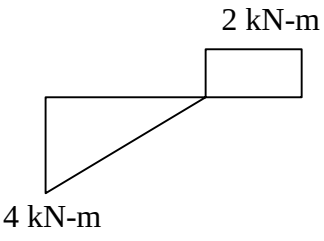
$M_A = 4 \times 3 = 12$ kN-m

35. The bending moment diagram for the beam shown below is

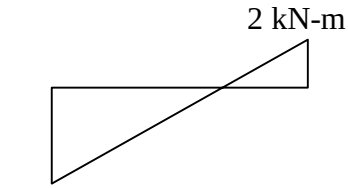


(Rope tied at B, turned at fixed point E, and on pulley at D)

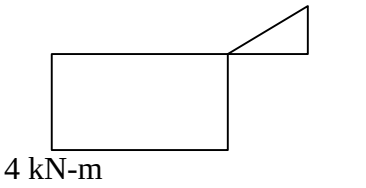
(a)



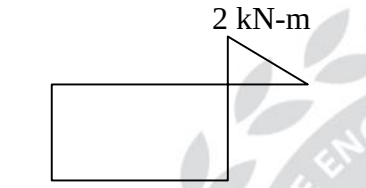
(b)



(c)



(d)



35. Ans: (d)

36. A circular shaft rotates at 200 rpm and is subjected to a torque of 1500 Nm. The power transmitted would be

(a)10 π kW (b) 15 π kW

(c) 20 π kW (d) 30 π kW

36. Ans: (a)

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

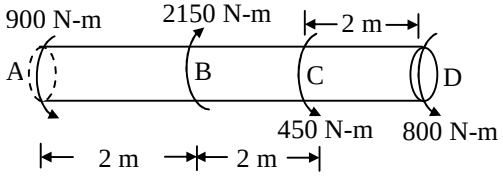
$= \frac{2\pi(200)(1500)}{60}$

$= 10000\ \pi$ N-m/s

$= 10\pi$ kN-m/s

$= 10\pi$ kW

37. Torques are transmitted to the solid circular shaft as shown in the figure below. If the corresponding permissible stress in the shaft is 60 N/mm^2, the diameter of the shaft is nearly.



(a) 57.3 mm (b) 47.5 mm

(c) 37.3 mm (d) 27.3 mm

37. Ans: (b)

Sol: Maximum torque in the shaft is

T_{AB} = 900 N-m

T_{BC} = 1250 N-m

T_{CD} = 800 N-m

Maximum T = 1250 N-m

$T = \tau(Z_P)$

$\tau = \frac{16T}{\pi d^3}$

$60 = \frac{16\times1250\times10^3}{(\pi)(d)^3}$

d = 47.5 mm

38. A solid circular shaft has a diameter d. Polar modulus will be

(a) $\frac{\pi}{16}d^2$ (b) $\frac{\pi}{64}d^3$

(c) $\frac{\pi}{16}d^3$ (d) $\frac{\pi}{32}d^2$

38. Ans: (c)

Sol: Polar section modulus, $Z_P = \frac{\pi}{16}d^3$

39. A hollow steel shaft has outside diameter d and inside diameter $\frac{d}{2}$. The value of d for the shaft, if it has to transmit 200 hp at 105 rpm with a working shear stress of 420 kg/cm^2, is

(a) 5.6 cm (b) 2.6 cm

(c) 12.1 cm (d) 15.5 cm

39. Ans: (c)

Sol: Given:

P = 200 hp

N = 105 rpm

$\tau = 420$ kg/cm^2

$$P = \frac{2\pi NT}{4500}$$

$$200 = \frac{2\pi(105)(T)}{4500}$$

$$T = \frac{4500 \times 200}{2\pi(105)}$$

T = 1364.18 kg-m

$$\text{but, } d = \frac{D}{2}$$

$$\therefore\ Z_P = \frac{\pi}{16D} D^4\left(1 - \frac{1}{2^4}\right)$$

$$Z_P = 0.184\, D^3$$

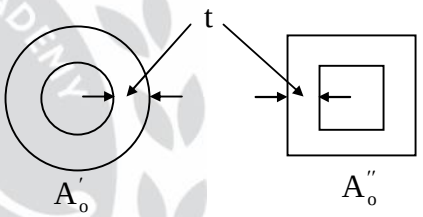
$$\tau = \frac{T}{Z_P}$$

$$420 = \frac{1364.18 \times 10^2}{0.184\, D^3}$$

D = 12.1 cm

40. Two thin-walled tubular members made of the same material have the same length, same wall thickness and same total weight and both subjected to the same torque of magnitude T. If the individual cross-sections are circular and square, respectively, as in the figures, then the ratios of the shear stress τ, reckoned for the circular member in relation to the square member will be

Figures not to scale



(a) 0.785 (b) 0.905

(c) 0.616 (d) 0.513

40. Ans: (a)

Sol: Shear stress in a thin circular tube

$$\tau_{max} = \frac{T}{2\pi R^2 t} \qquad \ldots (1)$$

Shear stress in a thin square tube

$$\tau_{max} = \frac{T}{2 \cdot t \cdot b^2}$$

The weights of two material is same.

(A) circular tube = (A) square tube

$(2\pi R)t = 4bt$

$$b = \frac{\pi R}{2}$$

$$\frac{(\tau_{max})_{circular}}{(\tau_{max})_{square}} = \frac{T/2\pi R^2 t}{T/2tb^2}$$

$$= \frac{b^2}{\pi R^2} = \frac{(\pi R/2)^2}{\pi R^2}$$

$$= \frac{\pi^2 R^2}{4\pi R^2} = \frac{\pi}{4} = 0.785$$

41. In the analysis of beams subjected to loads, the point with Nil Bending Moment can be a
1. Point of Contraflexure
2. Point of Maximum Shear Force
3. Point of Inflexion

Which of the above statements is/are correct?

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

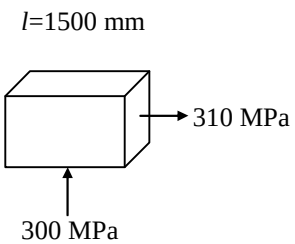
41. Ans: (c)

42. A mild steel bar, 1.5 m long , has a square section 40 mm × 40 mm .The bar is subjected to a two-dimensional stress, σ_x = 310 N/mm^2 (tensile) and σ_y = 300 N/mm^2 (compressive). E= 2× 10^5 N/mm^2, Poisson's ratio $\mu = 0.3$. The elongation of the bar in the direction of σ_x will be

(a) 1.25 mm (b) 1.75 mm
(c) 2.25 mm (d) 3 mm

42. Ans: (d)

Sol:



$$\varepsilon_x = \frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E}$$

$$\frac{\delta\ell}{1500} = \frac{310}{E} - 0.3\frac{(-300)}{E}$$

$$\delta\ell = \left[\frac{310 + 0.3\times 300}{2\times 10^5}\right]\times 1500$$

δl = 3 mm

43. A tractor has a permissible loaded speed of 200 m/minute , which can increase by 25% when the load is removed/deposited. Generally, it is operated at 80% of the permissible speed (loaded or unloaded). It works at a location where haul distance is 120 m. Rest allowance per round-trip is taken as 50 seconds on an average. Fixed time per trip, for loading and unloading and turnaround, etc., is 30 seconds .What is its effective cycle time?

(a) 157 seconds (b) 161 seconds
(c) 173 seconds (d) 182 seconds

43. Ans: (b)

Exp: Effective cycle time

$$= \frac{(\text{Forward time} + \text{Return time})}{\text{Efficiency}}$$

+Loading/ unloading time + Rest Allowance

$$= \frac{\left(\frac{\text{Haul distance}}{\text{Forward velocity}} + \frac{\text{Haul distance}}{\text{Return velocity}}\right)}{\eta}$$

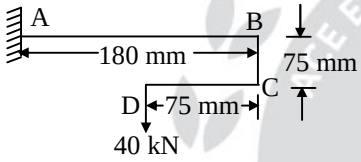
+loading/ unloading time+ Rest Allowance

$$= \frac{\left(\frac{120}{\frac{200}{60}} + \frac{120}{\frac{250}{60}}\right)}{0.8} + 30 + 50$$

$$= \frac{(36 + 28.8)}{0.8} + 30 + 50$$

= 81 + 80 = 161 seconds

44. The bending moments at A for the beam shown below (not to scale) is



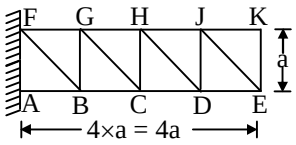
(a) 3200 kN-mm (b) 3600 kN-mm

(c) 4200 kN-mm (d) 4800 kN-mm

44. Ans: (c)

Sol: $M_A = 40 \times (180 - 75) = 4200$ kN-mm

45. In the pin-end cantilever truss shown below, member FG had been fabricated 10mm longer than required. How much will point E deflect vertically ?



(a) 10 mm (b) 20 mm

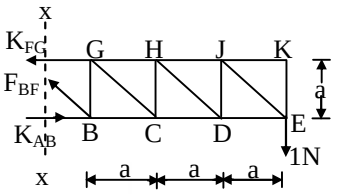
(c) 30 mm (d) 40 mm

45. Ans: (c)

Sol: $\delta_{v_E} = \sum \frac{PK\ell}{AE} = \sum K \times \Delta$

= vertical deflection of point E

Adopting method of sections; cut the section passing through GF, BF and AB vertically and adopt RHS.



Now $\sum M_B = 0$

$1 \times 3a - K_{FG} \times a = 0$

$\Rightarrow K_{FG} = 3N$

Due to lack of fit $\Delta_{FG} = 10$ mm $\rightarrow$ given

For all other members $\Delta = 0$

Thus $\delta_{VE} = \sum K \times \Delta = K_{FG} \times \Delta_{FG} = 3 \times 10$

= 30 mm

46. The purpose of lateral ties in a short RC column is to

(a) Avoid buckling of longitudinal bars

(b) Facilitate compaction of concrete

(c) Increase the load carrying capacity of the column

(d) Facilitate construction

46. Ans: (a)

Sol: The functions of lateral ties in short R.C column are

- To avoid the buckling of longitudinal steel (i.e keep longitudinal steel in position)
- To take care of secondary effects like shrinkage, creep, temperature change

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PAPER PATTERN

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

PAPER STRUCTURE

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

SYLLABUS

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

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

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

(based on the previous exam papers)

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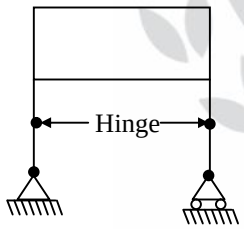
47. When a two-hinged parabolic arch is subjected to a rise in ambient temperature, the horizontal thrust at the support will
(a) Increase
(b) Decrease
(c) Remain same
(d) Increase or decrease depending on the span

47. Ans: (a)

Sol: Two –hinged parabolic arch being an indeterminate structure the rise in temperature increases the Horizontal Thrust

48. The degree of static indeterminacy for a rigid frame as shown below is



(a) 0 (b) 1
(c) 2 (d) 3

48. Ans: (b)

Sol: r = 3; c = No. of closed boxes = 1

Ignoring hinges $D_s = D_{se} + D_{si}$

$= (r–3) + 3C$

$= (3–3) + 3\times1 = 3$

Each flexural hinge will offer one additional $\sum M = 0$ equilibrium equation

Thus final $D_s = 3–1–1 = 1$

49. In the slope-deflection equations, deformations are considered to be caused by
(a) Shear forces and bending moments only
(b) Axial forces, shear forces and bending moments
(c) Axial forces and bending moments only
(d) Bending moments only

49. Ans: (d)

Sol: The standard slope-deflection equation is written as

$$M_{AB} = M_{FAB} + \frac{2EI}{\ell}\left[2\theta_A + \theta_B \pm \frac{3\delta}{\ell}\right] \text{ in}$$

which all deformations are considered to be caused by B.M. only

50. The maximum bending moment caused by a set of concentrated moving loads is
(a) Always at the mid-point of span
(b) Between the mid-point and concentrated load next to the mid-point of the span
(c) Not definable
(d) Always under a load close to the centroid of the set of loads

50. Ans: (d)

Sol: Absolute maximum B.M occurs under a load close to the centroid of set of loads for this to take place the centroid of set of loads and nearest maximum axle load is placed symmetrical to mid-span.

51. Force method of analysis of a structure is particularly preferred when
    1. The degrees of freedom of the structure become large
    2. The structure has less numbers of static, and more numbers of kinematic, indeterminacies
    3. The structure has more numbers of static, and less numbers of kinematic, indeterminacies

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

51. Ans: (b)

Sol: Degree of freedom is defined for a body undergoing mechanism also. Whereas force method of analysis is applicable for a statical structure in which D_s is less and D_K is more. Since dimension of matrix in force method is equal to D_s.

52. Stiffness matrix method is in the category of
    1. Compatibility method
    2. Displacement method
    3. Force method
    4. Equilibrium method

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

52. Ans: (d)

Sol: Stiffness method is displacement method because unknown quantities are taken as joint displacements. It also involves equilibrium principle i.e [K] {d} = {Q}

53. Muller-Breslau Principle for obtaining influence lines is applicable to
    1. Statically determinate beams and frames
    2. Statically indeterminate structures, the material of which is elastic and follows Hooke's law
    3. Any statically indeterminate structure

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

53. Ans: (a)

Sol: Muller-Breslau principle is adopted both for statically determinate and indeterminate structure. Since it follows Maxwell-Betti's theorem hence the material should be elastic and follows Hooke's law.

54. The plastic neutral axis
    1. Divides the given section into two equal halves
    2. Divides the given section into two unequal parts
    3. Lies on the centroidal axis of the section

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

54. Ans: (a)

Sol: Plastic neutral axis is also known as equal area axis which divides the cross sectional area into two equal halves.

55. The plastic moment capacity M_p is

(a) Less than the yield moment

(b) Equal to the yield moment

(c) Greater than the yield moment

(d) Dependent on section dimensions

55. Ans: (c)

Sol: $\frac{M_P}{M_Y} = \frac{Z_P}{Z_e} = S$ = Shape factor

$M_P = S \times M_Y$

56. Web crippling is caused by

(a) Excessive bending moment

(b) Failure of web under point loads

(c) Width of flanges

(d) Column action of web

56. Ans: (b)

57. The block shear failure of a bolted joint in tension occurs because of

1. Use of high shear strength bolts
2. Use of plates with higher bearing strength

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

57. Ans: (a)

(Refer Limit state design of Steel Structures by S K Duggal Page No. 250)

58. As per IS code, the maximum longitudinal pitch allowed in bolted joints of tension members is nominally

(a) 12 times the thickness of the plate

(b) 12 times the diameter of the bolt

(c) 16 times the thickness of the plate

(d) 16 times the diameter of the bolt

58. Ans: (c)

59. ISMB 100 (r_x = 40 mm, r_y = 10 mm) has been used as a column in an industrial shed. Along the minor axis, the column has restraints in the form of purlins at 1.0 m intervals. Effective length factor along major and minor axes are 1.2 and 1.0, respectively. If the slenderness ratio is restricted to 120, the maximum column height will be

(a) 1.0 m (b) 2.4 m (c) 4.0 m (d) 4.8 m

59. Ans: (c)

Sol: For ISMB 100 column section

r_{xx} = 40 mm; r_{yy} = 10 mm

Effective length about major axis = KL_{xx} = 1.2L

Effective length about minor axis

$= KL_{yy} = 1.0L$

Slenderness ratio about minor axis = $\frac{1.0L}{r_{yy}}$

$= \frac{1\times1000}{10} = 100 < 120$

Maximum slenderness ratio = $\frac{KL}{r} = 120$

About major axis (XX axis)

$\frac{KL_{xx}}{r_{xx}} = 120 \Rightarrow \frac{1.2L_{xx}}{40} = 120$

$L_{xx} = 40 \times \frac{120}{1.2} = 4000\,mm$

Maximum height of column = 4 m

60. As per IS 800-2007, the permitted slenderness ratio for a bracing member in case of hangers shall be

(a) 140 (b) 145 (c) 150 (d) 160

60. Ans: (d)

Sol: As per IS 800:2007 (Clause 12.8.2.2) the permitted slenderness ratio for a bracing member in case of hanger bars shall be 160.

A bracing member is subjected to tension as well as compressive loads. If such member is designed for compression like lacing member.

The maximum (or) limiting slenderness ratio of lacing member = 145

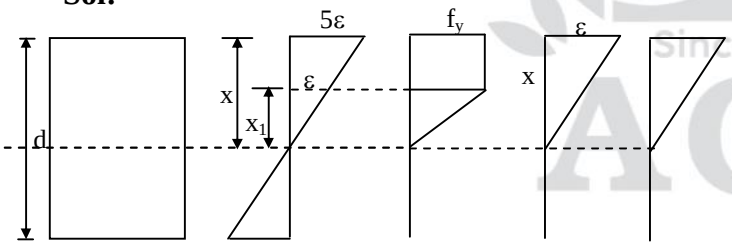
61. A rectangular beam of depth d is under bending. Load has been gradually increased when the top fibre has obtained five times the strain at the first yield .What depth of the beam will still respond by elastic conditions ?

(a) 0.16 d (b) 0.20 d

(c) 0.25 d (d) 0.40 d

61. Ans: (b)

Sol:



$x \rightarrow 5\varepsilon$

$x_1 \rightarrow \varepsilon$

$$\frac{x}{x_1} = 5$$

$$x_1 = \frac{1}{5}(x)$$

$x_1 = 0.2\ x$

62. The ultimate moment capacity of a mid steel section is usually

(a) Equal to the plastic moment capacity

(b) More than the yield moment capacity

(c) Less than the plastic moment capacity but more than the yield moment capacity

(d) More than the plastic moment capacity

62. Ans: (a)

63. The portal bracing in a truss- bridge is used to

(a) Transfer load from top of end posts to bearings

(b) Maintain the rectangular shape of the bridge cross-section

(c) Stiffen the structure laterally

(d) Prevent the buckling of top chord under side sway

63. Ans: (a)

64. Consider the following cases in the design of reinforced concrete members in flexure:

1. Over-reinforced section
2. Tension failure
3. Compression failure
4. Under-reinforced section

Which of the above cases are considered for safe design of R.C. members in flexure?

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

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

64. Ans: (b)

Sol: For safe design, tension failure in steel is preferred because it will give prior warning before failure occur.

In under reinforced section, the nature of failure is ductile.

65. The bond between steel and concrete is mainly due to
1. Mechanical resistance
2. Pure adhesive resistance
3. Frictional resistance

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

65. Ans: (d)

Sol: Mechanism in bond is due to

1. Mechanical resistance: It is due to ribs (or) legs on the surface of reinforcing bar.
2. Pure adhesive resistance: It is due to chemical gum in concrete.
3. Frictional resistance: It is due to shrinkage of concrete.

66. The carbonation process is demonstrated more by
(a) Atmospheric corrosion
(b) Chloride corrosion
(c) Stress corrosion
(d) Hydrogen embrittlement

66. Ans: (a)

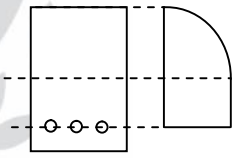
67. When a spirally reinforced short column is loaded axially, the concrete inside the core is subjected to
(a) Bending and compression
(b) Biaxial compression
(c) Triaxial compression
(d) Uniaxial compression

67. Ans: (c)

68. In a reinforced concrete section, shear stress distribution is diagrammatically
(a) Wholly Parabolic
(b) Wholly Rectangular
(c) Parabolic above NA and Rectangular below NA
(d) Rectangular above NA and Parabolic below NA

68. Ans: (c)

Sol:



Shear stress distribution in Reinforced section is above N.A parabolic and below N.A rectangle.

69. As per IS 456-2000, the maximum permissible shear stress, $\tau_{C\,max}$, is based on
(a) Diagonal tension failure
(b) Diagonal compression failure
(c) Flexural tension failure
(d) Flexural compression failure

69. Ans: (b)

70. Footings shall be designed to sustain the
1. Applied loads
2. Moments and forces under relatable loading conditions
3. Induced reactions

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

70. Ans: (d)

Sol: Footings shall be designed for
(i) Bending Moment
(ii) One way shear force
(iii) Two way shear force

71. Reinforced concrete slabs are designed for
1. Shear
2. Flexure
3. Positive bending moment
4. Negative bending moment

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

71. Ans: (c)

Sol:

Reinforced concrete slabs are designed for
1. Flexure
(i) + Bending Moment
(ii) − Bending Moment

Shear cannot be designed,

If $\tau_v > \tau_c$

$\therefore$ Redesign

72. As compared to the working stress method of design, the limit state method of design premises that the concrete can admit
(a) A lower stress level
(b) A higher stress level
(c) Occasionally higher, but usually lower, stress level
(d) only the same stress level

72. Ans: (b)

As compared to W.S.M in L.S.M the concrete can take higher stress level

Ex: For a given grade M_{20}

W.S.M	L.S.M
σ_{cbc}	$0.446\ f_{ck}$
$\frac{f_{ck}}{3}$	$0.45\ f_{ck}$
$(20/3) = 7$	$(0.45 \times 20) = 9$

73. The bending stress in a T- beam section is maximum
1. At top fibre
2. At centroidal fibre
3. At bottom fibre

(a) 1 only
(b) 2 only
(c) 3 only
(d) At a level which is dependent on the loading condition

73. Ans: (c)

74. If the loading on a simply supported pre-stressed concrete beam is uniformly distributed, the centroid of the pre-stressing tendon should be as
    (a) A straight profile along the lower edge of the kern
    (b) A parabolic profile with convexity downward
    (c) A straight profile along the centriodal axis
    (d) A circular profile with convexity upward

74. Ans: (b)

75. In a post-tension pre-stressed concrete beam, the end block zone is in between the end of the beam and the section where
    (a) The shear stresses are maximum
    (b) Only shear stresses exist
    (c) No lateral stresses exist
    (d) Only longitudinal stresses exist

75. Ans: (d)

76. In the pre-tensioning method
    1. Tension in concrete is induced directly by external force
    2. Tension is induced in the tendons before concreting
    3. Concrete continues to be in tension after pre-stressing

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

76. Ans: (b)

77. Flexural collapse in over-reinforced beams is due to
    (a) Primary compression failure
    (b) Secondary compression failure
    (c) Primary tension failure
    (d) Bond failure

77. Ans: (a)

Sol: In over reinforced sections, the strain in concrete will reach its ultimate strain before steel is reaching its max strain. The concrete is a brittle material and nature of failure is sudden. It is also called primary compression failure.

78. If a beam is likely to fail due to high bonding stresses, then its bond strength can be increased most economically by
    (a) Providing vertical stirrups
    (b) Increasing the depth of the beam
    (c) Using smaller diameter bars in correspondingly more numbers
    (d) Using higher diameter bars by reducing their numbers

78. Ans: (c)

Sol: If bond is not getting satisfied than economical option is reduce the diameter of bar and increase number of bars by keeping same area of steel

79. A single-acting reciprocating pump has a stroke of 25 cm, speed of 135 rpm, and a piston of 30 cm diameter. If its slip has been estimated as 4% at a particular operating condition, what is the corresponding realized discharge through a height of 14 m?

(a) 33.2 *l*ps (b) 35.6 *l*ps

(c) 37.0 *l*ps (d) 38.2 *l*ps

79. Ans: (d)

Sol: L = 0.25 m, N = 135 rpm

D = 0.3 m, S = 0.04

Q_{Act} = ?

$$S = 1 - \frac{Q_{Act}}{Q_{The}}$$

$$\therefore Q_{Act} = (1 - S) \times Q_{The}$$

$$= (1 - 0.04) \times \frac{ALN}{60}$$

$$= 0.96 \times \frac{\frac{\pi}{4}(0.3)^2 \times 0.25 \times 135}{60}$$

$$= 0.0382 \text{ m}^3/\text{sec}$$

$$= 38.2 \text{ } l\text{ps}$$

80. In the design of pre-stressed concrete structures, which of the following limit states will qualify as the limit states of serviceability?

1. Flexural
2. Shear
3. Deflection
4. Cracking

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

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

80. Ans: (b)

81. Consider the following statements:

1. Pumps used in series are generally of the centrifugal type.
2. Centrifugal pumps, though yielding comparatively smaller discharges than axial flow pumps, yield higher heads(at each stage) compared to axial flow pumps.

Which of the above statements is/ are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

81. Ans: (c)

Sol: 1. Multistage pumps (series pump for high head lift) are made from impellers of centrifugal type.

2. Axial pumps develops higher discharges than centrifugal pumps.
3. Centrifugal pumps yields higher heads than axial pumps.

82. When steel reinforcing bars are provided in masonry, the bars shall have an embedment with adequate cover in cement-sand mortar not leaner than

(a) 1:3 (b) 1:4

(c) 1:5 (d) 1:6

82. Ans: (a)

83. The efficiency of pumpcrete is based primarily on
1. The capacity of pump
2. The aggregate size, which should not exceed 8 cm
3. The diameter of pipe being large, with more than 30cm being desirable
4. The performance of the agitator

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

83. Ans: (a)

Sol: Efficiency of concrete pump function of its capacity as well agitator. This pump is capable of pumping 130 m^3 of concrete per hour with 8 Inch ($\simeq$200 mm) pipe. The pipe diameter should be atleast 3 times the maximum aggregate size. Large aggregates can tend to get blocked near the bends. A slump 5 cm to 15 cm is recommended. 5 cm slumps are impractical for pumping and slumps above 12.5 cm should be avoided.

84. In a non-tilting drum mixer,
1. Large size aggregate upto 20-25 cm can be handled
2. Mixing time is less than 2 minutes
3. Discharge is through buckets onto the platform
4. For large-size mixers, the mixing time should be slightly increased if handling more than 800 litres of the mix.

Which of the above statements are correct?

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

84. Ans: (b)

Sol: In Non-tilting type drum concrete mixer, maximum aggregate size is 6 cm. The mixing time is around 2 minutes. Discharge is through buckets onto the platform.

85. How many impellers are required for multi-stage pump to lift 4000 *l*pm against total head of 80m at a speed of 750rpm; given that N_s for each impeller should be between 720 to 780 units?

(a) 6 (b) 5
(c) 4 (d) 3

85. Ans: (*)

Sol: $Q = 4000\ l\text{pm} = \frac{4000\times10^{-3}}{60}\text{m}^3/\text{sec}$

$= \frac{1}{15}\text{m}^3/\text{sec}$

$H_{Total} = 80$ m

$N = 750$ **rps** $= 750 \times 60$ rpm

$N_s = 720$ to 780

$$N_s = \frac{N\sqrt{Q}}{(H)^{\frac{3}{4}}}$$

$$750 = \frac{750\times60\sqrt{\frac{1}{15}}}{(H)^{\frac{3}{4}}}$$

$$(H)^{\frac{3}{4}} = \sqrt{\frac{1}{15}}\times60$$

$$(H)^{3/4} \simeq 15$$

$H = (15)^{4/3} = 37$ m

No. of impellers required

$$= \frac{\text{Total Head}}{\text{Head per Impeller}}$$

$$= \frac{80}{37} = 2.16$$

say 3 pumps

86. A 15 cm centrifugal pump delivers 6 *l*ps at a head of 26 m running at a speed of 1350 rpm. A similarly designed pump of 20cm size runs at the same speed. What are the most likely nearest magnitudes of discharges and delivery head provided by the latter pump?

(a) 11 *l*ps and 46m (b) 14 *l*ps and 52m

(c) 11 *l*ps and 52m (d) 14 *l*ps and 46m

86. Ans: (d)

Sol: $D_1 = 15$ cm $D_2 = 20$ cm

$Q_1 = 6$ *l*ps $N_2 = 13$ rpm $= N_1$

$H_1 = 26$ m

$N_1 = 13$ rpm

$Q_2 = ?$

$H_2 = ?$

$$\frac{\sqrt{H_1}}{N_1 D_1} = \frac{\sqrt{H_2}}{N_2 D_2}$$

$$H_2 = H_1 \times \left(\frac{D_2}{D_1}\right)^2 = 26 \times \left(\frac{20}{15}\right)^2 = 26 \times \frac{16}{9}$$

$= 46.2$ m

$$\frac{Q_1}{D_1^2\sqrt{H_1}} = \frac{Q_2}{D_2^2\sqrt{H_2}}$$

$$Q_2 = Q_1 \times \left(\frac{D_2}{D_1}\right)^2 \times \sqrt{\frac{H_2}{H_1}}$$

$$= 6 \times \left(\frac{20}{15}\right)^2 \times \sqrt{\frac{46.2}{26}} = 6 \times \frac{16}{9} \times 1.33$$

$= 14.21$ *l*ps

87. Which of the following statements are correct as operating characteristics of a centrifugal pump?

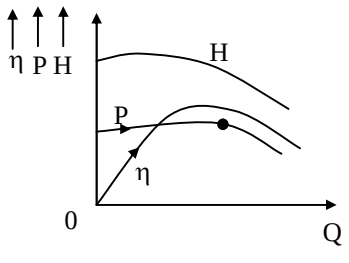
1. As discharge increases from zero value, head slightly increases; then the head declines gently; and beyond a certain discharge, the head falls steeply.
2. As discharge increases, efficiency increases from zero, rising fast to a maximum value and then falls rapidly, more rapidly than the head-discharge curve.
3. BHP increases from a non-zero (positive) value at zero discharge, the increase being only moderate before it starts falling beyond a certain discharge.

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

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

87. Ans: (a)

Sol:



88. Engines used in earthwork equipment are qualified by the power developed under specified conditions. As operating conditions change, the power developed will increase with local ambience, if

1. Ambient temperature increases
2. Ambient temperature decreases
3. Ambient pressure increases
4. Ambient pressure decreases

Which of the above statements are correct?

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

88. Ans: (c)

89. Manometric head developed h_m in m, and discharge Q in *l*ps in respect of two pumps, 1 and 2, are tabulated. The pumps are connected in series against a static head of 100m. Total head losses for a discharge of Q are $\frac{Q^2}{100}$(m). What is the delivered discharge?

Q in *l*ps	15	18	20	22	25
h_{m1} in m	60.6	61.2	62.0	55.0	48.0
h_{m2} in m	50.8	51.0	48.8	45.8	40.0

(a) 20.15 *l*ps (b) 21.25 *l*ps
(c) 21.95 *l*ps (d) 22.20 *l*ps

89. Ans: (*)

90. A reciprocating pump has a stroke of 30cm, speed of 100 rpm, and a piston of 22.5 cm diameter. It discharges 18.9 *l*ps. What is the slip of the pump?

(a) 3.12% (b) 3.54%
(c) 4.15% (d) 4.95%

90. Ans: (d)

Sol: L = 0.3 m

N = 100 rpm

d = 0.225 m

Q = 0.0189 m^3/sec

S = ?

$$S = 1 - \frac{Q_{Act}}{Q_{Th}}$$

$$= 1 - \frac{0.0189}{\frac{\pi}{4}\left(0.225^2 \times 0.3 \times 100\right)}{60}$$

$$= 1 - \frac{0.0189}{0.0199}$$

$$= 1 - 0.9505$$

$$= 0.0495 = 4.95\%$$

91. The following data were recorded when a centrifugal pump worked at its maximum efficiency: Q= 40 *l*ps; Manometric head developed = 25m; Input shaft horse power = 11.9W. What is the non-dimensional specific speed of the pump if it was running at 1500 rpm? (May adopt the following (all in S.I . units) :

$g^{1/4} = 1.77$, $g^{1/2} = 3.132$, $g^{3/4} = 5.544$,

$\sqrt{2} = 1.414$, $\sqrt{5} = 2.236$ and $\sqrt{10} = 3.162$)

(a) 165 (b) 155
(c) 145 (d) 135

91. Ans: (b)

Sol: Non-dimensional Specific speed of a

Pump, $N_S = \frac{N\sqrt{Q}}{(g.H)^{3/4}}$

$= \frac{1500 \times \sqrt{40}}{(g \times 25)^{3/4}}$

$= \frac{1500 \times 2 \times \sqrt{10}}{(g)^{3/4}(5)^{3/2}}$

$\simeq 15 = \frac{1500 \times 2 \times 3.162}{5.544 \times 11.1}5$

92. The total head to be developed by a centrifugal pump is expected to be up to 50m. The normal ratio of radii of impeller rim and impeller eye of 2 is maintained. The design is for a speed of 1300 rpm. What is the nominal diameter of the impeller? Take $\sqrt{g}$ =3.13 and $\frac{1}{\pi} = 0.318$.

(a) 53cm (b) 57cm (c) 60cm (d) 64cm

92. Ans: (a)

Sol: H = 50 m

$\frac{D_1}{D_2} = \frac{R_1}{R_2} = 2$ N = 1300 rpm

$mgH = \frac{1}{2}m\left(U_1^2 - U_2^2\right)$

$2gH = \left(\frac{\pi D_1 N}{60}\right)^2 - \left(\frac{\pi D_2 N}{60}\right)^2$

$2gH = \frac{N^2}{60^2} \times \pi^2\left(D_1^2 - D_2^2\right)$

$\sqrt{2gH} = \frac{N}{60} \times \pi\sqrt{D_1^2 - D_2^2}$

$\sqrt{2 \times 9.81 \times 50} = \frac{1300}{60} \times \pi\, D_1\sqrt{1 - \left(\frac{D_2}{D_1}\right)^2}$

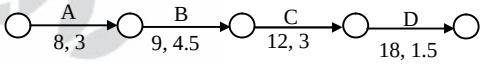
$\sqrt{2 \times 9.81 \times 50} = \frac{1300}{60} \times \pi \times D_1\sqrt{1 - \left(\frac{1}{2}\right)^2}$

$\sqrt{2 \times 9.81 \times 50} = \frac{1300}{60} \times \pi \times D_1\sqrt{1 - \left(\frac{1}{4}\right)}$

D = 0.531 m

= 53.1 cm

93. Activities A, B, C and D constitute a small project; their interrelationship, expected duration and standard deviation of this expected duration are shown in the figure, respectively.



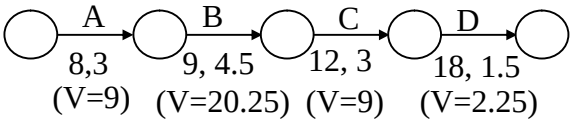
With a view to improving the speed of implementation, each of B,C and D are split into three equal segments, maintaining appropriate inter-relationships between A and each of these nine segments. What will be the standard deviation of the modified project duration after segmentation (to the nearest $\frac{1}{10}$ unit) ?

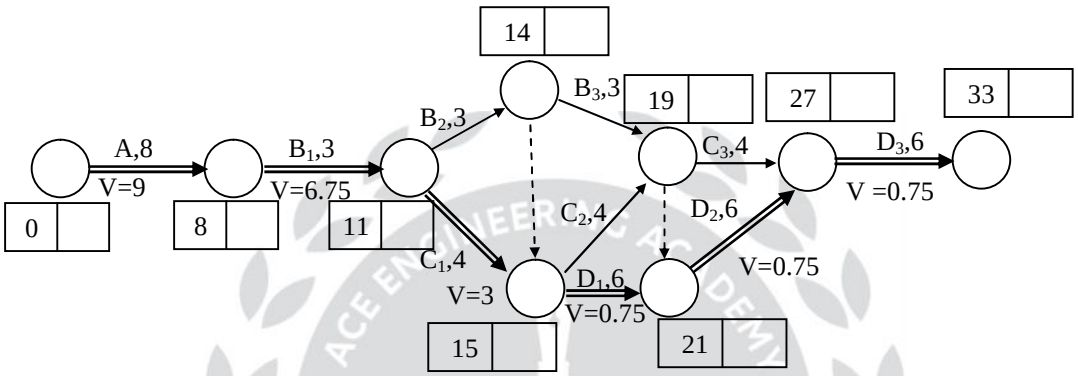
(a) 6.2 (b) 5.6

(c) 5.2 (d) 4.6

93. Ans: (d)

Sol:





Critical path : A – B_1 – C_1 – D_1 – D_2 – D_3

Project duration = 33

$\sigma_{\text{critical path}} = \sqrt{\sum V_{\text{critical path}}} = \sqrt{9+6.75+3+0.75+0.75+0.75} = \sqrt{21} \simeq 4.6$

94. Which of the following is/are the main drawback(s) in adopting bar charts?

1. All the activities are shown as being independent of each other.
2. The sequence of activities is not defined at all.
3. It is difficult to judge whether an activity is completed or not.

(a) 1 only (b) 2 only

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

94. Ans: (b)

95. The purpose of work-break–down structure project planning is mainly to

1. Facilitate and improve the decision- making on procurement of resources.
2. Relate activities under particular trade specializations to help in organizing for project staff.
3. Co-ordinate regarding milestone events across trade specializations to improve the synergy between the trades.

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

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

95. Ans: (d)

96. Which of the following statements is/are correct?
    1. An activity is in between two node numbers, which need not be in an increasing order in the activity progress sequence.
    2. The length of the arrow in a network has certain significance.
    3. Concurrent activities are mutually independent and can possibly be taken up simultaneously.

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

96. Ans: (b)

97. Which of the following statements are implicit in developing the critical path network?
    1. Only one time estimate is required for any activity
    2. Time only is the controlling factor at this stage
    3. Time and cost both are controlling factors at this stage
    4. Critical events may have positive, negative, or zero float

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

97. Ans: (b)

98. In the Critical Path Method of project planning, free float can be
    (a) Greater than independent float
    (b) Greater than total float
    (c) Less than independent float
    (d) Equal to total float

98. Ans: (a)

Sol: TF ≥ FF ≥ IF

99. Slack time in PERT analysis
    (a) Can never be greater than zero
    (b) Is always zero for critical activities
    (c) Can never be less than zero
    (d) Is minimum for critical events

99. Ans: (b)

Sol: Slack time for critical activities and critical events = 0

100. A small project consists of 3 activities P, Q and R to be executed in that sequence. The relationship between Time Duration (in 'Units' of time-T) and corresponding total direct cost (C units) for each of the activities, for alternate mutually exclusive possible durations for each activity, are tabulated herewith:

P		Q		R	
T	**C**	**T**	**C**	**T**	**C**
8	250	6	340	8	400
9	235	7	320	10	375
10	225	8	295	12	350
11	215	9	275		

For a total duration of 25 units of time, the least total direct cost for the complete project will be

(a) 965 units (b) 950 units

(c) 940 units (d) 925 units

100. Ans: (d)

Sol: Minimum total direct cost = 250 + 275 + 400
= 925 units

Directions: Each of the next **Twenty (20)** items consists of two statements, one labelled as the **'Statement (I)'** and the other as **'Statement (II)'**. Examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

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

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

(c) Statement (I) is true but Statement (II) is false

(d) Statement (I) is false but Statement (II) is true

101. **Statement (I):** Splitting of fibres is a type of seasoning defect in wood

Statement (II): Seasoning of timber is a general requirement for structural purposes.

101. Ans: (b)

102. **Statement (I):** Hardwoods are used in special purpose heavy constructions.

Statement (II): Hardwoods too are porous in nature.

102. Ans: (b)

Sol: Hardwood is non porous. It is dense.

$\therefore$ Statement-2 is wrong.

103. **Statement (I):** In general, bricks cannot be used in industrial foundations.

Statement (II): Heavy duty bricks can withstand higher temperatures.

103. Ans: (d)

Sol: Heavy duty bricks can be used in industrial bricks.

$\therefore$ Statement-1 is wrong.

Heavy duty bricks can withstand higher temperature.

$\therefore$ Statement -2 is correct.

104. **Statement (I):** In multistoried constructions, burnt clay perforated bricks are used to reduce the cost of construction.

Statement (II): Perforated bricks are economical and they also provide thermal insulation.

104. Ans: (a)

105. **Statement (I):** Positive displacement pumps can be used for pumping of ready-mixed concrete.

Statement (II): The coarse aggregate in the mix is unlikely to be crushed during positive displacement.

105. Ans: (a)

106. **Statement (I):** Fire resistance of plastering can be achieved by mixing surkhi to the cement mortar.

Statement (II): Insulation against sound and fire can be achieved by adding sufficient water in-situ just before applying the mortar.

106. Ans: (c)

Sol: Fire resistant mortar is prepared by adding 1 part of aluminous cement to 2 parts of finely crushed powder of bricks (surkhi).

$\therefore$ Statement – 1 is correct.

Insulation against sound and fire can not be achieved by adding water just before applying mortar.

$\therefore$ Statement – 2 is wrong.

107. **Statement (I):** Water containing less than 2000 ppm of dissolved solids can generally be used satisfactorily for making concrete.

Statement (II): The presence of any of zinc, manganese, tin, copper or lead reduces the strength of concrete considerably.

107. Ans: (a)

Sol:

Statement I & II are true and II is correct explanation to I

108. **Statement (I):** Though a non-elastic material, yet concrete exhibits a linear relationship between stress and strain at low values of stress.

Statement (II): The modulus of elasticity of concrete is dependent on the elastic properties of aggregate and on curing.

108. Ans: (b)

109. **Statement (I):** Finer the cement, greater is the need for water for hydration and workability.

Statement (II): Bleeding of a mix occurs due to low water-cement ratio.

109. Ans: (c)

110. **Statement (I):** The failure of a mild steel specimen of circular cross-section, subjected to a torque occurs along its cross-section.

Statement (II): The failure occurs on a plane of the specimen subjected to maximum shear stress; and mild steel is relatively weak in shear.

110. Ans: (a)

Sol: Statement 1: True

Statement 2: True

111. **Statement (I):** In elastic analysis of structures, the Neutral Axis is the intersection between the plane of bending and the neutral plane.

Statement (II): Neutral Axis in the context of plastic analysis of structures is always the Equal Area Axis of the cross-section.

111. Ans: (b)

112. **Statement (I):** Whereas shutter vibrators are preferred for use with pre-stressed beams, needle vibrators are preferred in foundation concreting.

Statement (II): Needle vibrators are susceptible to get dysfunctional with leaking in of cement slurry which is not the case with the shutter vibrator.

112. Ans: (b)

113. **Statement (I):** The forward edge of wheels or outriggers acts as a fulcrum in determining the lifting capacity of a mobile crane.

Statement (II): There is in-built security and safety against sudden dropping of load, as well as against abrupt swinging, in the working of a mobile crane.

113. Ans: (b)

114. **Statement (I):** Hand-operated chain-hoists include differential screw-geared types within their range.

Statement (II): In case of a hoist-winch, the capacity of the hoist is increased by a number of gear reductions.

114. Ans: (b)

115. **Statement (I):** When employing weigh batching for mix preparation, bulking of sand has to be accounted for.

Statement (II): Bulked sand will affect the proportional composition of the ingredients to be used in making wet concrete of the desired eventual strength.

115. Ans: (d)

116. **Statement (I):** Critical path(s) through a CPM network can be identified even without working out the backward pass computations by a competent user.

Statement (II): Critical path is the progressive chain of activities from start to finish (not excluding between splitting and merging nodes) through the network where total float is absent throughout (including through dummy arrows, if appropriate).

116. Ans: (b)

117. **Statement (I):** For implementing weigh-batching separate compartments are made for storing large quantities of the aggregates. Besides lifting and loading equipments, there must be regular assessment of grading and also of moisture content.

Statement (II): Whereas eventual strength of the mix depends also on the grading of the ingredients, the water needs too must be properly computed and implemented.

117. Ans: (b)

118. **Statement (I):** Resources Optimization is largely a pre-implementation pursuit whereas Resources Allocation is a through-implementation dynamic process.

Statement (II): Resources Allocation has a larger bearing on Inventory Management than Resources Optimization.

118. Ans: (c)

119. **Statement (I):** Crashing of project duration always increases the cost of the project on its completion, no matter what the indirect, or overhead, costs are.

Statement (II): The critical path along the project activities network diagram is compressed in the process of investigating the crashing of the project duration, and not the non-critical activities, up to a certain stage of crashing.

119. Ans: (d)

120. **Statement (I):** In the operation of reciprocating pumps, slip can sometimes be negative.

Statement (II): Under conditions of high speed, long suction pipes (without capitation) and short delivery pipes, inertia pressure can be relatively rather high, causing the delivery valve to open before the discharge stroke begins.

120. Ans: (a)