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Address : Office no. 6, 'A' Wing, 3rd Floor, Vega Center Bldg, Shankar Sheth Road, near Income Tax Bldg., Above Airtel Office, Swargate, Pune - 411042.

Phone : 020 - 48627716, **Mobile :** 9420716716

E-mail : iit.academy.pune@gmail.com, iitianspublication@gmail.com

Website : www.iitiansacademypune.com

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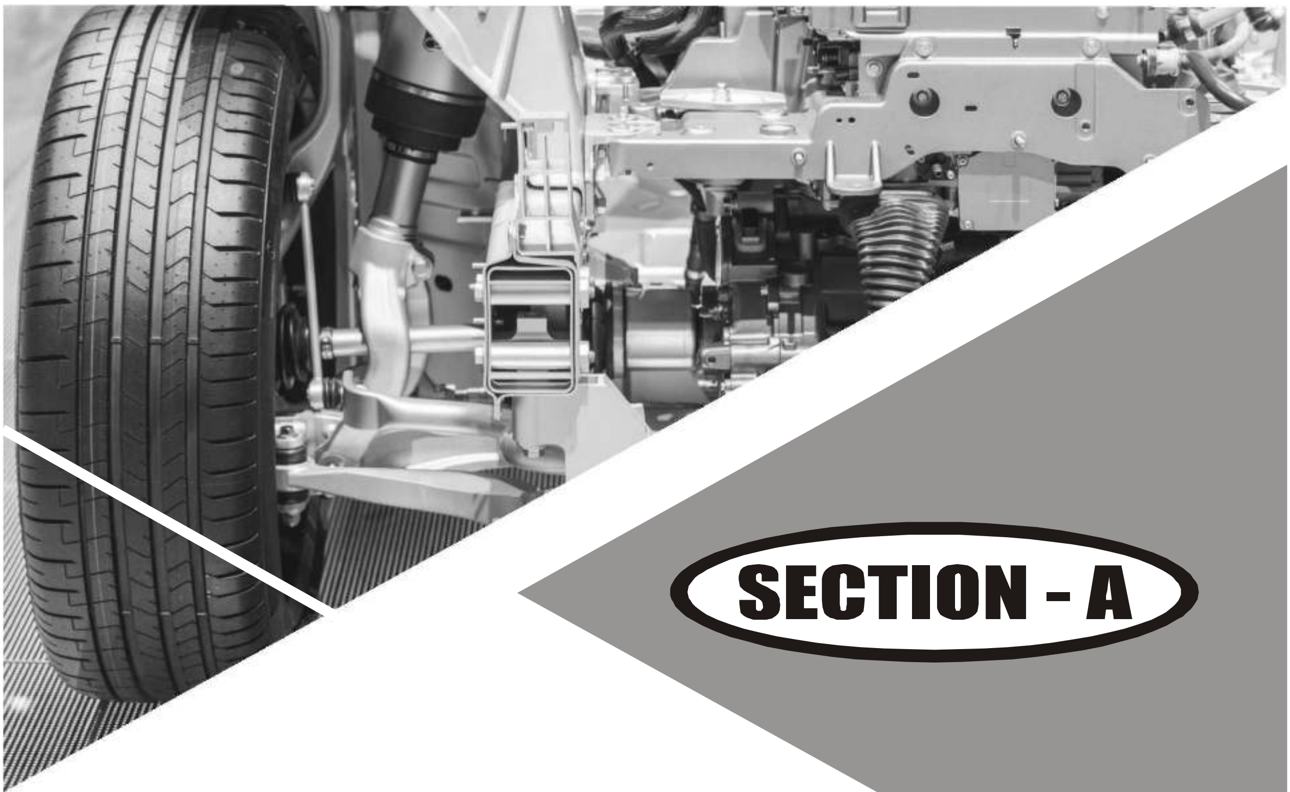
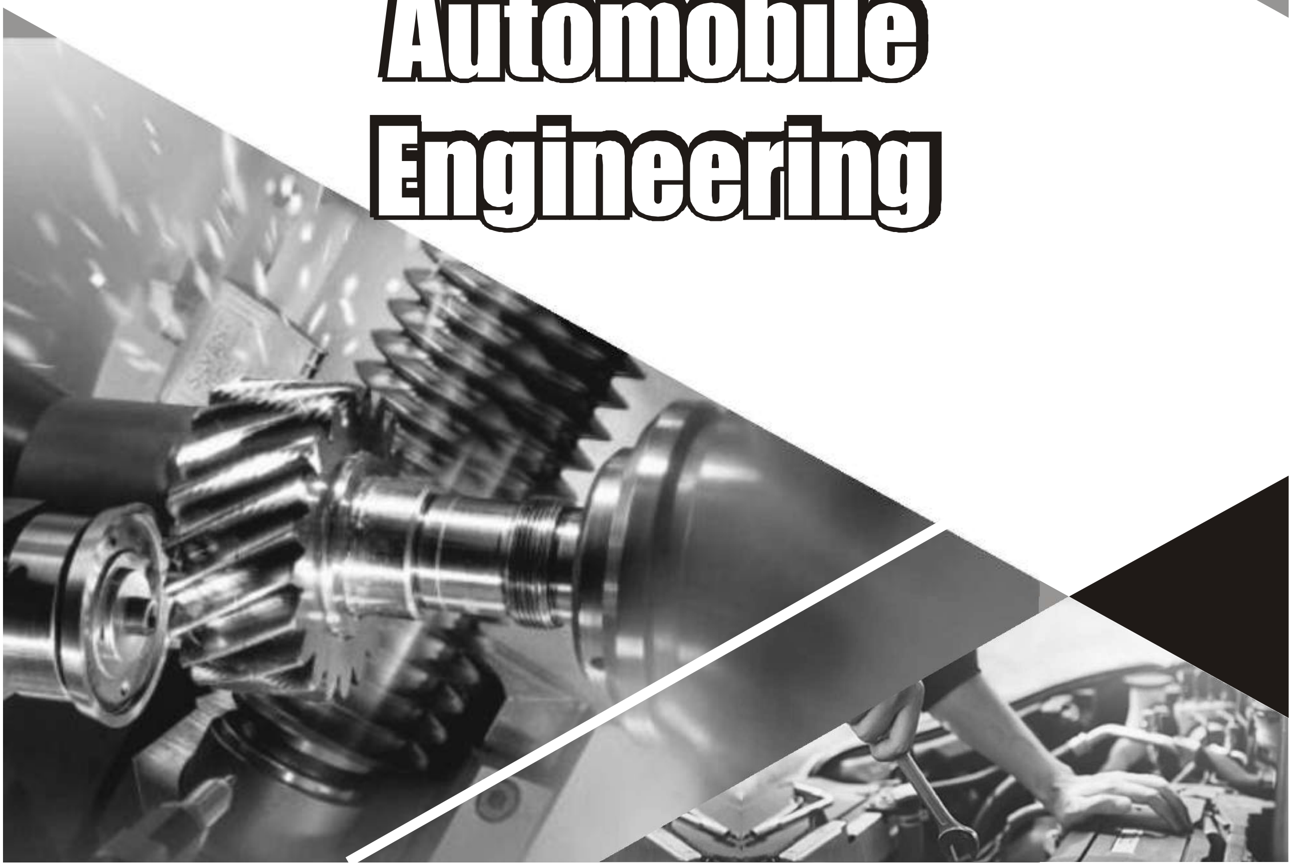


SECTION - A

Mechanical and Automobile Engineering



Strength of Material

CONTENT

1 Simple Stress-Strain and Thermal Stresses

MPSC

1. The relation between Young's Modulus 'E', modulus of Rigidity 'G' and Poisson's ratio $\frac{1}{m}$ is,

(1) $E = MG$ (2) $E = 2G\left(1+\frac{1}{m}\right)$

(3) $E = G\left(1+\frac{1}{m}\right)$ (4) $E = \left(\frac{MG}{2}\right)$

[MPSC - AMVI : 2002]

2. Modulus of rigidity is the ratio of ....

(1) Tensile stress to tensile strain

(2) Shear stress to shear strain

(3) Compressive stress to compressive strain

(4) lateral strain to longitudinal strain

[MPSC - AMVI : 2002]

3. A steel rod of 20 mm diameter and 500 mm long is subjected to an axial pull of 30kN. If $E = 2 \times 10^5$ N/mm^2, the elongation of the rod will be

(1) 0.239 mm (2) 0.0239 mm

(3) 0.00239 mm (4) 23.9 mm

[MPSC - AMVI : 2002]

4. What is the strain in a bar having cross-section area 50 mm^2 subjected to 10 kN axial load? Assume Young's Modulus as 2×10^5 N/mm2

(1) 0.001 (2) 0.002

(3) 0.0001 (4) 0.01

[MPSC - AMVI : 2002]

5. If material expands freely due to heating. it will develop

(1) Thermal stresses (2) Tensile stresses

(3) Compressive stresses (4) No stress

[MPSC - AMVI : 2003]

6. The property by which a body regains its original shape after removal of force is defined as

(1) Plasticity (2) Elasticity

(3) Ductility (4) Malleability

[MPSC - AMVI : 2005]

7. The ratio of change in volume and original volume of the body is called as

(1) Tensile strain (2) Compressive strain

(3) Shear strain (4) Volumetric strain

[MPSC - AMVI : 2005]

8. When a bar is subjected to a change of temperature and its deformation is prevented the stress induced in the bar is

(1) Tensile stress (2) Compressive stress

(3) Shear stress (4) Thermal stress

[MPSC - AMVI : 2011]

9. Hooke's law holds good up to

(1) Yield point (2) Elastic limit

(3) Plastic limit (4) Breaking point

[MPSC - AMVI : 2011]

10. The Poisson's ratio for steel varies from

(1) 0.23 to 0.27 (2) 0.25 to 0.33

(3) 0.31 to 0.34 (4) 0.32 to 0.42

[MPSC - AMVI : 2011]

11. Factor of safety is defined as the ratio of

(1) Ultimate stress to working stress

(2) Working stress to ultimate stress

(3) Breaking stress to ultimate stress

(4) Ultimate stress to breaking stress

[MPSC - AMVI : 2011]

12. The principal stresses at a point a two-dimensional stress system are σ_1, σ_2 and corresponding principal strains are ε_1, ε_2. If E and μ denote Young's modulus and Poisson's ratio, then which one of the following is correct?

(3) Both elastic and plastic
(4) Neither elastic nor plastic

[MPSC - 2014]

RPSC

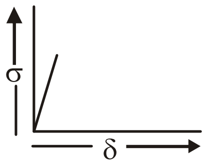
22. For a material with the Poisson's ratio μ, the modulus of elasticity (E) and the bulk modulus of elasticity (K) are same. Which of the following is correct?
(1) The material has μ = 0
(2) The material has μ = 1/2
(3) The material has μ = 1/3
(4) The material has μ = 3/4

[RPSC : 2013]

23. Modulus of Rigidity is related to -
(1) Length (2) Shape
(3) Size (4) Volume

[RPSC : 2018]

24. The stress-strain curve of an ideal elastic material with strain hardening will be as -

(1)


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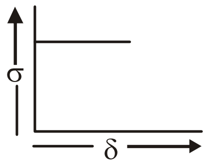

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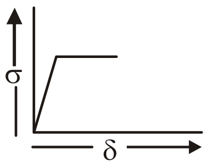

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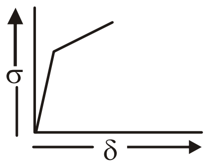


[RPSC : 2018]

25. In a 3 - D state of stress, the independent stress components required to define state-of-stress at a point are -
(1) 3 (2) 6
(3) 12 (4) 9

[RPSC : 2018]

26. If E is the Young's modulus, K is the bulk modulus and C is the modulus of rigidity, the relation between them is______

(1) $E = \frac{3K}{9K + C}$ (2) $E = \frac{9KC}{3K + C}$

(3) $E = \frac{3K + C}{9KC}$ (4) $E = \frac{3K}{9K + C}$

[RPSC : 2018]

27. The ratio of transverse contraction strain to longitudinal extension strain in the direction of stretching force within elastic limits and for a homogeneous materials is_____
(1) Modulus of Elasticity
(2) Modulus of Rigidity
(3) Bulk Modulus
(4) Poisson Ratio

[RPSC : 2018]

28. A steel rod 10 mm in diameter and 1 m long is heated from 20 °C to 120 °C, E = 200 GPa and $\alpha = 12 \times 10^{-6}$ per °C. If the rod is not free to expand, the thermal stress developed is :
(1) 120 MPa (tensile)
(2) 240 MPa (tensile)
(3) 120 MPa (compressive)
(4) 240 MPa (compressive)

[RPSC : 2018]

29. The ratio of lateral strain to linear strain is known as
(1) Modulus of elasticity
(2) Modulus of rigidity
(3) Poisson's ratio
(4) Elastic limit

[RPSC : 2018]

30. A steel bar of 40 mm × 40 mm square cross-section is subjected to an axial compressive load of 200 kN. If the length of the bar is 2 m and E = 200 GPa, the elongation of the bar will be :
(1) 1.25 mm (2) 2.70 mm
(3) 4.05 mm (4) 5.40 mm

[RPSC : 2018]

43. The thermal stresses are caused due to
(1) Variation in temperature
(2) Specific heat
(3) Latent heat
(4) None of the options
[GPSC : 2018]

44. The point corresponding to maximum stress in engineering stress-strain diagram is designated as
(1) Ultimate tensile stress
(2) Yield stress
(3) Fracture stress
(4) None of the options
[GPSC : 2018]

45. Poisson's ratio of perfectly linear elastic material is
(1) 0 (2) 1
(3) 0.3 (4) 0.5
[GPSC : 2019]

46. Materials having same properties in all directions are called
(1) Smart materials
(2) Functional materials
(3) Isotropic materials
(4) Ideal materials
[GPSC : 2019]

47. In a tensile test on mild steel specimen, the breaking stress as compared to ultimate tensile stress is
(1) More
(2) Less
(3) Same
(4) More/less depending on composition
[GPSC : 2019]

48. Among the following, which material is elastic?
(1) Steel (2) Ceramic
(3) Glass (4) Cast Iron
[GPSC : 2019]

49. The relationship among the elastic constant E (Young's modulus), K (Bulk modulus) and v (Poisson's ratio) is
(1) $K = \frac{3E}{(1-2v)}$ (2) $K = \frac{3E}{(1+2v)}$
(3) $K = \frac{E}{3(1+2v)}$ (4) $K = \frac{E}{3(1-2v)}$
[GPSC : 2019]

OPSC

50. Two identical circular rods made of cast iron and mild steel are subjected to same magnitude of axial force. The stress developed is within proportional limit. Which of the following observation is correct?
(1) Both rods elongate by same amount
(2) MS rod elongates more
(3) CI rod elongates more
(4) Both stress and strain are equal in both rods
[OPSC : 2015]

51. For a linearly elastic, isometric and homogeneous material, the number of elastic constants required to relate stress and strain are :
(1) Four (2) Two
(3) Three (4) Six
[OPSC : 2015]

52. Engineering stress-strain curve and true stress-strain curve are equal up to :
(1) Proportional limit
(2) Elastic limit
(3) Yield point
(4) Tensile strength point
[OPSC : 2019]

53. Strain is defined as the ratio of :
(1) Change in volume to original volume
(2) Change in length to original length
(3) Change in cross-sectional area to original cross-sectional area
(4) Any one of these
[OPSC : 2019]

(3) Becomes four times
(4) Remains unaffected

[TNPSC : 2017]

63. One kgf/cm^2 when converted to SI units is
(1) 0.0981 MPa (2) 0.98 MPa
(3) 10^4 Pa (4) 1 Pa

[TNPSC : 2017]

64. Lateral strain ($\in$') can be expressed as
(1) $\frac{\delta l}{l}$ (2) $\frac{l}{\delta l}$
(3) $\gamma \in$ (4) $-\gamma \in$

[TNPSC : 2018]

65. $\sigma \alpha \in$. This rule is known as
(1) Castinglo's theorem
(2) Hook's law
(3) Young's theorem
(4) Reynold law

[TNPSC : 2018]

66. The elastic stress-strain behaviour of rubber is
(1) Linear (2) Non-linear
(3) Plastic (4) Normal curve

[TNPSC : 2018]

67. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.09 mm and change in diameter is 0.0039 mm. Find its Poisson's ratio.
(1) 0.309 (2) 0.299
(3) 0.289 (4) 0.279

[TNPSC : 2019]

Answers Simple Stress-Strain and Thermal Stresses

1.	(2)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(4)	**6.**	(2)	**7.**	(4)	**8.**	(4)	**9.**	(2)
10.	(2)	**11.**	(1)	**12.**	(2)	**13.**	(4)	**14.**	(2)	**15.**	(3)	**16.**	(2)	**17.**	(3)	**18.**	(2)
19.	(1)	**20.**	(2)	**21.**	(2)	**22.**	(3)	**23.**	(2)	**24.**	(4)	**25.**	(2)	**26.**	(2)	**27.**	(4)
28.	(4)	**29.**	(3)	**30.**	(1)	**31.**	(2)	**32.**	(1)	**33.**	(4)	**34.**	(1)	**35.**	(3)	**36.**	(2)
37.	(2)	**38.**	(3)	**39.**	(2)	**40.**	(2)	**41.**	(3)	**42.**	(3)	**43.**	(1)	**44.**	(1)	**45.**	(2)
46.	(3)	**47.**	(2)	**48.**	(1)	**49.**	(4)	**50.**	(3)	**51.**	(2)	**52.**	(3)	**53.**	(4)	**54.**	(2)
55.	(3)	**56.**	(1)	**57.**	(3)	**58.**	(2)	**59.**	(2)	**60.**	(3)	**61.**	(3)	**62.**	(4)	**63.**	(1)
64.	(4)	**65.**	(2)	**66.**	(2)	**67.**	(3)										

Explanations Simple Stress-Strain and Thermal Stresses

1. Ans : 2

E = Young's modulus of elasticity (N/mm^2)
G = Shear modulus of rigidity (N/mm^2)
K = Bulk modulus of elasticity (N/mm^2)

μ = Poisson's ratio or $\left(\frac{1}{m}\right)$

Some Important relation between E, G, K and μ are as Follow.

$$E = 2G(1+\mu) = \boxed{2G\left(1+\frac{1}{m}\right)}$$

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

$$E = \left(\frac{9KG}{3K+G}\right) \text{ or } \frac{9}{E} \equiv \frac{1}{K} + \frac{3}{G}$$

$$\mu = \frac{3K-2G}{6K+2G}$$

2. Ans : 2

Defination's of elastic constants are

I) Modulus of rigidity (G) :

It is defined as the ratio of shear stress to shear strain.

The strain along (1) is given by Hook's law

$$\varepsilon_1 = \frac{\sigma_1}{E} - \mu\frac{\sigma_2}{E}$$

$E\varepsilon_1, = \sigma_1 - \mu\ \sigma_2$ ....(I)

Similarty along (2) is

$$\varepsilon_2 = \frac{\sigma_2}{E} - \mu\frac{\sigma_1}{E}$$

$E\varepsilon_2, = \sigma_2 - \mu\ \sigma_1$ ....(II)

From equation (I) and (II)

$E\varepsilon_1 = \sigma_1 - \mu\ (E\varepsilon_2 + \mu\ \sigma_1)$ $\quad \because \sigma_2 = E\varepsilon_2 + \mu\ \sigma_1$

$E\varepsilon_1 = \sigma_1 - \mu E\varepsilon_2 - \mu^2 \sigma_1$

$E\ (\varepsilon_1 + \mu\ \varepsilon_2) = \sigma_1\ (1 - \mu^2)$

$$\sigma_1 = \frac{E}{1-\mu^2}(\varepsilon_1 + \mu\ \varepsilon_2)$$

Similarly relation for second principal stress is

$$\sigma_2 = \frac{E}{1-\mu^2}(\varepsilon_2 + \mu\ \varepsilon_1)$$

13. Ans : 4

We know that

$$E = \frac{9KG}{3K+G}$$

$$\frac{1}{E} = \frac{3K+G}{9KG}$$

$$\frac{9}{E} = \left(\frac{1}{K} + \frac{3}{G}\right)$$

Where,

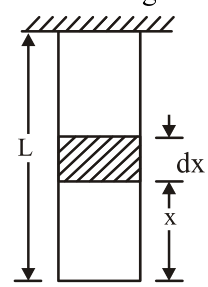
E = Young's modulus of elasticity (N/mm^2)

G = Shear modulus of rigidity (N/mm^2)

K = Bulk modulus of elasticity (N/mm^2)

14. Ans : 2

Consider a bar hanging freely under it's own weights as shown in Fig.



L = Length of the bar

A = Cross section area of the bar

E = Young's modulus for the bar material

w = Specific weight of the bar material

Now, consider a small section dx of the bar at a distance x from lower end. We know that the weight of the bar for length of x

$$P = wAx$$

$\therefore$ Elongation of small section of the bar, due to weight of the bar for small section of length x,

$$= \frac{PL}{AE} = \frac{(wAx).dx}{A.E} = \frac{wx.dx}{E}$$

Total elongation of the bar may be found out by integrating the above equation between 0 and L

$$\therefore \qquad \delta_\ell = \int_0^L \frac{wx.dx}{E}$$

$$= \frac{w}{E}\int_0^L x.dx$$

$$= \frac{w}{E}\left[\frac{x^2}{2}\right]_0^L$$

$$\delta_\ell = \frac{wL^2}{2E} = \frac{WL}{2AE}$$

($\because$ W = wAL = Total weight)

Note :

From above result, we found that the deformation of the bar, due to Its weight, is equal to half of the deformation, if same body is subjected to direct load equal to weight of the body

15. Ans : 3

Important terms related to stress-strain diagram

(a) Ultimate stress : The ratio of largest load in a test to the original cross-section area of the test piece is called ultimate stress.

$$\therefore \text{Ultimate stress} = \frac{\text{Maximum load}}{\text{original cross section area}}$$

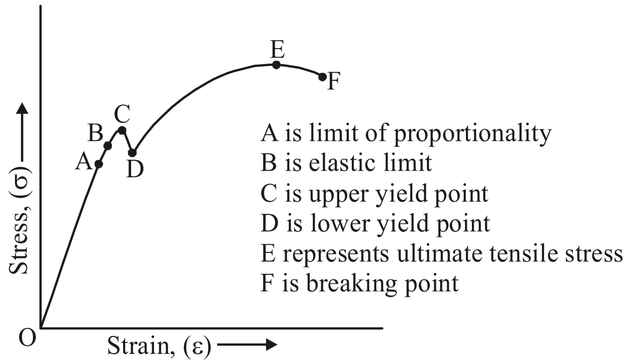
(b) Breaking stress : It is the ratio of load at breaking point to the original cross-section area of test piece.

$$\therefore \text{Breaking stress} = \frac{\text{Load at breaking point}}{\text{original cross section area}}$$

(c) Yield stress : It is defined as the ratio of load at yield point to original cross-section area of the test piece

$$\therefore \text{Yield stress} = \frac{\text{Yield Load}}{\text{original cross section area}}$$

16. Ans : 2



The following are the specific point on the curve.

I) Limit of proportionality (A) :

In the range OA, the stress is directly proportional to strain. Point A is called limit of proportionality.

Up to point A, Hook's law is obeyed.

II) Elastic limit (B) :

If the load is increased beyond A upto the point B, the material behaves in elastic manner that is on removel of load, the material return back to it's original shape and size.

III) Upper Yield point (C) :

At this point there is an increase in strain even though there is no increase in stress (Load)

This is the point at which plastic deformation is initiated.

IV) Lower yield point (D) :

After upper yield point, there is a drop in the value of stress. The point upto which this abnormality occures is called lower yield point.

Note : Upper yield point is unstable in nature but lower yield point is stable, during designing lower yield point is considered

V) Ultimate point (E) :

The stress corresponding to this point is maximum.

After increasing load beyond yield point, the stress-strain curve rises till the point 'E' which is called as ultimate point.

At this stage cross-section area at particular section start reducing very fast, that is neck formation will start from this point.

VI) Breaking point (F) :

The point where material breaks is called breaking point.

The stress associated with this point is known as breaking stress or rupture stress.

17. Ans : 3

$E = 2G(1 + \mu)$

$$(1 + \mu) = \frac{E}{2G}$$

$$(2 + 2\mu) = \frac{E}{G} \quad \text{...............(1)}$$

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

$$(1 - 2\mu) = \frac{E}{3K} \quad \text{...............(2)}$$

Adding (1) & (2) we get,

$$3 = \frac{E}{G} + \frac{E}{2K} = E\left(\frac{1}{G} + \frac{1}{3K}\right)$$

$$= \frac{E}{3KG}(3K + G)$$

$$E = \frac{9KG}{3K + G}$$

E = Young's modulus of elasticity (N/mm^2)

G = Shear modulus of rigidity (N/mm^2)

K = Bulk modulus of elasticity (N/mm^2)

μ = Poisson's ratio or $\left(\frac{1}{m}\right)$

18 Ans : 2

Given,

Large diameter (d_1) = (D + a) and

Smaller diameter (d_2) = (D - a)

P = Pull on the bar

L = Length of the bar

E_1 = Young's modulus by the tapering formula.

E_2 = Young's modulus by the mean diameter formula.

δl = Extension of the bar.

First of all, we will find out the values of young's modulus for test bar by tapering formula and then by the mean diameter formula, we know that extension of the bar by uniformly varying formula.

$$\delta_l = \frac{4PL}{\pi E_1 d_1 d_2} = \frac{4PL}{\pi E_1 (D+a)(D-a)}$$

$$= \frac{4PL}{\pi E_1 (D^2 - a^2)}$$

$$E_1 = \frac{4PL}{\pi (D^2 - a^2)\delta_l} \quad ....(I)$$

Extension of the bar by mean diameter (D) formula,

$$\delta_l = \frac{P.L}{A E_2} = \frac{PL}{\frac{\pi}{4} D^2 \times E_2}$$

$$= \frac{4PL}{\pi D^2 E_2}$$

$$E_2 = \frac{4PL}{\pi D^2 . \delta_l} \quad ....(II)$$

$\therefore$ Percentage error involved

$$= \left(\frac{E_1 - E_2}{E_1}\right) \times 100$$

$$= \frac{\left[\frac{4PL}{\pi (D^2 - a^2).\delta_l}\right] - \left[\frac{4PL}{\pi D^2 . \delta_l}\right]}{\frac{4PL}{\pi (D^2 - a^2)\delta_l}} \times 100$$

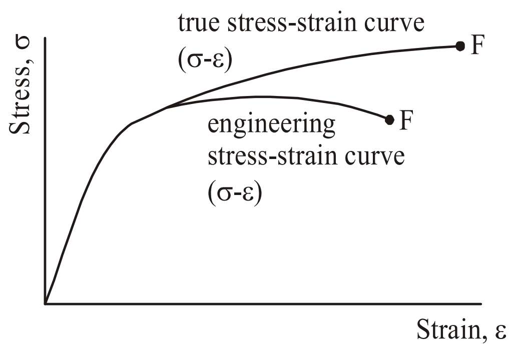
$$= \frac{\frac{1}{(D^2 - a^2)} - \frac{1}{D^2}}{\frac{1}{(D^2 - a^2)}} \times 100$$

$$= \frac{\frac{D^2 - (D^2 - a^2)}{(D^2 - a^2).(D^2)}}{\frac{1}{(D^2 - a^2)}} \times 100$$

$$= \frac{a^2}{D^2} \times 100 = \left(\frac{10a}{D}\right)^2$$

19 Ans : 1

True and Engineering Stress-Strain Curves



- Engineering stress is always lower than the corresponding true stress in tension, as Engineering stress consider original area of cross section while true stress consider a actual area of cross section.
- Engineering strain in tension is always higher than corresponding true strain as engineering strain considers original length while true strain consider actual length and actual length is always higher than original length in tension. In compression, engineering strain is always lower than corresponding true strain.
- The slope of engineering stress engineering strain diagram in tension is always lower than corresponding true stress-true strain diagram.

4 Moment of Inertia

MPSC

1. The moment of inertia of semicircular area about its diameter 'd' is

(1) $\frac{\pi D^4}{32}$ (2) $\frac{\pi D^4}{64}$

(3) $\frac{\pi D^4}{128}$ (4) None

[MPSC - AMVI : 1998]

2. A rectangular section has 200 mm depth and 300 mm width. Determine Moment of Inertia about centroidal axis parallel to the width.

(1) 450×10^6 mm^4
(2) 200×10^6 mm^4
(3) 300×10^6 mm^4
(4) 600×10^6 mm^4

[MPSC - AMVI : 2002]

3. If the two axes about which the product of inertia is found, are such that the product of inertia becomes zero, the two axes are called as

(1) Centroidal axes
(2) Principal axes
(3) Major and minor axes
(4) None of the above

[MPSC - AMVI : 2005]

4. Moment of inertia of triangular section having base 80 mm and height 60 mm about axis passing through CG and parallel to base is

(1) 15×10^6 mm^4
(2) 20×10^6 mm^4
(3) 480×10^3 mm^4
(4) 1440×10^3 mm^4

[MPSC - AMVI : 2013]

5. Moment of inertia of quarter circle of radius 'r' about 'x' axis passing through centroid is:

(1) $I_X = 0.055r^4$
(2) $I_X = 0.11r^4$
(3) $I_X = 0.4r^4$
(4) None of these

[MPSC - AMVI : 2017]

6. Moment of inertia of hollow rectangular section having outer depth 'D' and breadth 'B' and dimensions of inner rectangle are depth 'd' and width 'b' about horizontal axis passing through centroid is:

(1) $\frac{BD^3}{12}$

(2) $\frac{bd^3}{12}$

(3) $\frac{BD^3 - bd^3}{12}$

(4) $\frac{BD^2 - bd^2}{12}$

[MPSC - AMVI : 2017]

7. Moment of Inertia of Triangular section of base "b" and height "h" about its base is:

(1) $\frac{bh^3}{3}$ (2) $\frac{bh^3}{36}$

(3) $\frac{bh^3}{12}$ (4) None of these

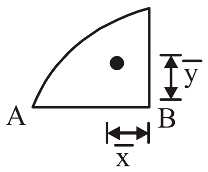
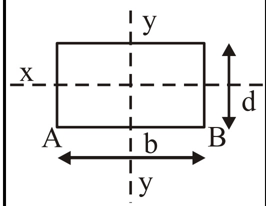
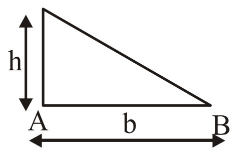
[MPSC - 2014]

8. The mass moment of inertia of a cylinder having radius 'R' and mass 'm' about its axis is equal to

(1) $I = \frac{1}{2}mR^2$ (2) $I = mR^4$

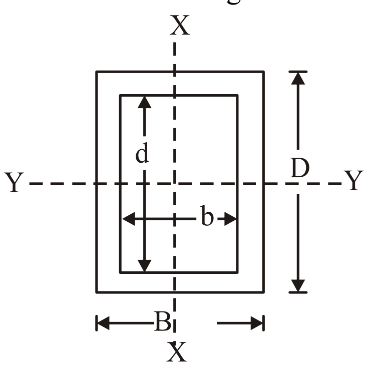
(3) $I = \frac{m}{3}R^3h$ (4) $I = \frac{mR}{2}$

[MPSC Civil Engg. : 2017]

3. quarter circle		about its centroid is $I_{xx} = 0.055\ r^4$ about its base is $I_{AB} = \frac{\pi}{256} d^4$
4.Rectangle		about its centroid is $I_{xx} = \frac{bd^3}{12}$ $I_{yy} = \frac{bd^3}{12}$ about its base is $I_{AB} = \frac{bd^3}{3}$
5. Triangle		about its centroid is $I_{xx} = \frac{bh^3}{36}$ about its base is $I_{AB} = \frac{bh^3}{12}$

6. Ans : 3

Consider hollow reactangular section



B = Breadth of the outer rectangle

D = Depth of the outer rectangle

b, d = corresponding value

for the cut out rectangle

we know that the MOI of the outer rectangle about x - x axis

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

and MOI of inner rectangle about x - x axis is

$$= \frac{bd^3}{12}$$

MOI of the hollow rectangular section about x - x axis,

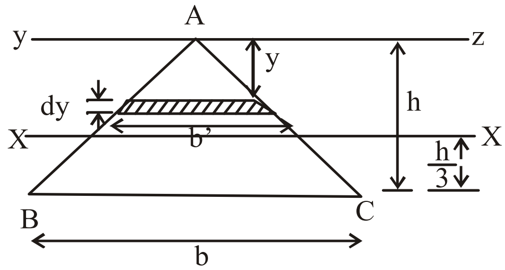
$$I_{xx} = \text{MOI of outer rectangle} - \text{MOI of inner rectangle}$$

$$= \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$I_{xx} = \frac{B.D^3 - bd^3}{12}$$

$$\text{Similarly, } I_{yy} = \frac{DB^3 - db^3}{12}$$

7. Ans : 3



Consider a triangular section of base 'b' and height 'h' as shown in fig. The centroidal axis parallel to the base is at $\frac{h}{3}$ from it

Consider an elemental strip parallel to x - x axis at a distance y from apex 'A' and of thickness dy.

area of element strip = b'dy.

$$\frac{b'}{y} = \frac{b}{h} \quad \text{.....(Similarity triangle)}$$

28. The maximum normal stress theory is used for
(1) Brittle materials
(2) Ductile materials
(3) Plastic materials
(4) Non-Ferrous materials
[GPSC : 2019]

29. If the centre of Mohr's stress circle coincides with the origin on the $\sigma - \tau$ coordinates, then
(1) $\sigma_x + \sigma_y = 0$ (2) $\sigma_x - \sigma_y = 0$
(3) $\sigma_x + \sigma_y = 1/2$ (4) $\sigma_x - \sigma_y = 1/2$
[GPSC : 2019]

30. Maximum principal stress theory is applicable for
(1) Ductile materials (2) Brittle materials
(3) Elastic materials (4) All of the above
[GPSC : 2019]

31. Maximum shear stress in a Mohr's circle
(1) Is equal to the radius of Mohr's circle
(2) Is greater than the radius of the Mohr's circle
(3) Is less than the radius of the Mohr's circle
(4) None of the above
[GPSC : 2019]

32. **Assertion (A) :** A plane state of stress always results in a plane state of strain.
Reason (R) : A uniaxial state of stress results in a three-dimensional state of strain.
(1) Both A and R are individually true and R is the correct explanation of A.
(2) Both A and R are individually true but R is not the correct explanation of A.
(3) A is true but R is false.
(4) A is false but R is true.
[GPSC : 2019]

OPSC

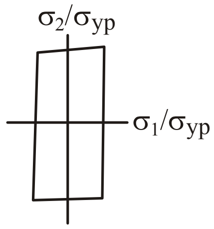
33. The maximum distortion energy theory of failure is suitable to predict the failure of one of the materials is :
(1) Brittle material (2) Ductile material
(3) Plastics (4) Composite materials
[OPSC : 2015]

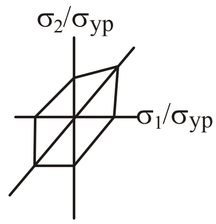
34. Tha state of stress at a point under plane stress condition is σ_{xx} = 40 MPa, σ_{yy} = 100 MPa and τ_{xy} = 40 MPa. The radius of the Mohr's circle representing the given state of stress in MPa is :
(1) 40 (2) 50
(3) 60 (4) 100
[OPSC : 2019]

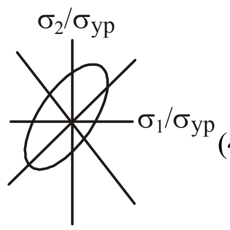
35. Mohr's circle for the state of stress defined by $\begin{bmatrix} 20 & 0 \\ 0 & 20 \end{bmatrix}$ is a circle with :
(1) Centre at (0, 0) and radius 20 MPa
(2) Centre at (0, 0) and radius 40 MPa
(3) Centre at (20, 0) and radius 20 MPa
(4) Centre at (20, 0) and zero radius
[OPSC : 2019]

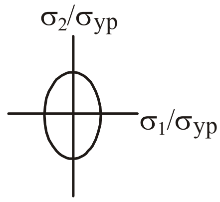
36. Which of the following is applied to brittle materials?
(1) Maximum principal stress theory
(2) Maximum principal strain theory
(3) Maixmum strain energy theory
(4) Maximum shear stress theory
[OPSC : 2019]

37. Which one of the following figures represents the maximum principal stress theory?

(1)


(2)


(3)


(4)


[OPSC : 2019]

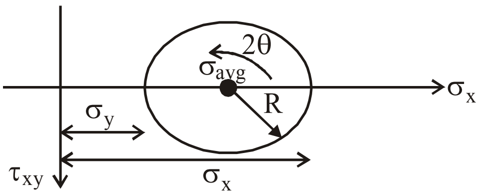
$$\sigma_{P1} = \frac{\sigma}{2} + \frac{1}{2}\sqrt{\sigma^2 + 4\sigma^2}$$

11. Ans : 4

Minor principal plane is at an angle of $(\theta_p + 90^o)$ where,

θ_p = Angle of major principal plane

12. Ans : *



equation of mohr's circle is

$$(\sigma_x - \sigma_{avg})^2 + (\tau_{xy} - 0)^2 = R^2$$

From equation of circle

Center of mohr's circle $= (\sigma_{avg}, 0)$

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

Correct option is (1)

13. Ans : 4

Given,

σ_1 = 1.5 f (tensile)

σ_2 = f (tensile)

$\sigma_3 = -\frac{f}{2}$ (compressive)

σ = 200 N/mm^2

According maximum shear stress theory

$$\max\left\{\left|\frac{\sigma_1 - \sigma_2}{2}\right|, \left|\frac{\sigma_2 - \sigma_3}{2}\right|, \left|\frac{\sigma_3 - \sigma_1}{2}\right|\right\} \le \frac{\sigma}{2}$$

$$\max\left\{|1.5F - FI|, \left|F - \left(\frac{-F}{2}\right)\right|, \left|\frac{-F}{2} - 1.5F\right|\right\}$$

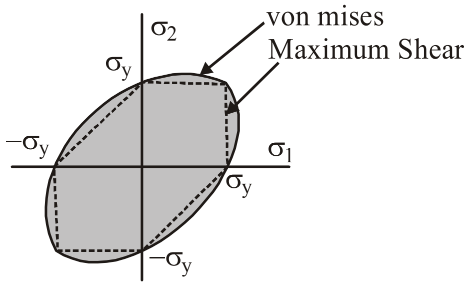
$$\le 200 N/mm^2$$

$$\max\left\{\frac{f}{2}, \frac{3f}{2}, 2f\right\} \le 200 N/mm^2$$

2f = 200 N/mm^2

f = 100 N/mm^2

14. Ans : 2



- Maximum shear stress theory is well justified for ductile material.
- Maximum shear stress theory is more conservative than the von mises criterion since It lies inside the von mises ellipse as shown in the fig.

Note :

Maximum principal stress theory (Rankine's theory) gives satisfactory result for brittle material.

15. Ans : 1

From Torsion equation

$$\frac{T}{J} = \frac{\tau}{r}$$

$$\tau = \frac{16T}{\pi d^3} \qquad ....(T = M_t)$$

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

17. Ans : 1

- Maximum principal stress theory (Rankine's theory) is not suitable for safe design of ductile material because ductile materials are weak in shear.
- This theory is suitable for safe design of brittle materials under all loading conditions (3D, 2D) because brittle materials are weak in tension.

18. Ans : 1

Given,

σ_x = 80 MPa (tensile)

σ_y = 20 MPa (tensile)

τ_{xy} = 40 MPa

τ_{max} = ?

Maximum shear stress (τ_{max}) is

7 Metal Cutting

MPSC

1. To increase surface finish during machining -
(1) Increase depth of cut
(2) Increase feed rate
(3) Increase cutting speed
(4) Use cutting tool with build - up
[MPSC - AMVI : 1998]

2. Kerosene is used as cutting fluid while machining
(1) Magnesium (2) Copper
(3) Aluminium (4) Brass
[MPSC - AMVI : 1998]

3. Negative rake angle is provided usually on........
(1) HSS carbon tools
(2) High carbon steel tools
(3) Cemented carbide tools
(4) Ceramic tools
[MPSC - AMVI : 1998]

4. For soft materials like brass, the cutting tools should have
(1) Large side rake angle
(2) Zero side rake angle
(3) Back rake angle between 6^0 to 15^0
(4) Small end relief angle
[MPSC - AMVI : 1998]

5. What are the two basic ways of metal cutting using a single-point cutting tool and a multi-point cutting tool ?
(1) "Single" and "multi-direction" cutting
(2) "Perpendicular" and "Oblique" cutting
(3) "Orthogonal" and "Oblique" cutting
(4) "Orthogonal" and "Straight" cutting
[MPSC - AMVI : 2002]

6. The vector sum of cutting velocity and chip velocity is .... shear velocity.
(1) Equal to (2) More than
(3) Less than (4) Half of the
[MPSC - AMVI : 2003]

7. The rake angle of cutting tool ....
(1) Controls the chip formation
(2) Prevents rubbing
(3) Determines the profile of the tool
(4) Determines whether the cutting action is oblique or orthogonal
[MPSC - AMVI : 2003]

8. What are conditions which tend to promote the formation of built-up edge of cutting tool?
(1) Low cutting speed, low rake angle and high speed
(2) High cutting speed, low rake angle and high speed
(3) High cutting speed, high rake angle and high feed
(4) Low cutting speed, high rake angle and low feed
[MPSC - AMVI : 2003]

9. The orthogonal cutting takes place when cutting face of tools is at of the angles mentioned below to the line of action of tool
(1) 45^0 (2) 60^0
(3) 90^0 (4) 120^0
[MPSC - AMVI : 2003]

10. The shear angle for two dimensional cutting operation is given by an equation
Where r = cutting ratio
α = rake angle
ϕ = shear angle

(1) $\tan\phi = \dfrac{r\cos\alpha}{1+\sin\alpha}$

(2) $\tan\phi = \dfrac{r\cos\alpha}{1-\sin\alpha}$

(3) $\tan\phi = \dfrac{1-r\sin\alpha}{r\cos\alpha}$

(4) $\tan\phi = \dfrac{1+r\sin\alpha}{r\cos\alpha}$

[MPSC - AMVI : 2015]

(3) Avoiding rubbing action with the finished surface
(4) Better heat dissipation

[GPSC : 2018]

35. Friction at the tool-chip interface can be reduced by
(1) Decreasing the rake angle
(2) Increasing the depth of cut
(3) Decreasing the cutting speed
(4) Increasing the cutting speed

[GPSC : 2018]

36. Which cutting condition affects the cutting temperature predominantly ?
(1) Depth of cut (2) Cutting speed
(3) Tool cutting edge (4) None of the options

[GPSC : 2018]

37. The element at the junction of the side cutting edge and end cutting edge in single point cutting tool is called as
(1) Approach angle (2) Nose
(3) Side cutting edge (4) End relief angle

[GPSC : 2018]

38. Cutting speed generally expressed in______.
(1) Meter
(2) Millimeter/minute
(3) Revolution/minute
(4) None of the options

[GPSC : 2018]

OPSC

39. Discontinuous chips occur in case of :
(1) Ductile materials
(2) Plastics
(3) Composites
(4) Brittle materials

[OPSC : 2015]

40. For proper cutting cutting materials does not require ....
(1) Higher hardness
(2) Hot hardness
(3) High wear resistance
(4) High friction

[OPSC : 2015]

41. A built up edge is formed while machining :
(1) Ductile material at high speed
(2) Ductile material at low speed
(3) Brittle material at high speed
(4) Brittle material at low speed

[OPSC : 2019]

42. In HSS, tungsten can be substitute by :
(1) Chromium (2) Nickel
(3) Molybdenum (4) Cobalt

[OPSC : 2019]

43. In an orthogonal cutting, depth of cut is havled and feed rate is doubled. If the chip thickness ratio is unaffected with the changed cutting condition, the actual chip thickness will be :
(1) Doubled (2) Halved
(3) Unchanged (4) Quadrupled

[OPSC : 2019]

TNPSC

44. Cutting power consumption in turning can be significantly reduced by
(1) Increasing rake angle of the tool
(2) Increasing the cutting angle of the tool
(3) Widening the nose radius of the tool
(4) Increasing the clearance angle

[TNPSC : 2017]

45. Blade in the hack saw cuts during the
(1) Forward stroke
(2) Backstroke
(3) Both stroke
(4) Pressure applied

[TNPSC : 2017]

46. The relationship between tool life (T) and cutting speed (V) m/min is expressed as
(1) $V^nT = C$ (2) $VT^n = C$

From right angle Δ ABC

$$\sin\phi = \frac{BC}{AB} = \frac{t_1}{L_S}$$

t_1 = uncut chip thickness
t_2 = chip thickness

$$r = \frac{t_1}{t_2} = \text{ chip thickness ratio}$$

L_S = Length of shear plane

$$AB = L_S = \frac{t_1}{\sin\phi} \quad \text{-------(1)}$$

Δ ABD $\angle$ A = 90 − ϕ + α

$$\sin\left[90-(\phi-\alpha)\right] = \frac{BD}{AB}$$

$$AB = \frac{BD}{\cos(\phi-\alpha)} = \frac{t_2}{\cos(\phi-\alpha)} = L_S \quad \text{-------(2)}$$

equation (1) and equation (2)

$$\frac{t_1}{\sin\phi} = \frac{t_2}{\cos(\phi-\alpha)}$$

$$\frac{t_1}{t_2} = r = \frac{\sin\phi}{\cos(\phi-\alpha)}$$

$$r = \frac{\frac{\sin\phi}{\cos\phi}}{\frac{\cos\phi\cos\alpha + \sin\phi\sin\alpha}{\cos\phi}}$$

$$r = \frac{\tan\phi}{\cos\alpha + \tan\phi\sin\alpha}$$

r. cosα + r. tanϕ sinα = tanϕ
tanϕ - r tanϕ. sinα = r. cosα
tanϕ (1 - r sinα) = r cosα

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

ϕ = f (r, α)

r↑, ϕ↑

α↑, ϕ↑

11. Ans : 1

- A common type of high speed steel contains 18% tungsten, 4% chromium 1% vanadium.
- The tungsten will be added to increase the hot hardness temperature of tool material.
- Chromium is added to improve the strength of the tool material.
- Vanadium is added to improve the wear resistance of tool material.

12. Ans : 4

- Milling cutter and grinding wheel are multipoint cutting tool oblique machining operation.
- Parting tool is a single point cutting tool that has only one cutting edge and zero rake angle.

13. Ans : 2

- The decreasing order of influence of process parameters on tool life

V > f > d

Where,

V = cutting speed
f = feed rate
d = depth of cut

14. Ans : 2

Irrespective of machining conditions during machining of hard and brittle material only discontinous chips are produced.

15. Ans : 2

Dynamometer is used for measurement of forces in machining.

16. Ans : 1

Shear angle (ϕ) :

It is the angle made by the shear plane w.r.t. the cutting velocity vector or direction of tool travel.

- shear angle (ϕ) can be calculated as :

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

17. Ans : 1

- In orthogonal cutting, the cutting edge of the tool is perpendicular to the direction of the tool.

- The decreasing order of influence of process parameters on tool life

$$V > f > d$$

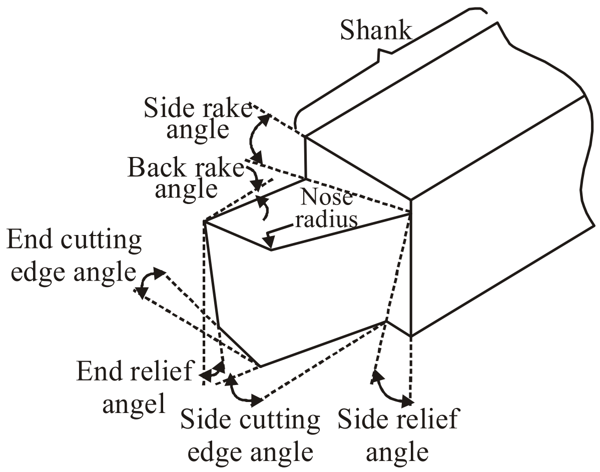
where,

V = cutting speed

f = feed rate

d = depth of cut

37. Ans : 2



Nose : The element at the junction of the side cutting edge and end cutting edge in single point cutting tools is called nose.

Side cutting edge : The top edge of major flank is called side cutting edge.

End cutting edge : The top edge of the minor flank is called end cutting edge.

Nose radius : It is radius of the nose. Nose radius increases the life of tool and provide better surface finish.

End relief angle : The angle formed between the minor flank and a line normal to the base of tool is called end relief angle. It avoid the rubbing of the workpiece against tool.

Back rake angle : The angle formed between the tool face and line parallel to the base is called back rake angle.

Lip angle : It is defined as the angle between face and minor flank of the single point cutting tool.

Side rake angle : The angle formed between the tool face and line perpendicular to shank is called side rake angle.

Side relief angle : The angle formed between the major flank surface and plane normal to the base of the tool is called side relief angle.

This angle avoids the rubbing between workpiece and flank when the tool is fed longitudinally.

38. Ans : 2

- Cutting speed is a relative speed at which the tool passes through work material and remove metal. It's generally expressed in millimeter/ minute.
- Feed rate is defined distance travelled by tool for one spindle revolution. It is expressed in mm/ rev.
- Depth of cut is the total amount of metal removed per pass of cutting tool. It is expressed in mm.

39. Ans : 4

Factors that leads discontinous chip formation are

1) Brittle metal
2) Low cutting speed
3) High depth of cut
4) High feed
5) Low back rake angle

40. Ans : 4

For proper cutting tool material must have following properties.

- Hot hardness
- Toughness
- Wear resistance
- Low friction
- Chemical stability
- Higher hardness
- Shock resistance
- Favourable cast

42. Ans : 3

In high speed steel tungsten can be substitute by molybdenum because the atomic weight of

Theory of Machines

CONTENT

30. A planar linkage having 8 links and 9 joints of single degree of freedom will have_____degree of freedom.
(1) 1 (2) 2
(3) 3 (4) 4
[RPSC : 2018]

31. Which of the following is an inversion of single slider - crank chain ?
(1) Elliptical Trammel
(2) Hand Pump
(3) Scotch Yoke
(4) Oldham's Coupling
[RPSC : 2018]

32. In a four bar linkage, the sum of the length of the smallest and longest link is less than the sum of the length of the other two links. If the smallest link is fixed, the linkage becomes
(1) Structure
(2) Double rocker
(3) Double crank mechanism
(4) Crank - rocker mechanism
[RPSC : 2018]

33. Which one of the following is an exact straight-line mechanism using lower pairs ?
(1) Watt's mechanism
(2) Grasshopper mechanism
(3) Robert's mechanism
(4) Peaucellier's mechanism
[RPSC : 2018]

GPSC

34. Inversion of a mechanism is
(1) Changing of a higher pair to lower pair
(2) Obtained by fixing different links in a kinematic chain
(3) Turning it upside down
(4) Obtained by reversing the input and output motion
[GPSC : 2018]

35. Four bar mechanism has at least one revolving link if the sum of length of the largest and shortest links is_______sum of lengths of other two links
(1) Twice (2) Greater than
(3) Less than (4) None of the options
[GPSC : 2018]

36. In a four bar mechanism if link opposite to shortest link is fixed and shortest link is made as coupler, other two links would oscillate. This mechanism is called as
(1) Crank and rocker (2) Double rocker
(3) Crank and slider (4) None of the options
[GPSC : 2018]

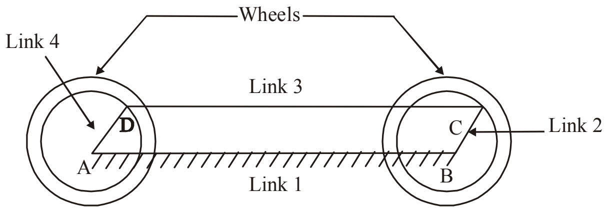
37. In a kinematic chain, a ternary joint is equivalent to
(1) Two binary joints
(2) Three binary joints
(3) One binary joint
(4) None of the options
[GPSC : 2018]

38. In a kinematic pair, when the elements have surface contact while in motion, it is a
(1) Higher pair (2) Lower pair
(3) Closed pair (4) Unclosed pair
[GPSC : 2018]

39. Which of the following is an inversion of single-slider-crank chain ?
(1) Elliptical trammel
(2) Hand pump
(3) Scotch yoke
(4) Oldham's coupling
[GPSC : 2018]

40. Which of the following is a lower pair?
(1) Ball and socket
(2) Piston and cylinder
(3) Cam and follower
(4) (1) and (2) above
[GPSC : 2019]

41. Any point on a link connecting double slider crank chain will trace a
(1) Straight line (2) Circle
(3) Ellipse (4) Parabola
[GPSC : 2019]



There are three inversions:

1) Beam Engine or Crank and lever mechanism.
2) Coupling rod of locomotive or double crank mechanism.
3) Watt's straight line mechanism or double lever mechanism

22. Ans : 1

- In a four bar chain, all four pairs forms a turning pair.

23. Ans : 1

Lower Pair :

- In lower pair, the contact between two link is a area or surface contact.

Degree of freedom = 1

Examples : 1) Sliding Motion
2) Rotary Motion
3) Belt & Pulley with Slip
4) Rolling without slipping

24. Ans : 3

Given,

No of link (n) = 6

Degree of freedom = 1

D.O.F. = 3 (n-1) -2j - h ---------(1)

Where,

n = No. of links

j = No. of binary links

h = No. of higher pair

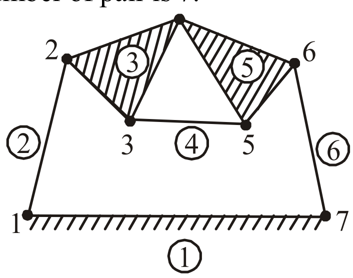
Eq^n (1)

$1 = 3(6-1) - 2 \times j - 0$

$\therefore 1 = 15 - 2j$

$j = 7$

Total number of pair is 7.



Above linkage satisfy the all condition given in the question. So it will have 7 pairs and two links are ternary link out of six link.

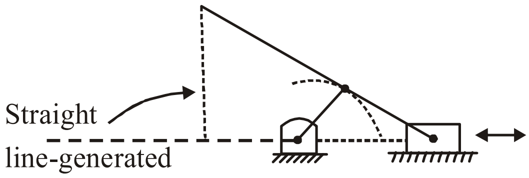
25. Ans : 2

For generating exact straight line following mechanism are used,

i) Harts mechanism
ii) Peaucellier's mechanism
iii) Scott Russel and modified scott Russel Mechanism.

Out-of above option, In scott-Russel mechanism consist of four links.

In this mechanism, motion between links are sliding or rolling.



26. Ans : 1

Lower Pair :

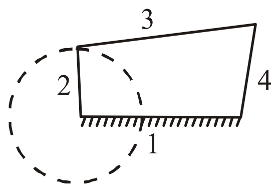
- In lower pair, the contact between two link is a area or surface contact.

Degree of freedom = 1

Examples : 1) Sliding Motion
2) Rotary Motion
3) Belt & Pulley with Slip
4) Rolling without slipping
5) Shaft rotating in a journal.

27. Ans : 1

In four bar mechanism, if link adjcent to shortest link is fixed, it become's crank-rocker mechanism. In crank-rocker mechanism one link can make complete rotation and output link i.e. rocker oscillates.



- In above fig. link (2) i.e. crank make complete rotation and link (4) i.e. rocker make oscillatory motion.

32. Ans : 3

- **Grashoff's linkage or chain :**
  It stated that "sum of length of smallest and longest link is less than sum of length of other two links".
  $L + S < (P + Q)$
  Where,
  L = Length of longest link
  S = Length of smallest link
  P & Q = Length of other two links
- **Inversions**
  1) Shortest link fixed → Double crank mechanism
  2) Adjacent to shortest link fixed → crank-rocker
  3) Opposite to shortest link fixed → Double Rocker Mechanism
- **Non-Grashoff's linkage or chain :**
  $(L + S) > (P + Q)$
  By fixing any link ⇒ Rocker - Rocker (Double rocker) mechanism.
- **If $(L + S) = (P + Q)$** ⇒ Same inversion as Grashoff's linkage.

33. Ans : 4

Mechanism	Application
1. • Watt's • Robert • Grasshopper • Tchebi cheff	Used to generate approximate straight line motion.
2. • Hart's • Peaucellier's • Scott Russel • Modified scott Russel	Used to generate exact straight line motion.

34. Ans : 2

- Inversion is obtained by fixing different link of a mechanism.
- Every mechanism is an inversion of itself.
- No. of possible inversion are equal to the No. of different links.

35. Ans : 3

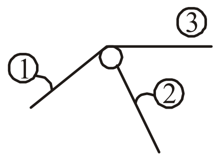
- In mechanism, at least one revolving link is possible when it is Grashoff's linkage.
- When $(L+S) \leq (P + Q)$, then atleast one link is revolving.

36. Ans : 2

	Link Fixed	Inversion
1)	If shortest link are fixed	Crank-Crank mechanism (Double Crank)
2)	If link opposite to shortest link is fixed	Rocker-Rocker (Double Rocker)

37. Ans : 1

- Three links are joint at same connection then it is ternary joint.



1 ternary joint = 2 binary joint

40. Ans : 4

Lower Pair :

- In lower pair, the contact between two link is a area or surface contact.
  Degree of freedom = 1

Examples :
1) Sliding Motion
2) Rotary Motion
3) Belt & Pulley with Slip
4) Rolling without slipping
5) Ball and socket
6) Piston and cylinder

41. Ans : 3

Any point on link connecting double slider crank chain will trace a ellipse.

42. Ans : 4

a) $n = 2p - 4$

$n = 2p - 4$
Where, n = No. of link
p = No. of pair

32. A gear train in which axes of some of the gears are in motion is called
(1) Compound gear train
(2) Reverted gear train
(3) Epicyclic gear train
(4) None of these
[RPSC : 2016]

33. In spur gears, the circle on which the involute is generated is called
(1) Base circle (2) Pitch circle
(3) Clearance circle (4) Addendum circle
[RPSC : 2016]

34. The maximum efficiency for spiral gears is
(1) $\frac{\sin(\theta+\varphi)+1}{\cos(\theta-\varphi)+1}$ (2) $\frac{\cos(\theta-\varphi)+1}{\sin(\theta+\varphi)+1}$
(3) $\frac{\cos(\theta+\varphi)+1}{\cos(\theta-\varphi)+1}$ (4) $\frac{\cos(\theta-\varphi)+1}{\cos(\theta+\varphi)+1}$
θ = Shaft angle, φ = Friction angle
[RPSC : 2016]

35. In a clock mechanism, the gear train used to connect minute hand to hour hand is
(1) Epicyclic gear train
(2) Reverted gear train
(3) Compound gear train
(4) Simple gear train
[RPSC : 2016]

36. The radial distance of a tooth from the pitch circle to the bottom of the tooth, is called
(1) Dedendum (2) Addendum
(3) Clearance (4) Working depth
[RPSC : 2016]

37. In a gear train in which the axes of the shafts over which the gears are mounted, move relative to a fixed axis, is called_____
(1) Compound gear train
(2) Simple gear train
(3) Epicyclic gear train
(4) Reverted gear train
[RPSC : 2018]

38. If the number of teeth on the wheel rotating at 300 r.p.m. is 90, then the number of teeth on the mating pinion rotating at 1500 r.p.m. is
(1) 15 (2) 18
(3) 20 (4) 60
[RPSC : 2018]

39. The velocity ratio in the case of compound train of wheels is equal to -
(1) $\frac{\text{Number of teeth on first driver}}{\text{Number of teeth on last follower}}$
(2) $\frac{\text{Number of teeth on last follower}}{\text{Number of teeth on first driver}}$
(3) $\frac{\text{Product of teeth on the drivers}}{\text{product of teeth on the followers}}$
(4) $\frac{\text{Product of teeth on the followers}}{\text{product of teeth on the drivers}}$
[RPSC : 2018]

GPSC

40. The working surface above the pitch surface of the gear tooth is termed as
(1) Addendum (2) Dedendum
(3) Flank (4) Face
[GPSC : 2018]

41. For full depth of involute spur gears, minimum number of teeth of pinion to avoid interference depends upon
(1) Pressure angle
(2) Circular pitch
(3) Pitch diameter
(4) Aspect ratio
[GPSC : 2018]

42. Large speed reductions (greater than 20) in one stage of a gear train are possible through
(1) Helical gearing (2) Bevel gearing
(3) Spur gearing (4) Worm gearing
[GPSC : 2018]

2 respectively.

$F_{t2} = F_2 \text{ Cos } (\psi_2 + \phi)$, $F_{t1} = F_1 \text{ Cos } (\psi_2 - \phi)$

$Fn = Fn_1 = Fn_2$, $\mu Fn_1 = \mu Fn_2$

Input power = $F_{t1} \times v_1$

Output power = $F_{t2} \times v_2$

$$\text{Efficiency } \eta = \frac{F_{t2} \times V_2}{F_{t1} \times V_1}$$

$$= \frac{\text{Cos}(\psi_2 + \phi) \times \text{Cos}\,\psi_1}{\text{Cos}(\psi_1 - \phi) \times \text{Cos}\,\psi_2}$$

$$\left\{ \because \frac{V_2}{V_1} = \frac{\text{Cos}\,\psi_1}{\text{Cos}\,\psi_2} \right\}$$

$$\eta = \frac{2\cos\psi_1 \times \cos(\psi_2 + \phi)}{2\cos\psi_2 \times \cos(\psi_1 - \phi)}$$

$$\eta = \frac{\text{Cos}}{\text{Cos}} \frac{(\psi_1 + \psi_2 + \phi) + \cos(\psi_1 - \psi_2 - \phi)}{(\psi_1 + \psi_2 - \phi) + \cos(\psi_2 - \psi_1 - \phi)}$$

$$\eta = \frac{\cos(\theta + \phi) + \cos(\psi_1 - \psi_2 - \phi)}{\cos(\theta - \phi) + \cos[(\psi_1 - \psi_2 - \phi)]}$$

$\{\because \cos(-\infty) = \cos\infty\}$

$$\eta = \frac{\cos(\theta + \phi) + \cos(\psi_1 - \psi_2 - \phi)}{\cos(\theta - \phi) + \cos(\psi_1 - \psi_2 - \phi)}$$

For maximum efficiency

$\psi_1 - \psi_2 - \phi = 0$ $\{\theta = \psi_1 + \psi_2\}$

$$\eta_{max} = \frac{\cos(\theta + \psi) + 1}{\cos(\theta - \psi) + 1}$$

36. Ans : 1

Dedendum :

It is radial distance of a tooth from the pitch circle to the bottom of tooth.

Addendum :

It is radial distance of tooth from the pitch circle to the top of tooth.

38. Ans : 2

Given,

$T_1 = 90$

$N_1 = 300$ rpm

$N_2 = 1500$ rpm

$T_2 = ?$

$$\text{Velocity ratio} = \frac{\text{Angular velocity of follower}}{\text{Angular velocity of driver}}$$

$$\text{V. R.} = \frac{\omega_2}{\omega_1} = \frac{N_2}{N_1} = \frac{T_1}{T_2}$$

$$\therefore \frac{N_2}{N_1} = \frac{T_1}{T_2}$$

$$\therefore \frac{1500}{300} = \frac{90}{T_2}$$

$$T_2 = \frac{90}{5}$$

$$\therefore T_2 = 18$$

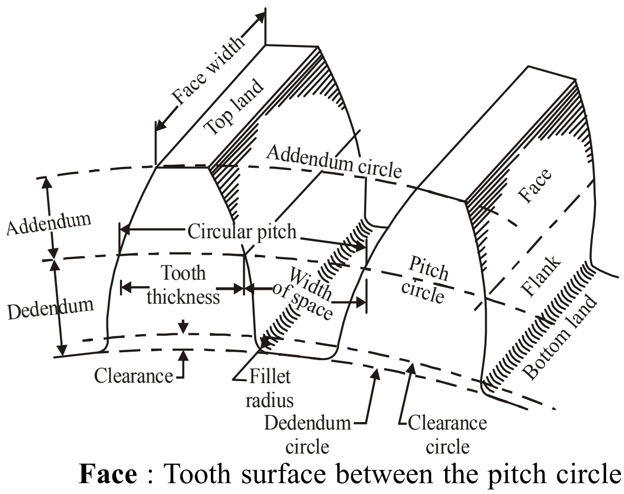
39. Ans : 4

Velocity ratio/Speed ratio =

$$\frac{\text{Product of No. of teeth on driven gear}}{\text{Product of No. of teeth on driving gear}}$$

$$\text{Train value} = \frac{1}{\text{Velocity ratio or speed ratio}}$$

40. Ans : 4



Face : Tooth surface between the pitch circle and the top land.

Flank : Tooth surface between the pitch circle and the bottom land including fillet.

$$m\ddot{x} + kx = 0$$

$$\ddot{x} + \frac{k}{m}x = 0$$

$$\ddot{x} + \omega_n^2 x = 0 \qquad \text{-------(A)}$$

Given,

$$\ddot{x} + 36\pi^2 x = 0$$

Compare with (A)

$$\omega_n^2 = 36\pi^2$$

$$\omega_n = 6\pi \text{ rad/sec.}$$

Frequency in Hz :

$$\omega_n = 2\pi F_n$$

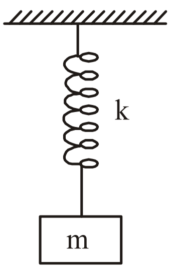
$$\therefore \quad F_n = \frac{6\pi}{2\pi}$$

$$F_n = 3 \text{ Hz}$$

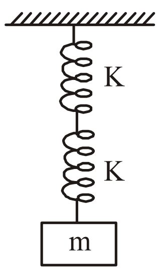
27. Ans : 1

- If input is unit step displacement, then their is no steady-state lag between input and viscous damped output.

28. Ans : 2



$$N = \sqrt{\frac{K}{m}}$$



$$\frac{1}{K_{eq}} = \frac{1}{K} + \frac{1}{K}$$

$$\frac{1}{K_{eq}} = \frac{2}{K}$$

$$K_{eq} = \frac{K}{2}$$

$$N_2 = \sqrt{\frac{K/2}{m}}$$

$$N_2 = \frac{1}{\sqrt{2}}\sqrt{\frac{K}{m}}$$

$$N_2 = \frac{1}{\sqrt{2}} N$$

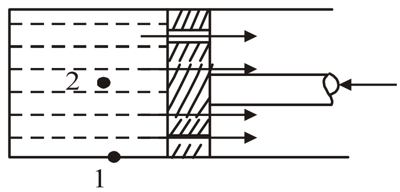
29. Ans : 2

Critical or whirling or whipping speed :

It speed of shaft at which shaft tends to vibrate violently in the transverse direction, that is shaft coincides with natural frequency of its transverse direction.

30. Ans : 1

Newton's law of viscosity



$$\tau = \mu \frac{du}{dy}$$

$$= \mu \times \frac{u_2 - u_1}{y_2 - y_1}$$

$$\tau = \mu \times \frac{u_2 - 0}{y_2 - 0}$$

$\tau \propto u$ (Velocity of fluid)

$F_D \propto u$ (Velocity of fluid)

$F_{Damping} \propto$ Velocity

$F_{Damping} \propto \dot{x}$

31. Ans : 2

- Damping ratio (ξ) :

$$\xi = \frac{\text{Actual damping coefficient}}{\text{critical damping coefficient}}$$

$$\xi = \frac{C_{actual}}{C_{critical}}$$

(3) 0.5 (4) Infinite

[GPSC : 2019]

51. Limiting friction depends upon

(1) Materials of the body in contact

(2) Weight of the body to be moved

(3) Roughness of surface of contact of the two bodies

(4) All of the above

[GPSC : 2019]

52. In a simple truss, if n is the total number of joints, the total number of members is equal to

(1) 2n + 3 (2) 2n – 3

(3) n + 3 (4) n – 3

[GPSC : 2019]

53. If n < (2j – 3), where n is number of members used in a frame structure and j is the number of joints used in the structure, then the frame is called

(1) Perfect frame

(2) Deficient frame

(3) Redundant frame

(4) None of the above

[GPSC : 2019]

54. Two parallel forces 100 kN and 75 kN act on a body and have resultant of 25 kN. Then, the two forces are

(1) Like parallel forces

(2) Unlike parallel forces

(3) Concurrent forces

(4) None of the above

[GPSC : 2019]

OPSC

55. The effect of a force on a body depends on its:

(1) Direction (2) Magnitude

(3) Position (4) All of these

[OPSC : 2015]

TNPSC

56. If a constant force 'F' acts on a body of mass 'm' for time 't' and changes its velocity from u to v under an acceleration of 'α' all in the same direction, then for equilibrium of the body

(1) $F = \frac{mu}{t}$

(2) $F = \frac{mv}{t}$

(3) $F = m\left(\frac{v-u}{t}\right)$

(4) $F = m\left(\frac{v+u}{t}\right)$

[TNPSC : 2017]

57. A ball is thrown up. The sum of kinetic and potential energies will be maximum at

(1) The ground

(2) The highest point

(3) The centre

(4) All the points

[TNPSC : 2017]

58. On a ladder resting on smooth ground and learning against vertical wall, the force of friction will be

(1) Towards the wall at its upper end

(2) Away from the wall at its upper end

(3) Upwards at its upper end

(4) Downwards at its upper end

[TNPSC : 2018]

59. If two equal forces of magnitude P act at an angle θ, their resultant will be

(1) P/2 cos θ/2 (2) 2P sin θ/2

(3) 2P tan θ/2 (4) 2P cos θ/2

[TNPSC : 2018]

60. Which of the following is a statically inderminate structure?

(1) Load supported on composite member

(2) Load supported on two members

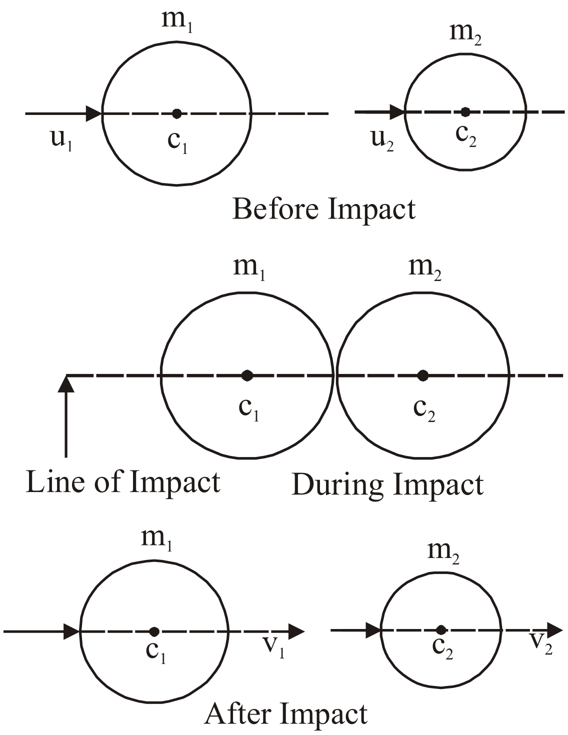
(3) Load supported on three members

(4) Thermal load supported on two members

[TNPSC : 2019]

38. Ans : 2

Coefficient of restitution is the ratio of relative velocity of separation to the relative velocity of approach



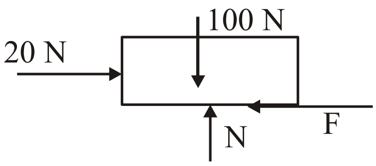
$u_1 - u_2$ = Relative velocity of approach
$v_2 - v_1$ = Relative velocity of separation

$$\therefore e = \frac{v_2 - v_1}{u_1 - u_2}$$

OR

$$\therefore e = -\left[\frac{v_2 - v_1}{u_2 - u_1}\right]$$

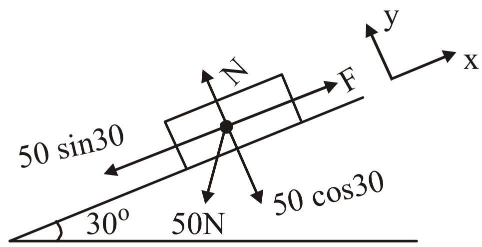
39. Ans : 4



$\Sigma y = 0 \rightarrow N = 100$ N
$F_S = \mu N = 0.3 \times 100 = 30$ N
The external force applied = 20 N < F_S

$\therefore$ Frictional force = External applied force = 20 N.

40. Ans : 1



$\Sigma F_x = 0 \rightarrow F = 50 \sin 30$
$\Sigma F_y = 0 \rightarrow N = 50 \cos 30$

$$\mu = \tan \phi = \frac{F}{N}$$

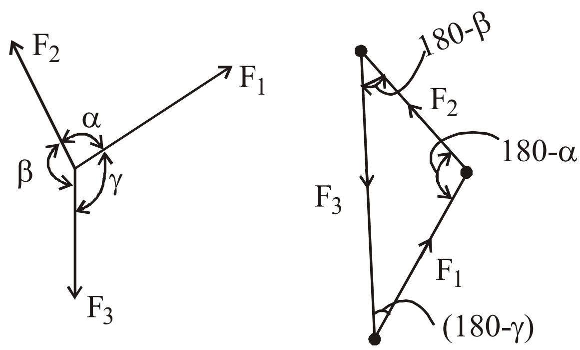
$$\mu = \frac{50 \sin 30}{50 \cos 30}$$

$$\mu = \frac{1/2}{\sqrt{3}/2}$$

$$\mu = \frac{1}{\sqrt{3}}$$

41. Ans : 4

Lami's theoram : (Only applied when body is in equilibrium) It's state that if the resultant of three vectors is zero, then each force is proportional to the sine of the angle between the other two forces.



by sine rule

$$\frac{F_1}{\sin(180-\beta)} = \frac{F_2}{\sin(180-\gamma)} = \frac{F_3}{\sin(180-\alpha)}$$

25. The dimensions of the coefficient of dynamic viscosity in (M.L.T) notation system are
(1) $M L T^{-1}$ (2) $M^{-1} L T$
(3) $M L^{-1} T$ (4) $M L^{-1} T^{-1}$
[RPSC : 2016]

26. Newton's law of viscosity is given by the relation
(1) $\tau = \sqrt{\mu} \times \frac{du}{dy}$ (2) $\tau = \mu \times \frac{du}{dy}$
(3) $\tau = \mu^{3/2} \times \frac{du}{dy}$ (4) $\tau = \mu^{2} \times \frac{du}{dy}$
[RPSC : 2016]

27. Which one of the following sets of condition celarly apply to an ideal fluid ?
(1) Viscous and compressible
(2) Non Viscous and incompressible
(3) Non Viscous and compressible
(4) Viscous and incompressible
[RPSC : 2018]

GPSC

28. In a Newtonian fluid shear stress is
(1) Inversely proportional to the velocity gradient
(2) Directly proportional to the velocity gradient
(3) Independent of the velocity gradient
(4) Practically zero
[GPSC : 2018]

29. The dimension of surface tension is
(1) MT^{-2} (2) MT^{-1}
(3) ML^{-2} (4) ML^{-1}
[GPSC : 2018]

30. Inviscid fluid is fluid for which viscosity is
(1) Zero
(2) Varying
(3) Maximum
(4) None of the options
[GPSC : 2018]

31. Viscosity of water is comparison to mercury is
(1) Lesser (2) Higher
(3) Equal (4) Unpredictable
[GPSC : 2019]

32. Newton's law of viscosity is about
(1) Ideal fluid
(2) Velocity gradient and rate of shear strain relation
(3) Shear deformation and shear stress relation
(4) Pressure and volumetric strain
[GPSC : 2019]

OPSC

33. SI unit of viscosity is :
(1) 1 poise (2) 10 poise
(3) Centipoise (4) None of the above
[OPSC : 2015]

34. Sonic velocity C for adiabatic is mentioned as :
(1) $C = \sqrt{\gamma RT}$
(2) $C = \gamma RT$
(3) $C = \sqrt{\gamma RT^2}$
(4) $C = [\gamma RT]^{1/3}$
[OPSC : 2015]

35. For a Newtonian fluid :
(1) Shear stress is proportional to acceleration
(2) Rate of shear stress is proportional to shear strain
(3) Shear stress is proportional to density
(4) Shear stress is proportional to rate of shear strain
[OPSC : 2019]

36. The sonic velocity in a fluid medium is directly proportional to :
(1) Mach number
(2) Pressure
(3) Temperature
(4) Square root of temperature
[OPSC : 2019]

Where,

K = Bulk modulus

ρ = Density

In Adiabatic process → $K = \gamma P$

In Isothermal process → $K = P$

γ is adiabatic index

we know, $P = \rho RT$ $\quad \frac{P}{\rho} = RT$

In Adiabatic process

$$C = \sqrt{\frac{\gamma P}{\rho}}$$

$$= \sqrt{\gamma RT}$$

Speed of sound in solids

$$C = \sqrt{\frac{E}{\rho}}$$

Where,

E = modulus of elasticity

14. Ans : 1

- The main reason of viscosity in case of liquid is molecular bonding or cohesion. where as in case of gas is molecular collision or molecular momentum transfer.
- Variation of viscosity with respect to temperature.

In case of liquid :

- with the increase in temperature, the shear stress is due to inter-molecular cohesion which decreases. So that viscosity decreases with increase in temperature.

For liquid $\mu_T = Ae^{B/T}$

In case of gases :

- With the increase in temperature, molecular collision or molecular momentum transfer get increased Hence shear stress get increased. So that viscosity increases with increase in temperature.

For gases $\mu_T = \dfrac{bT^{1/2}}{1 + a/T}$

Where,

μ_T = Dynamic viscosity at absolute temperature

A, B = Constants (for given liquid)

a, b = Constants (for given gas)

- The variation of viscosity with respect to pressure is negligible.

15. Ans : 3

- In the expression

$$\tau = A\left(\frac{du}{dy}\right)^n + B$$

Where,

A → Flow consistency index

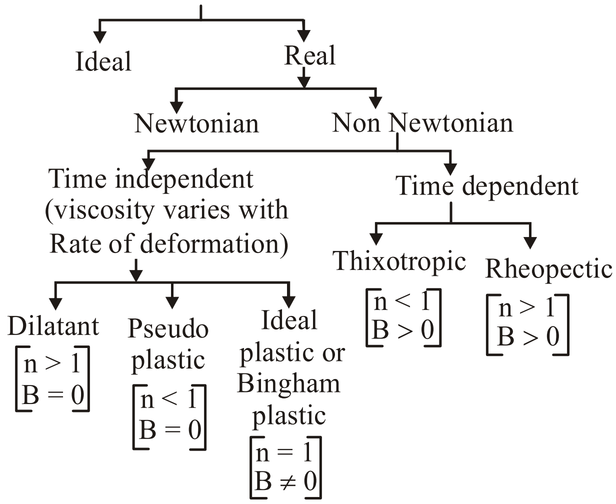
n → Flow behaviour index

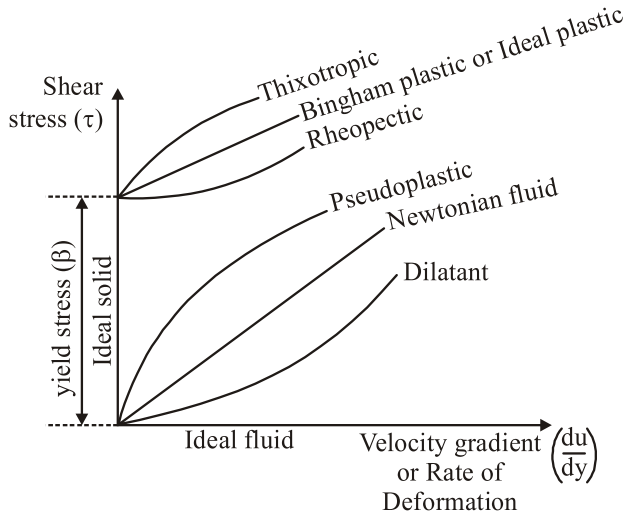
B → yield stress

if $n < 1 \quad B = 0$

then it is known as pseudoplastic fluid.

Classification of Fluids





1 Impact of Jet

MPSC

1. The efficiency of a free jet striking normally on a series of flat plates mounted on the periphery of a wheel never exceeds

(1) 40%

(2) 50%

(3) 60%

(4) 70%

[MPSC - AMVI : 2011]

2. A jet of water 75 mm diameter having a velocity of 20 m/s strikes normally a flat smooth plate. Determine the thrust on the plate, if the plate is at rest.

(1) 1500 N

(2) 1668 N

(3) 1700 N

(4) 1768 N

[MPSC - AMVI : 2011]

3. A jet of water issues from a nozzle with a velocity of 20 m/sec and it impinges normally on a flat plate moving away from it at 10 m/sec. If cross-sectional area of jet is $0.02 m^2$ and density of water is $1000 kg/m^3$, then force developed on the plate is

(1) 10 N

(2) 100N

(3) 1000N

(4) 2000N

[MPSC - AMVI : 2011]

4. For the maximum efficiency for the series of curved vanes, the velocity of vane is :

(1) Equal to the jet velocity

(2) 75% of the jet velocity

(3) 50% of the jet velocity

(4) 33% of the jet velocity

[MPSC - AMVI : 2017]

RPSC

5. If w = Specific weight of water in N/m^3, a = Cross sectional area of jet in m^2 and V = Velocity of jet in m/s, the force exerted (in N) by a jet of water impinging normally on a fixed plate is____

(1) $waV/2g$

(2) waV/g

(3) $waV^2/2g$

(4) waV^2/g

[RPSC : 2018]

TNPSC

6. If mass density is ρ, area is a and velocity of jet is V, then the force exerted by a jet of water on a stationary vertical plate in the direction of jet is given by

(1) ρaV

(2) ρaV^2

(3) ρa^2V

(4) ρaV^3

[TNPSC : 2019]

7. If (F) refers to force, (m) refers to mass, (v) refers to velocity and (t) refers to time, then which of the following equation is known as momentum principle?

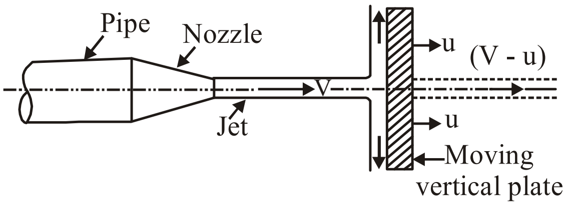
(1) $F = \frac{d(m^2v)}{dt}$

(2) $F = \frac{dv}{dt}$

(3) $F = \frac{d(mv)}{dt}$

(4) $F = \frac{d(mv)}{dt^2}$

[TNPSC : 2019]



$$F = \rho a\,(v - u)^2$$
$$= 1000 \times 0.02\,(20 - 10)^2$$
$$F = 2000\ N$$

4. Ans : 3

Let,

v = velocity of jet

u = velocity of curved vanes

- When curved vanes mounted equidistantly around the periphery of wheel then the entire fluid is utilized.

$$\text{Efficiency } (\eta) = \frac{\text{Work done per second}}{\text{Kinetic energy per second}}$$

$$= \frac{\rho a v\,(v-u)(1+\cos\theta)\times u}{\frac{1}{2}\rho a v^3}$$

$$= \frac{2u\,(v-u)(1+\cos\theta)}{v^2}$$

Condition for maximum efficiency

$$\frac{d\eta}{du} = 0$$

$$\therefore\ \frac{d}{du}\left[\frac{2u(v-u)(1+\cos\theta)}{v^2}\right] = 0$$

$$\therefore\ \frac{2(1+\cos\theta)}{v^2}\times\frac{d}{du}(uv-u^2) = 0$$

$$\therefore\ \frac{2(1+\cos\theta)}{v^2}(v-2u) = 0$$

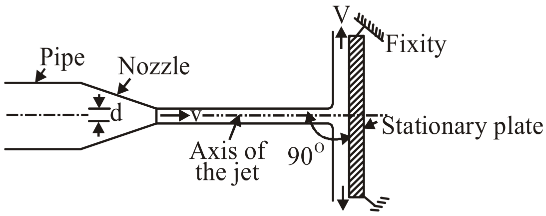
$$\frac{2(1+\cos\theta)}{v^2} \neq 0, \text{ therefore}$$

$$\therefore\ v - 2u = 0$$

$$\therefore\ u = \frac{v}{2}$$

Hence for the maximum efficiency for series of curved vanes, the velocity of vane is 50% of the jet velocity.

5. Ans : 4



- Force exterted by the the jet on the plate in the direction of jet

$$F_x = \text{Rate of change of momentum}$$
$$= \rho a v\,(v - 0)$$
$$F_x = \rho a v^2$$
$$= \frac{w a v^2}{g}$$

Where,

ρ = mass density

a = area of jet

w = specific weight of water

7. Ans : 3

- The net force acting on a mass of fluid is equal to change in momentum of flow per unit time in that direction.

As per Newton's second law of motion.

F = ma

Where,

F = force acting on the fluid

m = mass of fluid

a = Acceleration

$$\text{But } a = \frac{dv}{dt}$$

$$F = m.\frac{dv}{dt} = \frac{d(mv)}{dt}$$

- This equation is known as momentum principle.

■ ■ ■ ■

22. A turbine is working under a head of 20 m. It has been installed at a power plant where the atmospheric pressure is 10 m of water and vapour pressure is 0.20 m of water. If the Thomas cavitation factor is 0.25, what can be the maximum height of the discharge end of the runner from the tail race ?

(1) 9.8 m (2) 4.8 m
(3) 2.4 m (4) 4.4 m

[RPSC : 2016]

23. A tapered draft tube as compared to a cylindrical draft tube

(1) Prevents cavitation even under reduce discharge
(2) Prevents hammer blow
(3) Responds better to load fluctuations
(4) Converts more of kinetic head into pressure head

[RPSC : 2016]

24. The power which appears in the expression for the specific speed is the

(1) Water power
(2) Shaft power
(3) Power into the turbine
(4) None of the above

[RPSC : 2016]

25. Specific speed of an Pelton wheel ranges from

(1) 12 to 70 (2) 80 to 400
(3) 300 to 1000 (4) 1000 to 1200

[RPSC : 2016]

26. In a Francis turbine the discharge leaves the runner radially at exit for this turbine

(1) The blade tip is radial at the outlet
(2) The blade tip is radial at the inlet
(3) The guide vane angle is 90^o
(4) The absolute velocity is radial at outlet

[RPSC : 2016]

27. Which of the following turbines is most efficient at part load operation ?

(1) Propeller (2) Pelton wheel
(3) Francis (4) Kaplan

[RPSC : 2016]

28. Specific speed of turbine is expressed as

(1) $\frac{N\sqrt{P}}{H}$ (2) $\frac{N\sqrt{P}}{H^2}$
(3) $\frac{N\sqrt{P}}{H^{3/4}}$ (4) $\frac{N\sqrt{P}}{H^{5/4}}$

[RPSC : 2016]

29. The unit power P of a turbine developing a power P under a head H is equal to

(1) $P / H^{3/2}$ (2) $P / H^{5/2}$
(3) $P\sqrt{H}$ (4) $PH^{3/2}$

[RPSC : 2016]

30. The value of speed ratio (K_u) in case of Francis turbine ranges from

(1) 0.2 to 0.3 (2) 0.4 to 0.5
(3) 0.6 to 0.9 (4) None of above

[RPSC : 2016]

31. A Pelton turbine is considered suitable for which of the following head

(1) 10 to 20 m (2) 20 to 30 m
(3) 35 to 50 m (4) 100 to 250 m

[RPSC : 2016]

32. Kaplan turbine is

(1) A low head axial flow turbine
(2) A high head mixed flow turbine
(3) An impulse inward flow turbine
(4) An outward flow reaction turbine

[RPSC : 2016]

33. Which of the following serious problems arise from cavitation ?

(1) Damage to blade surface
(2) Fall in efficiency
(3) Noise and vibration
(4) All of above

[RPSC : 2016]

34. A surge tank is used to

(1) Avoid reversal of flow
(2) Prevent occurrence of hydraulic jump

3) **Low Head turbine**
Available Head is below 60 m.
Example - Kaplan & Propeller turbine

3. Ans : 2

(1) **Hydraulic efficiency (η_h) :** It is defined as the ratio of power given by water to runner of turbine to power supplied by the water at inlet of turbine.

$$\eta_n = \frac{\text{Power delivered to runner}}{\text{Power supplied at inlet}}$$

$$= \frac{\text{Rotor Power (R.P)}}{\text{Water Power (W.P)}}$$

(2) **Mechanical efficiency (η_m) :** It is defined as the ratio of power available at turbine shaft to the power given by water to runner of turbine.

$$\eta_m = \frac{\text{Power available at the turbine shaft}}{\text{Power delivered to runner}}$$

$$= \frac{\text{Shaft Power (S.P)}}{\text{Rotor Power (R.P)}}$$

(3) **Overall efficiency (η_o) :** It is defined as the ratio of power available at the turbine shaft to the power supplied by the water at inlet of turbine.

$$\eta_o = \frac{\text{power available at the turbine shaft}}{\text{power supplied at the inlet}}$$

$$= \frac{\text{Shaft Power (S.P)}}{\text{Water Power (W.P)}}$$

$$= \frac{S.P}{W.P} \times \frac{R.P}{R.P}$$

$$= \frac{S.P}{R.P} \times \frac{R.P}{W.P}$$

$$\eta_o = \eta_m \times \eta_h$$

4. Ans : 4

Specific speed : It is defined as the speed of geometrically similar turbine which would develop unit power when working under a unit head.

- It plays important role in the selection of turbine.
- it predicts the performance of turbine.

For turbine

$$N_S = \frac{N\sqrt{P}}{H^{5/4}}$$

Where,

N_S = specific speed of turbine
N = speed of actual turbine in rpm
P = shaft power in kw
H = Head under which turbine is working in m

Type of turbine		Specific speed range
1. Pelton wheel	- single jet	0 - 30
	- multi jet	30 - 60
2. Francis turbine		60 - 300
3. Kaplan & Propeller turbine		300 - 1000

5. Ans : 4

Cavitation : Phenomenon of formation of bubble of a flowing liquid in a region where the pressure of the liquid falls below the vapour pressure and sudden collapsing in a region of high pressure.

- Occur at discharge side of turbine or at inlet of draft tube of turbine.
- Cavitation in hydraulic turbine results in
  1) noise and vibration
  2) reduction of discharge
  3) drop in output and efficiency

6. Ans : 4

- The water turbine selected for head varying from 50 m to 150 m is Francis turbine.
- Francis turbine is medium head turbine & available head is between 60 m to 250 m.

7. Ans : 3

- An impulse turbine operates by initial complete conversion of hydraulic energy into kinetic energy.
- It is most suitable for high head application i.e. above 250 m.
- It is exposed to atmosphere.
- It is not requires draft tube.
- Example of impulse turbine is Pelton wheel turbine.

15. Ans : 3

- Due to slip in centrifugal pump, fluid does not follow exact blade profile path.
- Energy transfer by the blades of impeller to the fluid get reduced due to slip in case of centrifugal pump.

16. Ans : 2

- An air vessel is a closed chamber containing compressed air is in upper part and liquid to be pumped is in lower part.
- only used in reciprocating pump.
- It is made up of cast iron

17. Ans : 1

- Reciprocating pumps are most suited where High head are required on mains despite fluctuation in discharge

	Pump	Applications
1.	Rotary pump	High Discharge & low Head
2.	Reciprocating pump	Low discharge & High head

18. Ans : 4

- **Specific speed of centrifugal pump (N_S)**
- Speed of geometrically similar pump which would deliver unit quantity of liquid when working under unit manometric head.

$$N_S = \frac{N\sqrt{Q}}{H_m^{3/4}}$$

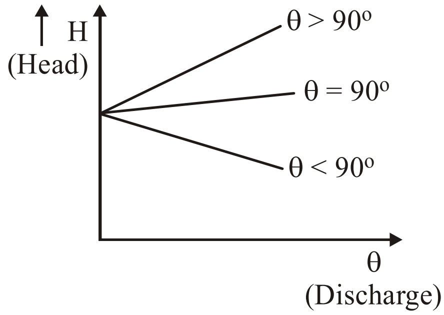
Where, N_S = Specific speed
N = speed of pump in rpm.
Q = Discharge through pump in m^3/s
H_m = manometric head in m.

20. Ans : 4

To get the minimum starting speed of a centrifugal pump, it is notice that if the pressure rise in the impeller is more than or equal to manometric head (H_m) then the centrifugal pump will start to deliver water.

22. Ans : 2

- Radial vane type of impeller of centrifugal pump, the head remains constant with variation in discharge.



Forward curved vane	$\phi > 90^0$
Backward curved vane	$\phi < 90^0$
Radial vane	$\phi = 90^0$

Where,
ϕ = vane angle at outlet

24. Ans : 4

The inertia of reciprocating parts in reciprocating pump does not affect the requirement of input work to the pump.

25. Ans : 1

- Axial flow pump is a pump in which fluid enters and leaves the pump in axial direction.

It is Non-positive displacement pump suitable for high discharge with low head.

26. Ans : 1

Power coefficient (C_p) = $\frac{P}{D^5N^3}$

$P \propto N^3$

When speed of centrifugal pump is doubled the power required to drive the pump will increase 8 times.

27. Ans : 3

- In double acting reciprocating pump, suction & delivery strokes occur simultaneously.

For single acting cylinder (Q_s)

$$Q_S = \frac{A \times L \times N}{60}$$

For double acting cylinder (Q_D)

$$Q_D = 2 \times \frac{A \times L \times N}{60}$$

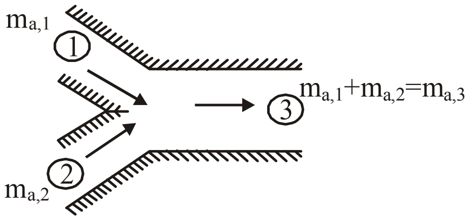
$$Q_D = 2Q_S$$

For cooling coil

$$BPF = \frac{T_2 - T_3}{T_1 - T_3}$$

40. Ans : 2

- An adiabatic mixing of two moist air stream during which no condensation of moisture takes is shown in the figure.



When two air streams at state point 1 and 2 mix, the resulting mixture obtained by mass and energy balance.

41. Ans : 2

- A split system air conditioner is a refrigerative air conditioner that splits its components into two parts :
- An indoor unit, which contain the evaporator component, and an outdoor unit which houses the compressor and condenser.

42. Ans : 3

When outside air is introduced for ventilation purpose there is a sensible as well as latent heat gain.

43. Ans : 2

Given :

Sensible heat (SH) = 30 kJ/S

Latent heat (LH) = 20 kJ/S

Sensible heat factor (SHF) = ?

$$SHF = \frac{SH}{SH+LH}$$

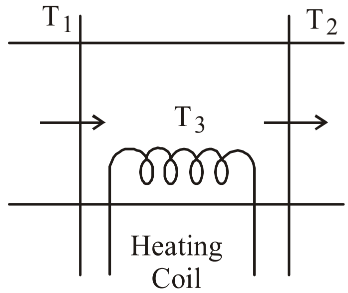
$$= \frac{30}{30+20}$$

$$= \frac{30}{50}$$

= 0.60

44. Ans : 3

Given,



$T_1 = 15^0c$

$T_2 = 25^0c$

$T_3 = 40^0c$

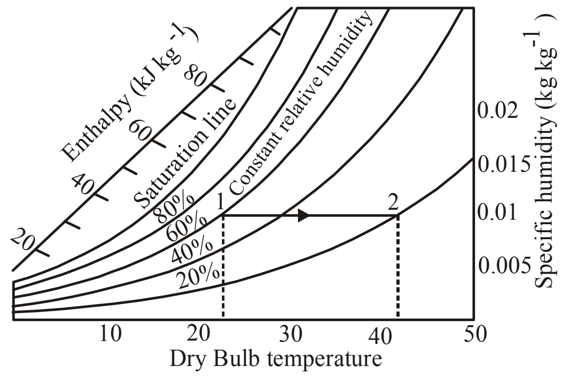
$$BPF_{HC} = \frac{T_3 - T_2}{T_3 - T_1}$$

$$= \frac{40-25}{40-15}$$

$$= \frac{15}{25}$$

$= 0.60$

46. Ans : 3

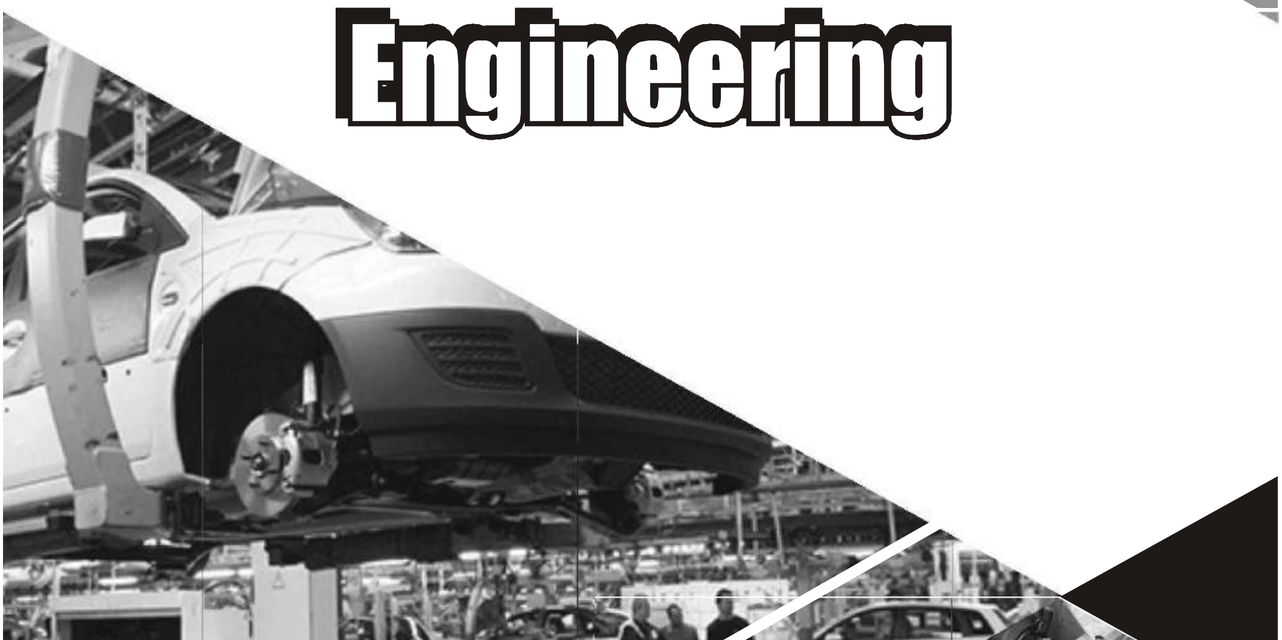


During Sensible Heating :

1) Relative humidity (φ) ↓
2) Specific enthalpy (h) ↑
3) Dew point temperature (DPT) → constant
4) Wet bulb temperature (WBT) → ↑

SECTION - C

Automobile Engineering



1 Automobile System

MPSC

1. The average reduction ratio in rear axle in a car lies between ....
(1) 1 and 3 : 1 (2) 4 to 8 : 1
(3) 6 to 10 : 1 (4) 3 to 6 : 1
[MPSC - AMVI : 1998]

2. The probable cause of uneven wear of tyre for a old truck be ....
(1) Low tyre pressure
(2) Excessive camber
(3) Tyres overloaded
(4) All of the above
[MPSC - AMVI : 1998]

3. In distributor DWELL ANGLE means ....
(1) Angle between two successive break of C.B. point
(2) Angle between breaking and making by successive cam lobs
(3) Angle in which C.B. point is open
(4) Angle of spark advance
[MPSC - AMVI : 1998]

4. Battery terminal sulphation is avoided by applying it ....
(1) Grease (2) Oil
(3) Petroleum jelly (4) Kerosine
[MPSC - AMVI : 1998]

5. The function of stabilizer in an automobile is to decrease the tendency to ....
(1) Pitch (2) Dip
(3) Roll (4) Yaw
[MPSC - AMVI : 1998]

6. For proper negotiation of the vehicle while cornering the following systems are useful ....
(a) Differential
(b) Correct steering angle
(c) Suspension spring
(d) Stabilizer

Answer options :
(1) All are correct
(2) a and b are correct
(3) a, b and c are correct
(4) a alone is correct
[MPSC - AMVI : 1998]

7. Match List-I correctly with List-II and select your answer using the codes given below.

List-I
A. Constant mesh gear box
B. Synchromesh gear box
C. Epicyclic gear box
D. Torque converter sleeve

List-II
1. Planet carrier
2. Turbine
3. Selector sleeve
4. Synchronising

Codes :

	A	B	C	D
(1)	2	3	4	1
(2)	3	4	2	1
(3)	4	1	2	3
(4)	3	4	1	2

[MPSC - AMVI : 1998]

8. Clutch dragging is noticeable ....
(1) On acceleration
(2) At low speed
(3) When clutch is disengaged
(4) At high speed
[MPSC - AMVI : 1998]

9. Gear box is provided in a vehicle to ....
(1) Obtain higher mileage
(2) Vary the torque ratio between the engine and road wheels
(3) Obtain variation of vehicle speed
(4) Send engine power of wheels
[MPSC - AMVI : 1998]

10. A collapsible steering column in one which collapsed to ....

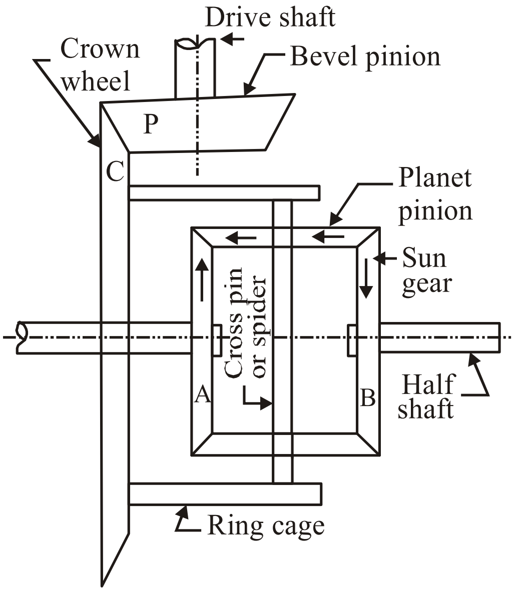
11. Ans : 1

Springs: There are three different spring types that are used in suspension systems: coil, leaf and torsion bar. Coil springs are merely wound torsion bars.

They are commonly used because they are compact, easily mounted and have excellent endurance life properties.

12. Ans : 1

Power flow from the drive shaft to the drive wheels follows the following pattern. From the drive shaft power is transferred to the pinion gear first, and since the pinion and ring gear are meshed, power flows to the ring gear. As the spider gear is connected with the ring gear, power flows to it.



13. Ans : 1

- Circumferential grooves are the deepest grooves molded in a tread pattern and remain visible throughout the tire's life. Tread depths are measured from the bottom of the circumferential grooves to the tread surface.
- Circumferential grooves have the greatest influence on the tire's hydroplaning resistance when driving through standing water. Circumferential grooves also provide lateral biting edges that enhance cornering traction on loose surfaces.

14. Ans : 3

- Constant-velocity joints (also known as homokinetic or CV joints) allow a drive shaft to transmit power through a variable angle, at constant rotational speed, without an appreciable increase in friction or play. **They are mainly used in front wheel drive vehicles.**
- The fact that it failed to maintain constant velocity during rotation was recognized by Robert Hooke in the 17th century, who proposed the first constant velocity joint, consisting of two Cardan joints offset by 90 degrees, so as to cancel out the velocity variations. This is the "**double Cardan**".

15. Ans : 3

- In comparison with a radial tyre one advantage of a cross ply tyre is Smoother ride at low speeds, because of the layout of the tire's plies and because of the flex of the sidewalls, assuring more stable contact with the road service and a softer ride. Less vibration. Extended tire life due to less heat generated by the tire.

16. Ans : 3

Disc brakes are better at managing and dispersing heat than drum brakes. This means that they experience less brake fade than drum brakes and offer a more consistent performance. This is because the disc is closer to the pads and expands even when the calipers are relaxed.

17. Ans : 4

- A hydraulic brake is an arrangement of braking mechanism which uses brake fluid, typically containing glycol ethers or diethylene glycol, to transfer pressure from the controlling mechanism to the braking mechanism.
- The working fluid normally used in hydraulic brake system is a solution of castor oil in alcohol along with neutralizer.

18. Ans : 1

- The process of removing air from the hydraulic brake system is called bleeding. Air is compressible, and any air in the system will be compressed during brake application, causing a

- You can use a vehicle registered in another state for a maximum of 1 year without having to pay road-tax.

16. Ans : 3

As per the CMVR, the speed governor of every transport vehicle shall be so set that the vehicle is incapable of being driven at a speed in excess of the maximum preset speed of the vechicle except down an incline.

17. Ans : 1

(1) This Act may be called the Bombay Motor Vehicles Tax Act, 1958.

(2) It extends to the whole of the '[State of Maharashtra].

(3) It shall be deemed to have come into force on the 1st day of April 1958.

18. Ans : 2

Electric fans of eight inches sweep adjustable, at least eight, in number, suitably spaced in the passenger compartment and controlled by switches located near the seat in case of tourist vehicles, is as per CMVR 1989.

19. Ans : 3

163. Scheme for payment of compensation in case of hit and run motor accidents.

(1) The Central Government may, by notification in the Official Gazette, make a scheme specifying, the manner in which the scheme shall be administered by the General Insurance Corporation, the form, manner and the time within which applications for compensation may be made, the officers or authorities to whom such applications may be made, the procedure to be followed by such officers or authorities for considering and passing orders on such applications, and all other matters connected with, or incidental to, the administration of the scheme and the payment of compensation.

(2) A scheme made under sub-section (1) may provide that—

(a) a contravention of any provision thereof shall be punishable with imprisonment for such term as may be specified but in no case exceeding three months, or with fine which may extend to such amount as may be specified but in no case exceeding five hundred rupees or with both;

(b) the powers, functions or duties conferred or imposed on any officer or authority by such scheme may be delegated with the prior approval in writing of the Central Government, by such officer or authority to any other officer or authority;

(c) any provision of such scheme may operate with retrospective effect from a date not earlier than the date of establishment of the Solatium Fund under the Motor Vehicles Act, 1939 (4 of 1939), as it stood immediately before the commencement of this Act: Provided that no such retrospective effect shall be given so as to prejudicial affect the interests of any person who may be governed by such provision.

20. Ans : 3

Hit and Run

The Motor Vehicles Act, 1988 is a piece of social legislation and its provisions are designed to protect the rights of road accident victims where the identity of motor vehicle causing the accident cannot be established. The relevant legal provision is enshrined in Section 161 of Motor Vehicles Act where a "hit and run motor accident" is defined as an accident arising out of the use of a motor vehicle or motor vehicles the identity whereof cannot be ascertained in spite of reasonable efforts for the purpose. This Scheme came into force from 1.10.1982.

This Section provides for payment of compensation (solatium) as follows:

- In respect of the death of any person resulting from a hit and run motor accident, now a fixed sum of Rs.25,000
- In respect of grievous hurt to any person resulting from a hit and run motor accident, now a fixed sum of Rs.12,500

21. Ans : 2

An All India Permit for Tourist Transport Operators shall be deemed to be invalid from the date on which the vehicle covered by the said permit completes nine years, in the case of protect the rights of road accident victims where the identity of motor vehicle causing the accident cannot be established. The relevant legal provision is enshrined in Section 161 of Motor Vehicles Act where a "hit and run motor accident" is defined as an accident arising out of the use of a motor vehicle or motor vehicles the identity whereof cannot be ascertained in spite of reasonable efforts for the purpose. This Scheme came into force from 1.10.1982.

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- In respect of the death of any person resulting from a hit and run motor accident, now a fixed sum of Rs.25,000
- In respect of grievous hurt to any person resulting from a hit and run motor accident, now a fixed sum of Rs.12,500.

29. Ans: 2

Form 27 which is the application for the assignment of a new registration mark to the motor vehicle.

Application for assignment of new registration mark to a motor vehicle.

(To be made in triplicate if the vehicle is held under an agreement of hire-purchase/lease/ hypothecation the duplicate copy and the triplicate copy with the endorsement of the Registering Authority simultaneusly, on the assignment of a new registration mark)

30. Ans: 2

The general insurance cover that is mandatory is third-party liability car insurance.

■ ■ ■ ■

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PHONE NO: (020) 48627716