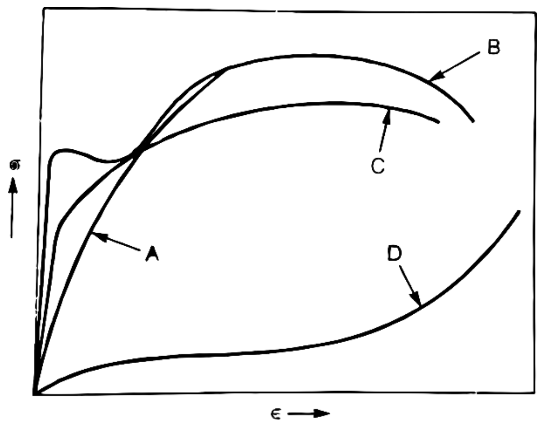
Q1. Consider the following stress-strain diagram and match the following:
List – I



List – II
1. Hard rubber
2. Soft rubber
3. structural steel
4. aluminum alloy

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	2	4	3	1
(c)	1	4	3	2
(d)	2	3	4	1

Q2. Match list-I (Material) with List – II (young's modulus):

List – I	List – II
A. Brass	1. 83-170 GPa
B. Steel	2. 96-110 GPa
C. Aluminium alloys	3. 70-79 GPa
D. Cast iron	4. 48-83 GPa
	5. 190-210 GPa

Codes:

	A	B	C	D
(a)	2	5	3	1
(b)	2	3	5	4
(c)	2	3	5	1
(d)	2	5	3	4

Q3. Resilience of a material is considered when it is subjected to
(a) fatigue
(b) Creep
(c) shock loading
(d) resonant condition

Q4. Flow stress corresponds to
(a) fluids in motion
(b) breaking point
(c) plastic deformation of solids
(d) rupture stress

Q5. Rupture stress is
(a) breaking stress
(b) maximum load/original cross-sectional area
(c) maximum stress
(d) load at breaking point/neck area

Q6. The property of a material by virtue of which it can be beaten or rolled into plates is called
(a) malleability
(b) elasticity
(c) plasticity
(d) ductility

Q7. A material capable of absorbing large amount of energy before fracture is known as
(a) shock proof
(b) toughness
(c) fatigue energy
(d) plasticity

Q8. A material has identical properties in all directions, it is said to be
(a) homogeneous
(b) isotropic
(c) elastic
(d) orthotropic

Q9. Creep is the gradual increase of
(a) plastic strain with time at constant load
(b) elastic strain with time at constant load
(c) plastic strain with time at varying load
(d) elastic strain with time at varying load

Q10. Resilience is
(a) maximum strain energy
(b) recoverable strain energy
(c) total potential energy
(d) shear strain energy (Beyond Hooke's Law)

Q11. The stress level, below which a material has a high probability of not failing under reversal of stress, is known as
(a) elastic limit
(b) endurance limit

(c) proportional limit
(d) tolerance limit

Q12. The linear relation between the stress and strain of a material is valid until
(a) fracture stress
(b) elastic limit
(c) ultimate stress
(d) proportional limit

Q13. Elastic limit the point
(a) up to which stress is proportional to strain
(b) at which elongation takes place without application of additional load
(c) up to which if the load is removed, original volume and shape are regained
(d) at which the toughness is maximum

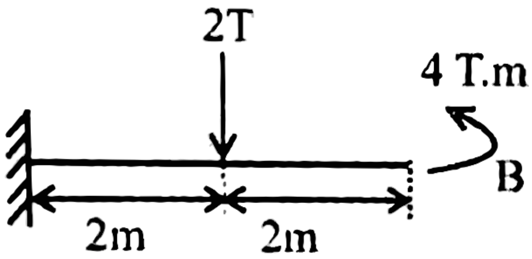
Q14. Modulus of resilience is
(a) a property to resist shocks
(b) a property to withstand heavy pressure
(c) a property to store energy without undergoing paramount deformation
(d) an index of elasticity

Q15. Proof resilience per unit volume of a material is known as
(a) resilience
(b) modulus of elasticity
(c) modulus of resilience
(d) toughness

Q16. In the design of singly reinforced simply supported beams, the maximum bending moment will be (Given W is the maximum load and I is the length):
(a) $W\ell/64$
(b) $W/8\ell^2$
(c) $W\ell^2/8$
(d) $W^2/32$

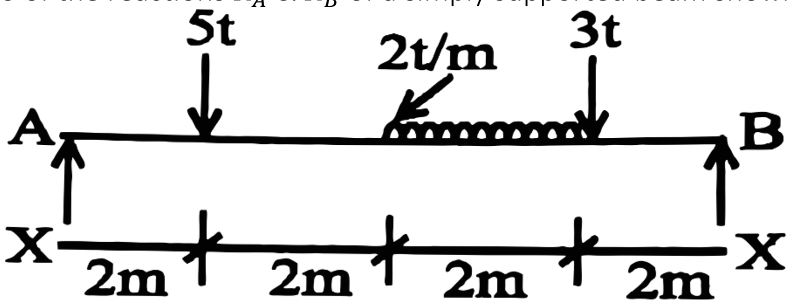
Q17. At hinge, bending moment will be:
(a) zero
(b) low
(c) moderate
(d) maximum

Q18. The B.M of a cantilever beam at A shown in the figure is.



(a) Zero
(b) 8 T.m.
(c) 10 T.m.
(d) 16 T.m.

Q19. The ratio of the reactions R_A & R_B of a simply supported beam shown below is:



(a) 0.50
(b) 0.40
(c) 0.67
(d) 1.00

Q20. A beam of length (l+2a) has supports 'l' aparts with an overhang 'a' on each side. The beam carries a concentrated load 'W' at each end. The shear force between the two supports is given by
(a) Zero
(b) 5W
(c) W
(d) 2W

Q21. Two identical simply supported beams of span 'l' are subjected to equal load 'W' at tis centre (as concentrate load) and the other one is carrying it in the form of u.d.l. over the entire span. The ratio of their mid-span bending moment will be.
(a) 1/2
(b) 2
(c) 4
(d) 8

Q22. The load at the free end of a uniform cantilever beam is increased, the failure will occur
(a) at the middle

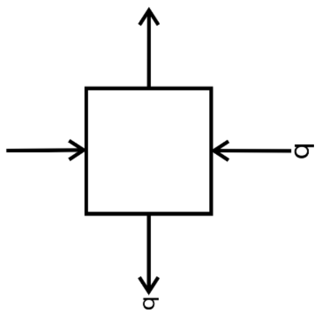
(b) at the fixed end
(c) at the point of application of load
(d) any where in the span

Q23. Slope in the beam is defined as
(a) Angle that the tangent to the elastic curve makes with the unbent beam axis
(b) Angle that the perpendicular to the elastic curve makes with the unbent beam axis
(c) Angle that the tangent to the elastic curve makes with the perpendicular beam axis
(d) Angle that the perpendicular of the beam axis makes with the elastic curve of the beam

Q24. In a simply supported beam of length 5m. a unit moment in kN-m is applied at both ends in opposite direction. The magnitude of bending moment at centre will be
(a) Zero
(b) 0.5 kN-m
(c) 1.0 kN-m
(d) 2.0 kN-m

Q25. A stress element is subjected to tensile stress of 5 MPa on both the principal planes. The radius of Mohr Circle corresponding to this element will be
(a) 10 MPa
(b) 7.5 MPa
(c) 5 MPa
(d) Zero

Q26. For such element only under normal stresses, the radius of Mohr circle is:



(a) σ
(b) $\sigma /2$
(c) 2σ
(d) 0.6 σ

Q27. In a Mohr's circle of $\sigma - \tau$ plane (σ = normal stress, τ = shear stress), the vertical diameter represents
(a) Maximum shear stress
(b) Maximum normal stress
(c) Principal stress
(d) Minimum normal stress

Q28. Principal planes are planes of
(a) maximum shearing stress
(b) zero shearing stress
(c) shearing stress having a magnitude of 50% of principal stress
(d) will be maximum

Q29. A rectangular block is subjected to normal stresses on two orthogonal face 600 MPa and 400 MPa of same nature. What shall be maximum shear produced on a plane?
(a) 500 MPa
(b) 300 MPa
(c) 250 MPa
(d) 100 MPa

Q30. At a point in a strained material, if two mutually perpendicular tensile stresses of 2000kg/cm² and 1000 kg/cm² are acting, then the intensity tensile stress on a plane inclined at 150 to the axis of the minor stress will be_________:
(a) 1250 kg/cm²
(b) 250 kg/cm²
(c) 500 kg/cm²
(d) 1000 kg/cm²

Q31. Maximum shear strain occurs on
(a) Principal planes
(b) 45 deg. With principal planes
(c) 90 deg. With principal planes
(d) All of above

Q32. If the column ends are effectively held in position and restrained against rotation at both ends. Then the effective length is:
(a) 2L
(b) L/2
(c) 0.707 L
(d) L

Q33. The ratio of the theoretical critical buckling load for a column with fixed ends to that of another column with the same dimension and material, but with pinned ends is equal to
(a) 0.5
(b) 4.0
(c) 2.0
(d) 1.0

Q34. The radius of gyration of a rectangular section (Depth D, width B) from a centroidal axis parallel to width is
(a) D/2
(b) $\frac{D}{2\sqrt{3}}$
(c) $\frac{D}{4\sqrt{3}}$

(d) $\frac{2D}{\sqrt{3}}$

Q35. A column that fails due to direct stress, is called:
(a) short column
(b) long column
(c) weak column
(d) medium column

Q36. A compression member is termed as column or strut if the ratio of its effective length to the least lateral dimension is more than
(a) 1
(b) 2
(c) 3
(d) 5

Q37. The allowable stress in a long column can be increased by increasing the
(a) radius of gyration
(b) eccentricity
(c) slenderness ration
(d) length of the column

Q38. A column pinned at both the ends has length L and flexural rigidity EI can carry a critical load of:
(a) $\frac{4\pi^2 EI}{L^2}$
(b) $\frac{2\pi^2 EI}{L^2}$
(c) $\frac{\pi^2 EI}{L^2}$
(d) $\frac{\pi^2 EI}{4L^2}$

Q39. Rankines Gorden formula used to find out buckling load of column
(a) Long column
(b) Medium column
(c) Short column
(d) None of these

Q40. Euler's formula is valid for:
(a) Short column only
(b) Long column only
(c) Both short and long columns
(d) None of the above

Q41. The slenderness ratio of a vertical column of square cross section of 10 cm side and 500 cm length is
(a) 117.2
(b) 17.3
(c) 173.2

(d) 137.2

Q42. If the Euler load for a column is 1000 kN and crushing load is 1200 kN, then the Rankine load will approximately be:
(a) 1200
(b) 600
(c) 900
(d) 545

Q43. When both ends of a column are fixed, the crippling load is F. if one end of the column is made free, the value of crippling load will be changed to……….
(a) F/4
(b) F/2
(c) f/16
(d) 4F

Q44. Radius of gyration of two rectangular columns is in a ratio of 3:1. What shall be the ratio of their depths?
(a) 3:1
(b) 1:3
(c) $1:\sqrt{3}$
(d) $\sqrt{3}:1$

Q45. A simply supported beam of span L and flexural rigidity El, carries a unit point load at its centre. The strain energy in the beam due to bending is
(a) $\frac{L^3}{48EI}$
(b) $\frac{L^3}{192EI}$
(c) $\frac{L^3}{96EI}$
(d) $\frac{L^3}{16EI}$

Q46. Deflection at the free end of a prismatic cantilever beam of length L, modulus of elasticity E and moment of inertia I under load P at the free and will be
(a) $PL^3/48EI$
(b) $PL^3/16EI$
(c) $PL^3/8EI$
(d) $PL^3/3EI$

Q47. For a beam carrying a uniform distributed load, the strain energy will be maximum in case the beam is
(a) Cantilever
(b) Simply supported
(c) Propped cantilever
(d) Fixed at both ends

Q48. A cantilever of length (L) carries a concentrated load (W) at the free end. If the length of the cantilever is doubled, the deflection at the free end, for the same load will be:
(a) 2 times
(b) 4 times
(c) 6 times
(d) 8 times

Q49. For a cantilever beam of length L carrying a triangular load of intensity 'w' at the support and zero at the free end, the slop of the free end is given by
(a) $\frac{WL^3}{8EI}$
(b) $\frac{WL^3}{12EI}$
(c) $\frac{WL^3}{24EI}$
(d) $\frac{WL^3}{48EI}$

Q50. If a simply supported beam of span ℓ carries a point load W at the mid span, then downward deflection under the load will be
(a) $Wl^3/3EI$
(b) $Wl^3/8EI$
(c) $Wl^3/48EI$
(d) $\frac{5}{384} \quad \frac{Wl^3}{3EI}$

Solutions

S1. Ans.(d)
Sol.

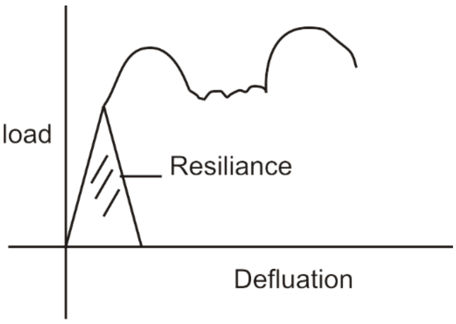
S2. Ans.(a)
Sol.

Material	Modules of Elasticity (GPa)
Alluminium alloys	70-79
Brass	96-110
Bronze	96-120

Cast Iron	83-170
Rubber	0.0007-0.004
Steel	190-210

S3. Ans.(c)
Sol. Resiliance is the ability of material to absorb energy with in the elastic limit & release by unloading.

Resiliance = $\frac{6y^2}{2E}$ (volume)



S4. Ans.(c)
Sol. The stress required to the metal to flow plastically to any given strain

S5. Ans.(d)
Sol. Rupture stress is the sudden and complete failure of a material under stress.

S6. Ans.(a)
Sol. Malleability is the property of material allows it to expand in all direction without rupture.

S7. Ans.(b)
Sol. <u>Toughness</u> – It is the ability of material to deform plastically to absorb Energy before fracture.

S8. Ans.(b)
Sol. <u>Isotropic</u> – material having same elastic property in any direction. Exp. – Brass, glass, Aluminium, Steel, Etc.

S9. Ans.(a)
Sol. Creep is the property of a specimen undergoes additional deformation with the passage of time under sustained loading within elastic limit. It’s can not be recover hence plastic in nature.

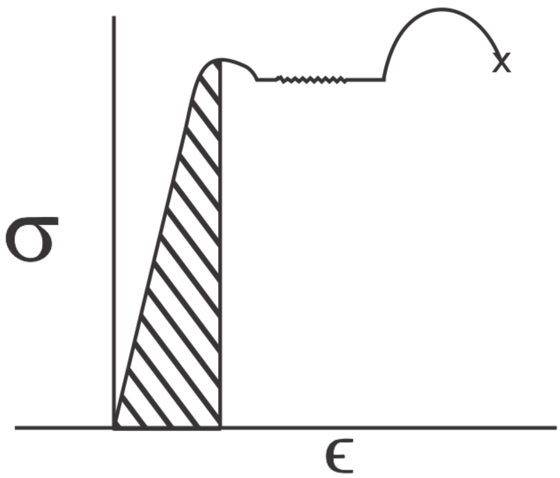
S10. Ans.(b) Refer solution of question number(3)

S11. Ans.(b)
Sol. The stress which can be withstand for some infinite number of cycles without failure is called endurance limit. Endurance limit magnitude less then yield strength.

S12. Ans.(d)
Sol. According to hooks law strain is directly proportional to stress within proportional limit

S13. Ans.(c)
Sol.

S14. Ans.(c)
Sol.



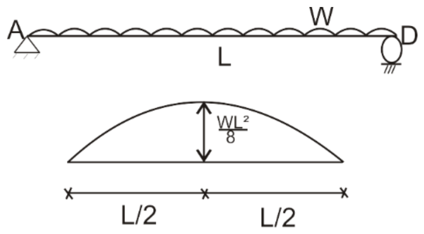
S15. Ans.(C)
Sol.

Proof Resiliance = $\frac{6y^2}{2E} \times Volume$

If volume is unity, then it becomes modulus of resiliance.

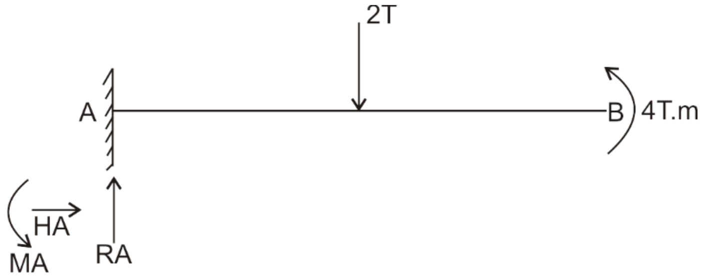
Modules of Resiliance = $\frac{6y^2}{2E}$

S16. Ans.(c)
Sol.



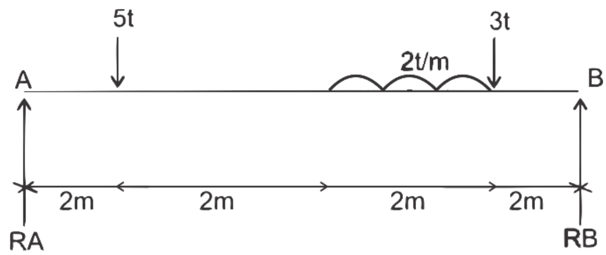
S17. Ans.(a)
Sol. At hinge the value of bending moment will be zero and the value of shear force at the hinge will be maximum.

S18. Ans.(b)
Sol.



$\sum fx = 0$
HA= 0
$\sum fy = 0$
RA= 2T
$\sum MB = 0$
-MA-2T×2m-2Tm = 0
Ma= 8 T.m

S19. Ans.(d)
Sol.



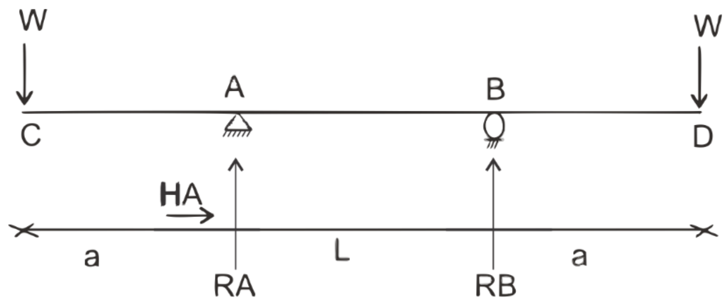
$\sum fx = 0$
$\sum fy = 0$
$R_A + R_B$ = 5t+3t+2t/m×2m
$R_A + R_B$ = 12t -------------------------(1)
$\sum MB = 0$
R_A×8 = 5t×6m+2t/m×2m(1m+2m)+3t(2m)
R_A×8 = 30+12+6
R_A×8 = 48

$\boxed{R_A = 6t}$ put in (1)

$\boxed{R_B = 6t}$

$\boxed{\frac{RA}{RB} = 1}$

S20. Ans.(a)
Sol.



$\sum fx = 0$

HA= 0

$\sum fy = 0$

RA + RB= 2W -(1)

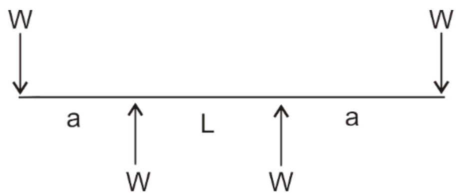
$\sum MB = 0$

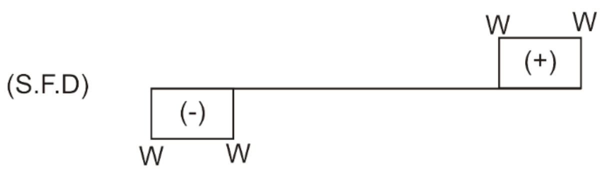
-W(L+a)+RA(L)+W(a) = 0

-WL-Wa+RA L+Wa = 0

R_A= W Punt in eq (1)

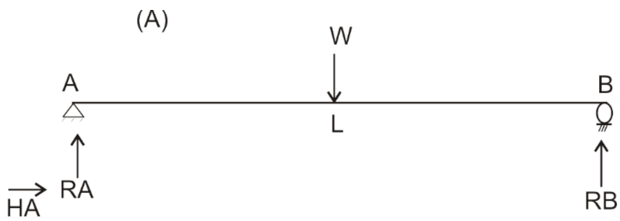
R_B= W





The shear force between the two support is equal to zero.

S21. Ans.(b)
Sol.

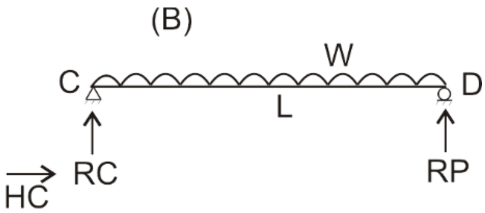


for symmetrical beam

RA= W/2 RB= $\frac{W}{2}$

B.M. at L/2from left support→

$\frac{W}{2} \times \frac{L}{2} \Rightarrow \frac{WL}{4} = M$



For symmetrical beam

$R_A = \frac{WL}{2}$

$R_B = \frac{Wl}{2}$

B.M at mid span.

$\frac{Wl}{2} \times \frac{L}{2} - W \times \frac{L}{2} \times \frac{L}{4}$

$\frac{Wl^2}{4} - \frac{WL^2}{8}$

$\frac{WL^2}{8} = M'$

$$\boxed{\frac{M}{M'} = \frac{\frac{WL}{4}}{\frac{WL^2}{8}} = 2}$$

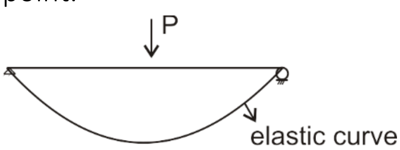
S22. Ans.(b)

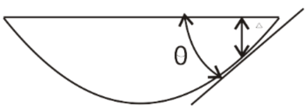
Sol. If the load at the free end of a cantilever beam is increased the failure will occure at the fixed end because due to increase of load moment resisted by fixed support is increased and when support moment reaction increased beyond it's limit then failure occure.

S23. Ans.(a)

Sol. Slope in the beam defined the angle that the tangent to the elastic curve makes with the unbent beam axis.

The vertical distance between beam axis & elastic carve at that point is called deflection at that point.

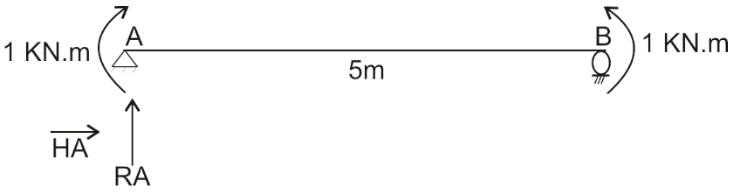




→ all elastic curve are deflected shape but all deflected shape's are not elastic curve.

S24. Ans.(c)

Sol.

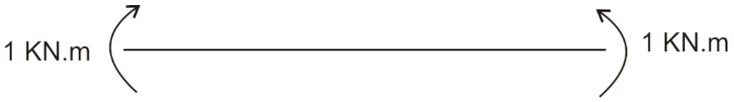


$\sum fy = 0$

RA+RB = 0

$\sum MB = 0$

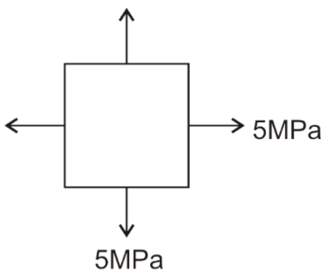
1+RB×5-1 = 0



The magnitude of bending moment at center equal to 1 KN.m

S25. Ans.(d)

Sol.



σx = 5 MPa

σy = 5 MPa

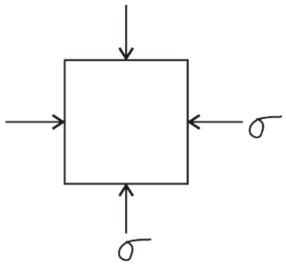
<u>Radious of Mah'r circle =</u> $\left|\frac{\sigma x-\sigma y}{2}\right|$

= $\left|\frac{5-5}{2}\right|$

= 0

S26 Ans.(a)

Sol.

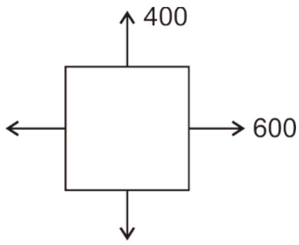


$\sigma_x = -\sigma$
$\sigma_y = \sigma$
Radious of Mohr circle = $\left|\frac{\sigma_x - \sigma_y}{2}\right|$
= $\left|\frac{-\sigma-\sigma}{2}\right|$
= σ

S27. Ans.(a)
Sol. In mohr circle verticle axis represent shear stress & Horizontal axis represent normal stress so the vertical diameter of circle represents maximum shear stress.

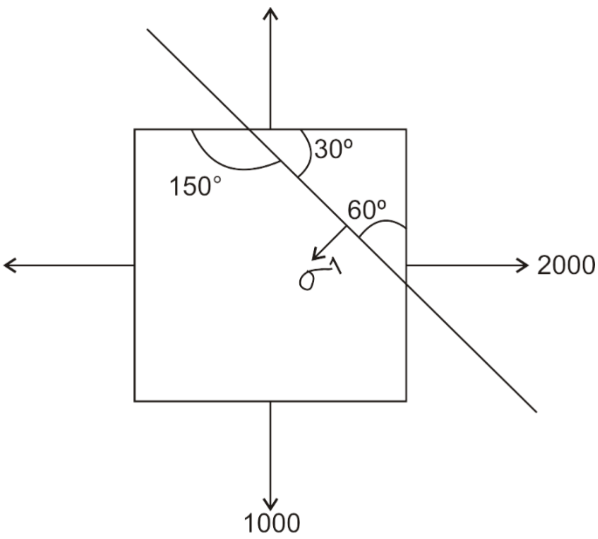
S28. Ans.(b)
Sol. Infinite plane's passes through a single point. Out of infinite plane's three planes are mutually perpendicular to each other and having zero shear stress, that planes are called principal plane.

S29. Ans.(d)
Sol.



σ_x= 600
σ_y = 400
Maximum shear (τ)= $\left|\frac{\sigma_x - \sigma_y}{2}\right|$
= $\left|\frac{600-400}{2}\right| = 100\ MPa$

S30. Ans.(a)
Sol. σ



σ_x = 2000

σ_y = 1000

$\theta = 60°$

τ_{xy} = 0

σ’= $6x\ cos^2\theta + 6y\ sin^2 + 2\ cxy\ cos\theta\ sin\theta$

σ’= $2000\ cos^2 60 + 1000\ sin^2 60 + 2 \times 0 \times \cos 60 \times sin60$

σ’= $2000 \times \frac{1}{4} + 1000 \times \frac{3}{4}$

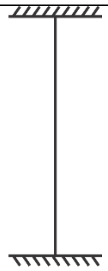
σ’= 500+750

σ’= 1250 kg/cm^2

S31. Ans.(b)
Sol. Max[m] shear strain occure on 45° with the principal planes.

S32. Ans.(b)
Sol.

Condition	Shape	Effective length
(i) If the column ends are effectively held in position and not restrained against rotation at both the end’s		Leff= L
(ii) If column ends are effectively held in position and restrained against rotation at one end		Leff = $\frac{L}{\sqrt{2}}$

(iii)	If column ends are effectively held in position and restrained against rotation at both end's		Leff = $\frac{L}{2}$
(iv)	One end is effectively held in position & restrained against rotation & other end is free.		Leff = 2L

S33. Ans.(b)

Sol. (i) $Pcr = \frac{\pi^2 EI}{Le^2}$

Both end's fixed

Le = L/2

$Pcr_1 = \frac{\pi^2 EJ\times4}{L^2}$ -(i)

(ii) both end's pinned

Le= L

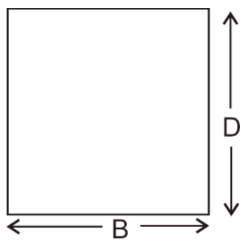
$Pcr_2 = \frac{\pi^2 EI}{L^2}$ -(ii)

$$\frac{Pcr_1}{Pcr_2} = \frac{\frac{\pi^2 EI \times 4}{L^2}}{\frac{\pi^2 EI}{L^2}}$$

= 4

S34. Ans.(b)

Sol.



I = $\frac{BD^3}{12}$

A= B×D

I= Ar² where r→ Radius of gyration

I = moment of Inertia

r= $\sqrt{\frac{I}{A}}$

= $\sqrt{\frac{BD^3/12}{BD}}$

r= $\frac{D}{2\sqrt{3}}$

S35. Ans.(a)
Sol. The short column fail's primarily due to direct stress because in short column the buckling stresses are very small compared to direct stresses.

S36. Ans.(c)
Sol. The ratio of effective length & least lateral dimension for column is greater then '3'.

Slenderness ratio (λ)= $\frac{leff}{L.L.D.}$

λ < 12 → short column

λ ≥12 → Long column

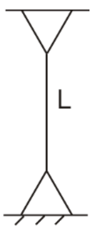
S37. Ans.(a)
Sol. The allowable stress in a long column can be increased by increasing it's radius of gyration and radius of gyration depends on moment of inertia.

$$R = \sqrt{\frac{I}{A}}$$

R- radius of gyration

I- Moment of Inertia

S38. Ans.(c)
Sol.



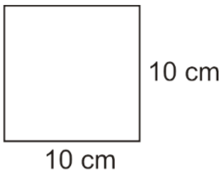
Leff= L

Critical load = $\frac{\pi^2 EI}{Le^2}$

$$Pcr = \frac{\pi^2 EI}{L^2}$$

S39. Ans.(b)
Sol. → Rankines Gorden formula used to find out buckling load of medium column.
→ Euler formula used for calculating buckling load of long column.

S40. Ans.(b)
Sol. → Ranking Gorden formula cased to find out bucking load of medium column.
→ Euler formula used for calculating buckling load of long column.

S41. Ans.(c)
Sol.


Length = 500 cm

I = $\frac{10\times10^3}{12} = \frac{10^4}{12}$

A= 10^2

$R = \sqrt{\frac{I}{A}} = \sqrt{\frac{10^4/12}{10^2}}$

R= 2.88 cm

λ = $\frac{LeH}{R_{min}} = \frac{500}{2.88} = 173.2$

S42. Ans.(d)
Sol. Pe= 1000 KN

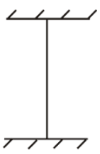
Pcr = 1200 KN

Rankine load = ?

$\frac{1}{P} = \frac{1}{Pe} + \frac{1}{Pc}$

$\frac{1}{P} = \frac{1}{1000} + \frac{1}{1200}$

P= 545.45 KN

S43. Ans.(c)
Sol.


$Le = \frac{L}{2}$

F= $\frac{\pi^2 EI\times4}{L^2}$ -(1)

(ii)


Le= 2L

Pcr = $\frac{\pi^2 EI}{4L^2}$ From equation(1)

Pcr = $\frac{F}{16}$

S44. Ans.(a)

Sol.

$$\frac{R_1}{R_2} = \frac{3}{1}$$

$$R = \frac{\sqrt{I_1/A_1}}{\sqrt{I_2/A_2}} = \frac{3}{1}$$

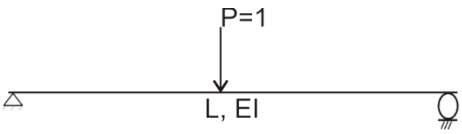
$$\sqrt{\frac{\frac{b_1 d_1^3/12}{b_1 d_1}}{\frac{b_2 d_2^3/12}{b_2 d_2}}} = \frac{3}{1}$$

$$\frac{\sqrt{\frac{d_1^2}{12}}}{\sqrt{\frac{d_2^2}{12}}} = \frac{3}{1}$$

$$\boxed{\frac{d_1}{d_2} = \frac{3}{1}}$$

S45. Ans.(c)

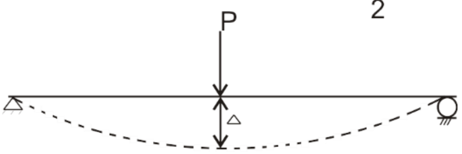
Sol.



strain Engergy = ?

1st method-

strain Engergy = $\frac{1}{2}$×P×△



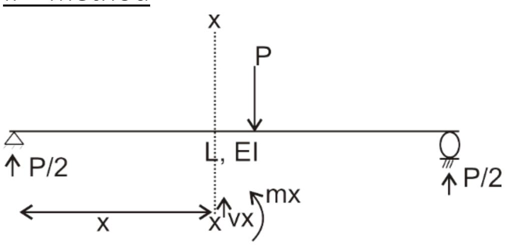
$$\boxed{\Delta = \frac{PL^3}{48EI}}$$

Strain energy = $\frac{1}{2} \times P \times \frac{PL^3}{48EI}$

= $\frac{P^2 L^3}{96EI}$ If P= 1

U= $\frac{L^3}{96EI}$

IInd method



B.M. at x-x section- $\frac{P}{2} \times x - Mx = 0$

$$m_x = \frac{P}{2}x$$

Strain engery (u)= 2x $\int_2^{L/2} \frac{Mx^2dx}{2EI}$

= $2 \times \int_0^{L/2} \frac{P^2x^2dx}{8EI}$

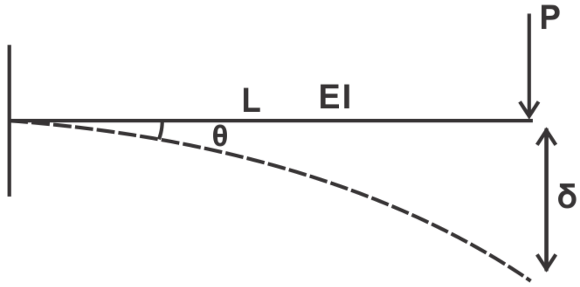
= $\frac{2P^2}{8EI}\left[\frac{x^3}{3}\right]_0^{L/2}$

= $\frac{2P^2L^3}{8\times8\times3EI} \Rightarrow \frac{P^2L^3}{96EI}$ P= 1

$$U = \frac{L^3}{96EI}$$

S46. Ans.(d)

Sol.



$$\boxed{\theta = \frac{PL^2}{2EI}}$$

$$\boxed{S = \frac{PL^3}{3EI}}$$

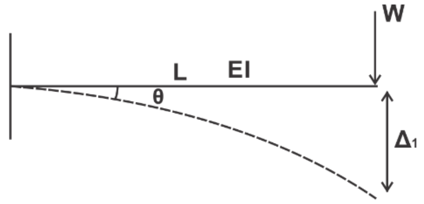
S47. Ans.(a)

Sol. In cantilever beam moment generated in the support is maximum because only one support in all beam.

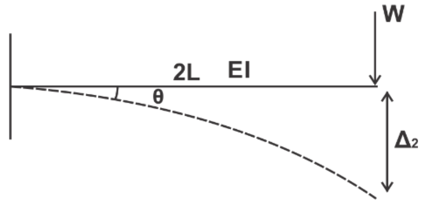
Strain energy $U = \int \frac{Mx^2dx}{2EI}$

S48. Ans.(d)

Sol.



$\Delta_1 = \frac{WL^3}{3EI}$



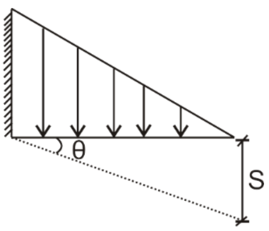
$\Delta_2 = \frac{w(2L)^3}{3EI}$

$\Delta_2 = \frac{8WL^3}{3EI}$

$\boxed{\Delta_2 = 8\Delta_1}$

S49. Ans.(c)

Sol.

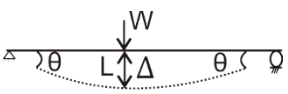


$\theta = \frac{WL^3}{24EI}$

$S = \frac{WL^4}{30EI}$

S50. Ans.(c)

Sol.



$\theta = \frac{WL^2}{16EI}$

$\Delta = \frac{WL^3}{48EI}$