ME-Objective-Paper-II

1. Which of the following statement apply to provision of flash gutter and flash land around the parts to be forged?
   1. Small cavities are provided which are directly outside the die impression.
   2. The volume of flash land and flash gutter should be about 20%-25% of the volume of forging.
   3. Gutter is provided to ensure complete closing of the die.

   (A) 1 and 2 only (B) 1 and 3 only (C) 1, 2 and 3 (D) 2 and 3 only

Key: **(A)**

Exp: Flash gutter is not having any relation with closing of die.

2. A hole and a shaft have a basic size of 25 mm, and are to have a clearance fit with a maximum clearance of 0.02 mm and a minimum clearance of 0.01 mm. The hole tolerance is to be 1.5 times the shaft tolerance. The limits of both hole and shaft using hole basis system will be

   (A) low limit of hole = 25mm, high limit of hole = 25.006 mm, upper limit of shaft = 24.99 mm and low limit of shaft = 24.986 mm

   (B) low limit of hole = 25mm, high limit of hole = 25.026 mm, upper limit of shaft = 24.8 mm and low limit of shaft = 24.76 mm

   (C) low limit of hole = 24 mm, high limit of hole = 25.006 mm, upper limit of shaft = 25mm and low limit of shaft = 24.99 mm

   (D) low limit of hole = 25.006 mm, high limit of hole= 25 mm, upper limit of shaft =24.99 mm and low limit of shaft = 25mm.

Key: **(A)**

Exp: Hole tolerance = 25.006-25 = 0.006

Shaft tolerance = 24.99-24.986 = 0.004

$\therefore$ Hole tolerance $=1.5\times$ shaft tolerance

$$\text{Max.clearance} = H_h - S_L = 25.006 - 24.986 = 0.02\,\text{mm}$$

$$\text{Min.clearance} = H_L - S_h = 25 - 24.99 = 0.01\,\text{mm}$$

3. Consider the following statements:

   In case of assembly of mating part
   1. the difference between hole size and shaft size is called allowance
   2. in transition fit, small positive or negative clearance between shaft and hole member is employable

   Which of the above statements is/are correct?

   (A) 1 only (B) Both 1 and 2

   (C) 2 only (D) Neither 1 nor 2

Key: **(B)**

Exp: Both the statements are correct, as difference between hole size and shaft size is called allowance and in transition fit, there exist both Positive and negative clearance.

4. An organization has decided to produce a new product. Fixed cost for producing the product is estimated as Rs.1,00,000. Variable cost for producing the product is Rs.100. Market survey indicated that the product selling price could be Rs 200. The break-even quantity is

(A) 1000 (B) 2000 (C) 500 (D) 900

Key: (A)

Exp: F.C + V.C = S.P

$$100000 + x \times 100 = x \times 200$$

$$\therefore x = 1000$$

5. Using exponential smoothing, a car manufacturing company predicted the demand for that year as 1040 cars. The actual sale was found to be 1140 cars. If the company's forecast for the next year is 1080, what is the value of the smoothening constant?

(A) 0.4 (B) 0.6

(C) 0.7 (D) 1.2

Key: (A)

Exp: $F_N = F_L + \alpha(D_L - F_L)$

$$1080 = 1040 + \alpha(1140 - 1040)$$

$$\therefore \alpha = 0.4$$

6. Coarse feed, low rake angle, low cutting speed and insufficient cooling help produce

(A) continuous chips in ductile materials

(B) discontinuous chips in ductile materials

(C) continuous chips with built-up edges in ductile materials

(D) discontinuous chips in brittle materials

Key: (D)

Exp: Brittle material shall surely give discontinuous chip in this condition, whereas ductile material may give or may not give depending upon the actual ductility of the material.

7. In NC machining, coordinated movement of separately driven axes motion is required to achieve the desired path of tool relative to workpiece. The generation of these reference signals is accomplished through a device called

(A) approximator

(B) interpolator

(C) coordinator

(D) director

Key: (B)

Exp: Interpolator is a device which manages the axis coordination in multi-axes machines like more than 3-axis machines.

8. A part is made from solid brass rod of 38 mm diameter and length 25 mm. The machining time taken to finish the part is 90 minutes and labour rate is Rs.2 per hour. Factory overheads are 50 % of direct labour cost. The density of material is 8.6 gm per cubic cm and its cost is Rs1.625 per Newton. The factory cost of part will be

(A) Rs.8.40 (B) Rs.4.80 (C) Rs.14.80 (D) Rs.18.40

Key: (A)

Exp: $\text{Material cost} = 1.625\left\{\underbrace{\frac{\pi}{4}\times 3.5\times 3.8\times 2.5}_{\text{volume}}\times\underbrace{\frac{8.6}{1000}}_{\text{density}}\times 9.81\right\}$

=Rs 3.89

$\text{labour charge} = 2\times 1.5 = 3\,\text{Rs}$

$\text{overhead charge} = \frac{3}{2} = 1.5\,\text{Rs}$

Total cost = 3.89+3+1.5=8.4 Rs

9. A company wants to expand the solid propellant manufacturing plant by the addition of more than 1 ton capacity curing furnace. Each ton of propellant must undergo 30 minutes of furnace time including loading and unloading operations. Furnace is used only 80 percent of the time due to power restrictions. The required output for the new layout is to be 16 tons per shift (8hours). Plant (system) efficiency is estimated at 50 percent of system capacity. The number of furnaces required will be

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

Key: (A)

Exp: $\text{Total time required } 16\times 30 = 480\,\text{min}.$

$\text{Total time available per furnace } = 80\times 60\times 0.8\times 0.5 = 192\,\text{min}.$

$\text{Hence No. of furnace required } = \frac{480}{192} = 2.5 \simeq 3$

10. The purpose of providing side rake angle on the cutting tool is to

(A) avoid work from rubbing against tool

(B) control chip flow

(C) strengthen tool edge

(D) break chips

Key: (B)

Exp: Provision of side rake angle ensures proper controlled chip flow.

11. The annual demand of a commodity in a supermarket is 80000. The cost of placing an order is Rs 4,000 and the inventory cost of each item is Rs 40. What is the economic order quantity?

(A) 2000 (B) 4000

(C) 5656 (D) 6666

Key: (B)

Exp: $\text{EOQ} = \sqrt{\frac{2\times D\times C_0}{C_C}} = \sqrt{\frac{2\times 80000\times 4000}{40}}$

$\therefore \text{EOQ} = 4000$

12. Consider the following statements:

In a single-server queueing model

1. The arrivals is a memoryless process
2. The arrivals is described as a Poisson distribution
3. Uncertainty concerning the demand for service exists

Which of the above statements are correct?

(A) 1 and 2 only (B) 1 and 3 only

(C) 1, 2 and 3 (D) 2 and 3 only

Key: (C)

Exp: Uncertainty in service rate reduces, if single server model is converter into multi server model for proper service distribution.

13. To construct an operating characteristic curve, an agreement has to be reached between producer and consumer through which of the following points?

1. Maximum proportion of defectives that will make the lot definitely unacceptable
2. The producer is willing to accept that some of satisfying the quality level (AQL) will be rejected $(\alpha = 5\%)$
3. Maximum level of percentage defectives that will make the lot definitely unacceptable
4. The consumer is willing to take lots of quality level (LTPD) even though they are unacceptable $(\beta = 10\%)$,

(A) 1, 2 and 3 only (B) 1, 2, 3 and 4

(C) 1, 2 and 4 only (D) 2, 3 and 4 only

Key: (B)

14. Assuming X and Y are the two control variables, the following are the constraints laid out for maximizing the profit:

Maximize profit (P) =8X+5Y

subject to

$\text{Constra int} - 1 : 2X + Y \le 1000$

$\text{Constra int} - 2 : 3X + 4Y \le 2400$

$\text{Constriant} - 3 : X + Y \le 800$

$\text{Constra int} - 4 : X - Y \le 350$

$\text{Constra int} - 5 : X \ge 0$

$\text{Constra int} - 6 : Y \ge 0$

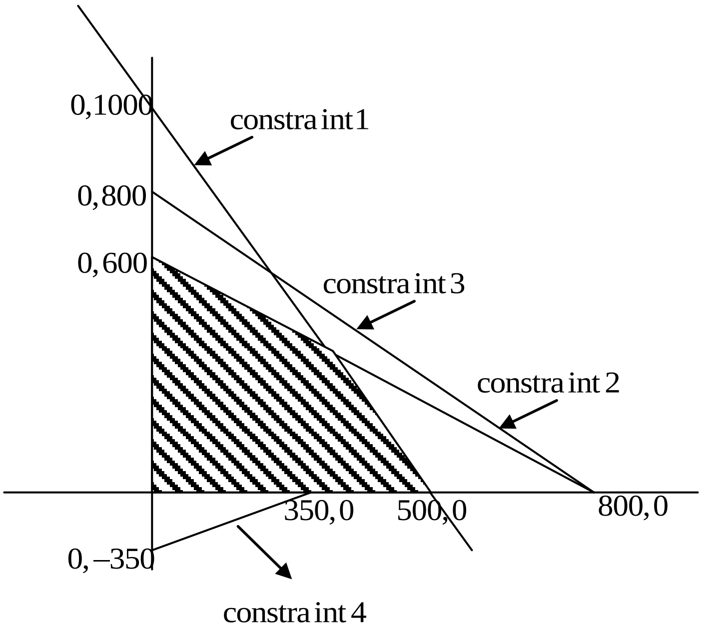
Which of the above constraints is a redundant one and does not have any effect on the solution?

(A) Constraint-1 (B) Constraint-3

(C) Constraint-4 (D) Constraint-5 and Constraint-6

Key: (B)

Exp:



Only the constraint 3 does not effect on the solution because it is not a part of feasible region.

15. A transportation problem consists of 3 sources and 5 destinations with appropriate rim conditions. The number of possible solutions is

(A) 15 (B) 225

(C) 6435 (D) 150

Key: (A)

16. Maximize $Z = 2X_1 + 3X_2$

subject to

$$2X_1 + X_2 \le 6$$
$$X_1 - X_2 \ge 3$$
$$X_1, X_2 \ge 0$$

The solution to the above LPP is

(A) optimal (B) infeasible

(C) unbounded (D) degenerate

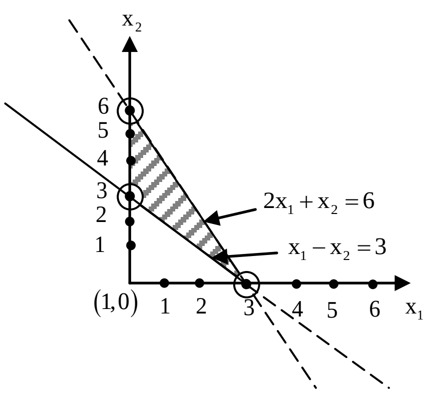
Key: (A)

Exp: $(z)_{(3,0)} = 2\times2+3\times0=6$

$(z)_{(0,3)} = 2\times0+3\times3=9$

$z_{(0,6)} = 2\times0+3\times6=18$

$(z)_{optimum} = 18$



17. A company has a store which is manned by 1 attendant who can attend to 8 technicians in an hour. The technicians wait in the queue and they are attended on first-come-first served basis. The technicians arrive at the store on an average 6 per hour. Assuming the arrivals to follow Poisson and servicing to follow exponential distribution, what is the expected time spent by a technician in the system, what is the expected time spent by a technician in the queue and what is the expected number of technicians in the queue?

(A) 22.5 minutes, 30 minutes and 2.75 technicians

(B) 30 minutes, 22.5 minutes and 2.25 technicians

(C) 22.5 minutes, 22.5 minutes and 2.75 technicians

(D) 30 minutes, 30 minutes and 2.25 technicians

Key: (B)

Exp: $\lambda = 6/\text{hr}, \mu = 8/\text{hr}$

$$\ell = \frac{6}{8} = \frac{3}{4}$$

$$L_s = \frac{\ell}{1-\ell} = \frac{3/4}{1-\frac{3}{4}} = 3$$

$$w_s = \frac{L_s}{\lambda} = \frac{3}{6} \times 60 = 30 \text{ mins}$$

$$L_q = L_s - \ell = 3 - \frac{3}{4} = 2.25$$

$$W_q = \frac{L_q}{\lambda} = \frac{2.25}{6} \times 60 = 22.5 \text{ mins}$$

18. Objective function

$Z = 5X_1 + 4X_2$ (Maximize)

subject to

$$0 \le X_1 \le 12$$
$$0 \le X_2 \le 9$$
$$3X_1 + 6X_2 \le 66$$
$$X_1, X_2 \ge 0$$

What is the optimum value?

(A) 6, 9 (B) 12, 5

(C) 4, 10 (D) 0, 9

Key: (B)

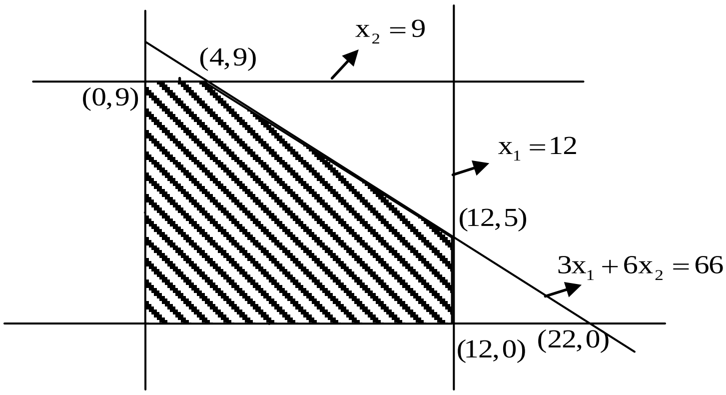
Exp:

At$(12,0), z = 60$, At$(0,9), z = 36$

At$(12,5), z = 80$

At$(4,9), z = 56$

$\therefore$ The maximum of $z = 80$ at $(12, 5)$



19. Which of the following defines the compiler's function correctly?

(A) It translates high-level language programs into object code

(B) It translates object code into a high-level language

(C) It translates object code into assembly language instructions

(D) It translates assembly language instructions into object code

Key: (D)

20. Which one of the following properties of work materials is responsible for the material removal rate in electrochemical machining?

(A) Hardness (B) Atomic weight

(C) Thermal conductivity (D) Ductility

Key: (B)

Exp: For ECM, atomic weight of the material is main criterion for M.R.R.

21. In a crank and slotted lever type quick return mechanism, the link moves with an angular velocity of 20 rad/s, while the slider moves with the linear velocity of 1.5 m/s. The magnitude and direction of Coriolis component of acceleration with respect to angular velocity are

(A) 30 m/s^2 and direction is such as to rotate slider velocity in the same sense as the angular velocity

(B) 30 m/s^2 and direction is such as to rotate slider velocity in the opposite sense as the angular velocity

(C) 60 m/s^2 and direction is such as to rotate slider velocity in the same sense as the angular velocity

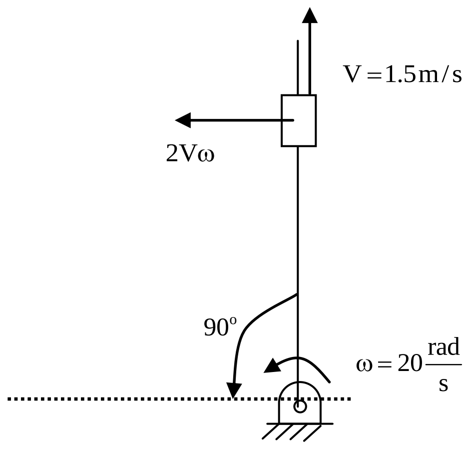
(D) 60 m/s^2 and direction is such as to rotate slider velocity in the opposite sense as the angular velocity.

Key: (C)

Exp: Magnitude of Coriolis acceleration $= 2V\omega$

$$= 2 \times 1.5 \times 20$$

$$= 60\ m/s^2$$



Direction: Rotate the link in direction of rotation and see the direction of linear velocity that will be direction of Coriolis acceleration.

22. Which of the following are associated with Ackerman steering mechanism used in automobiles?

1. Has both sliding and turning pairs
2. Less friction and hence long life
3. Mechanically correct in all positions
4. Mathematically not accurate except in three positions.
5. Has only turning pairs
6. Controls movement of two front wheels

(A) 2, 4, 5 and 6 (B) 1, 2, 3 and 6
(C) 2, 3, 5 and 6 (D) 1, 2, 3 and 5

Key: (A)

Exp: Ackerman steering mechanism has no sliding mechanism & not suitable for all the positions

23. The displacement of a follower of a cam in a printing machine is represented by the expression

$x = 10\theta + 120\theta^2 + 1500\theta^3 + 2000\theta^4 + 2500\theta^5$

where θ is the angle of rotation of the cam. The jerk given by the system at any position is

(A) $9000\omega^3 + 48000\omega^3\theta + 150000\omega^3\theta^2$

(B) $9000\omega^3$

(C) $240\omega^2 + 9000\omega^2\theta + 24000\omega^2\theta^2 + 50000\omega^3\theta^3$

(D) $48000\omega^3\theta + 150000\omega^3\theta^2$

Key: (A)

Exp: Displacement (x) $= 10\theta + 120\theta^2 + 1500\theta^3 + 2000\theta^4 + 2500\theta^5$

Velocity $\left(\frac{dx}{dt}\right) = 10\omega + 240\theta\omega + 4500\theta^2\omega + 8000\theta^3\omega + 12500\theta^4\omega$

Acceleration $\left(\frac{d^2x}{dt^2}\right) = 240\omega^2 + 9000\theta\omega^2 + 24000\theta^2\omega^2 + 50000\theta^3\omega^2$

Jerk : $\left(\frac{d^3x}{dt^3}\right) = 900\omega^3 + 48000\theta\omega^3 + 150000\theta^2\omega^3$

24. A body starting from rest moves in a straight line with its equation of motion being

$$s = 2t^3 - 3t^2 + 2t + 1$$

where s is displacement in m and t is time in s. Its acceleration after one second is

(A) $6 m/s^2$ (B) $2 m/s^2$ (C) $12 m/s^2$ (D) $3 m/s^2$

Key: (A)

Exp: $S = 2t^3 - 3t^2 + 2t + 1$

$$\frac{dS}{dt} = 6t^2 - 6t + 2$$

$$\frac{d^2S}{dt^2} = 12t - 6$$

$$\left(\frac{d^2S}{dt^2}\right)_{t=1} = 12 - 6 = 6m/sec^2$$

25. The crankshaft of reciprocating engine having a 20 cm crank and 100 cm connecting rod rotates at 210 r.p.m. When the crank angle is 45°, the velocity of piston is nearly

(A) 1.8 m/s (B) 1.9 m/s

(C) 18 m/s (D) 19 m/s

Key: **(3.5)**

Exp: $v_p = \omega r\left(\sin\theta + \frac{\sin 2\theta}{2n}\right)$

$$\omega = \frac{2\pi N}{60} = \frac{2\times 3.14\times 210}{60} = 21.98\ rad/sec$$

$$r = 6.2m$$

$$n = \frac{\ell}{r} = \frac{100}{20} = 5$$

$$\therefore v_p = 21.98\times 0.2\left(\sin 45° + \frac{\sin 90°}{2\times 5}\right)$$

$$\therefore v_p = 3.5m/sec$$

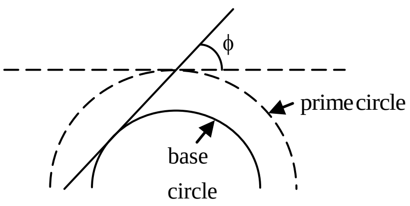
26. While designing a cam, pressure angle is one of the most important parameters which is directly proportional to

(A) pitch circle diameter (B) prime circle diameter

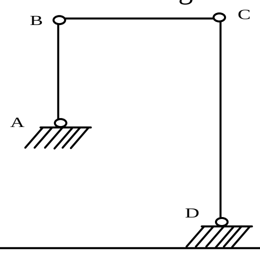
(C) lift of cam (D) base circle diameter

Key: **(D)**

Exp: Pressure angle relates with base circle diameter



27. A four-bar mechanism is as shown in the figure below. At the instant shown, AB is shorter than CD by 30 cm. AB is rotating at 5 rad/s and CD is rotating at 2 rad/s:



The length of AB is

(A) 10 cm (B) 20 cm

(C) 30 cm (D) 40 cm

Key: (B)

Exp: Velocity of joint $B(V_B) = 5 \times AB$

Velocity of joint $C(V_c) = 2 \times CD$

Since links are rigid so there is no axial relative i.e axial velocity remains same at every point in a link

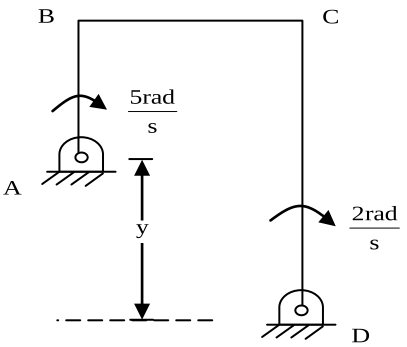
Considering link BC.

$V_B = V_C$

$5AB = 2 \times CD$

$5AB = 2 \times (AB + 30)$

$AB = \frac{60}{3} = 20 \text{ cm}$



28. A governor is said to be isochronous when the equilibrium speed is

(A) variable for different radii of rotation of governor balls

(B) constant for all radii of rotation of the balls within the working range

(C) constant for particular radii of rotation of governor balls

(D) constant for only one radius of rotation of governor balls

Key: (B)

Exp: Isochronism in governor means constant equilibrium speed for all the radii of rotation.

29. A planetary gear train is gear train having

(A) a relative motion of axes and the axis of at least one of the gears also moves relative to the frame

(B) no relative motion of axes and no relative motion of axes with respect to the frame

(C) no relative motion of axes and the axis of at least one of the gears also moves relative to the frame

(D) a relative motion of axes and none of the axes of gears has relative motion with the frame

Key: (A)

Exp: Planetary gear train ensures the relative motion of atleast one axis w.r.t. the frame

30. The flywheel of a machine having weight of 4500 N and radius of gyration of 2 m has cyclic fluctuation of speed from 125 r.p.m to 120 r.p.m. Assuming $g = 10 m/s^2$, the maximum fluctuation of energy is

(A) 12822 N-m (B) 24200 N-m (C) 14822 N-m (D) 12100 N-m

Key: (D)

Exp: Mass of flywheel $= \dfrac{\text{weight of flywheel}}{\text{Acceleration due to gravity}} = \dfrac{4500}{10}\text{kg}$

Moment of Inertia $= mk^2$

$= 450 \times (2)^2$

$= 1800 \text{kgm}^2$

$$\omega_1 = \frac{2\pi}{60} \times 125 \text{ rad/sec}$$

$$\omega_2 = \frac{2\pi}{60} \times 120 \text{ rad/sec}$$

$$\Delta E_{max} = \frac{1}{2} I\left(\omega_1^2 - \omega_2^2\right)$$

$$= 12087.2 \text{ N} - \text{m}$$

$$\simeq 12100 \text{ Nm}$$

31. Alumina doped with magnesia will have reduced thermal conductivity because its structure becomes

(A) amorphous (B) free of pores

(C) crystalline (D) mixture of crystalline and glass

Key: (A)

Exp: Reduction in thermal conductivity is due to its amorphous behavior.

32. Which of the following statements are associated with complete dynamic balancing of rotating systems?

1. Resultant couple due to all inertia forces is zero.
2. Support reactions due to forces are zero but not due to couples.
3. The system is automatically statically balanced.
4. Centre of masses of the system lies on the axis of rotation.

(A) 1, 2, 3 and 4 (B) 1, 2, and 3 only

(C) 2, 3 and 4 only (D) 1, 3 and 4 only

Key: (D)

Exp: Support reactions due to forces & couple both need to be zero

33. Which of the following statements is correct about the balancing of a mechanical system?

(A) If it is under static balance, then there will be dynamic balance also

(B) If it is under dynamic balance, then there will be static balance also

(C) Both static as well as dynamic balance have to be achieved separately

(D) None of the above

Key: (C)

Exp: Complete balancing means both static & dynamic should be balanced

34. The accelerometer is used as a transducer to measure earthquake in Richter scale. Its design is based on the principle that

(A) its natural frequency is very low in comparison to the frequency of vibration

(B) its natural frequency is very high in comparison to the frequency of vibration

(C) its natural frequency is equal to the frequency of vibration

(D) measurement of vibratory motion is without any reference point

Key: **(C)**

Exp: Natural frequency need to be equal to frequency of vibration so that resonance exists and it should show the indication of earthquake.

35. As compared to the time period of a simple pendulum of the earth, its time period on the moon will be

(A) 6 times higher (B) 6 times lower

(C) $\sqrt{6}$ times higher (D) $\sqrt{6}$ times lower

Key: **(C)**

Exp: $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$\frac{T_e}{T_m} = \sqrt{\frac{g_m}{g_e}}$$

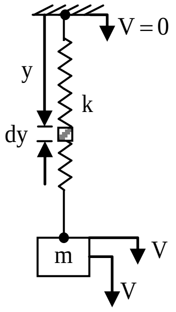
$$\therefore T_m = \sqrt{6}T_e$$

36. While calculating the natural frequency of a spring-mass system, the effect of the mass of the spring is accounted for by adding X times its value to the mass, where X is

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) $\frac{1}{4}$ (D) $\frac{3}{4}$

Key: **(B)**

Exp:



Velocity at a distance "y" from fixed End $= \frac{\text{Velocity at free end}}{\text{length of spring}} \times y$

$$\dot{y} = \left(\frac{V}{L}y\right)$$

$$\text{mass of element}(dm) = \left(\frac{\text{Mass of spring}}{\text{Length of spring}}\right) \times \text{length of element}$$

$$= \left(\frac{M_s}{L} dy\right)$$

$$\text{kinetic energy of element} = \frac{1}{2} dm \left(\dot{y}\right)^2$$

$$= \frac{1}{2}\left(\frac{M_s}{L} dy\right)\left(\frac{V}{L} y\right)^2$$

$$dk = \frac{1}{2}\frac{M_L}{L}\frac{V^2}{L^2} y^2 dy$$

Kinetic energy of whole spring

$$\int dk = \int_0^L \frac{1}{2}\frac{M_S V^2}{L^3} y^2 dy$$

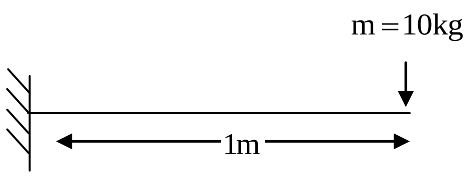
$$\Delta k = \frac{1}{2} \times \left(\frac{M_s}{3}\right) V^2$$

37. A block of mass 10 kg is placed at the free end of a cantilever beam of length 1m and second moment of area $300\,mm^4$. Taking Young's modulus of the beam material as 200 GPa, the natural frequency of the system is

(A) $30\sqrt{2}$ rad / s (B) $2\sqrt{3}$ rad / s (C) $3\sqrt{2}$ rad / s (D) $20\sqrt{3}$ rad / s

Key: (C)

Exp:



$I = 300\,m^4$

$E = 200GPa$

$$\omega_n = \sqrt{\frac{g}{\delta}}, \delta = \frac{wl^3}{3EI} = \frac{10g \times 1^3}{3 \times 2 \times 10^{11} \times 300 \times 10^{-12}}$$

$$\Rightarrow \delta = \frac{10g}{180}$$

$$\Rightarrow \omega_n = \sqrt{\frac{g \times 180}{10g}} = 3\sqrt{2} rad/s$$

38. The speed rating for turbine rotors is invariably more than $\sqrt{2}$ times its natural frequency to

(A) increase stability under heavy load and high speed

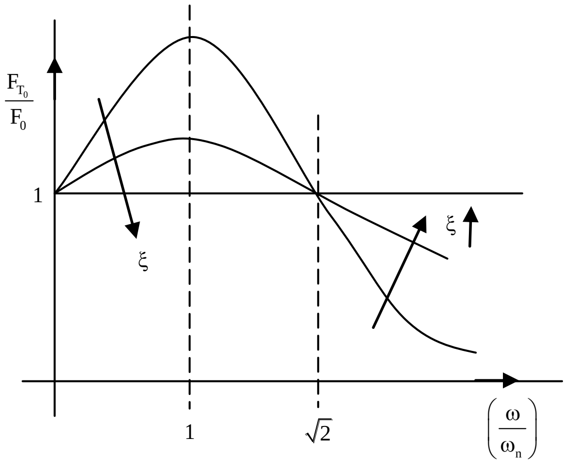
(B) isolate vibration of the system from the surrounding

(C) minimize deflection under dynamic loading as well as to reduce transmissibility of force to the surrounding

(D) None of the above

Key: (B)

Exp:



Force transmitted (F_{T_0}) is very less above $\left(\sqrt{2}\right)$,

Isolation is preferred.

39. The magnitude of swaying couple due to partial balance of the primary unbalancing force in locomotive is

(A) inversely proportional to the reciprocating mass

(B) directly proportional to the square of the distance between the centre lines of the two cylinders

(C) inversely proportional to the distance between the centerlines of the two cylinders

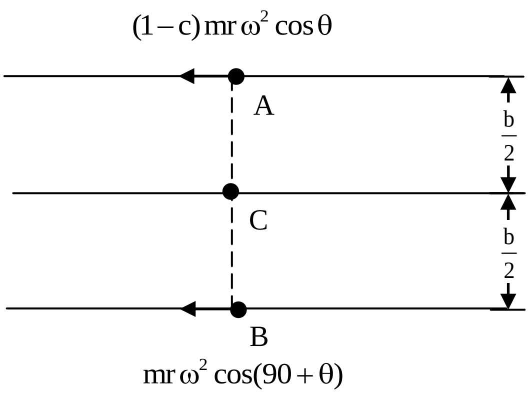
(D) directly proportional to the distance between the centerlines of the two cylinders

Key: (D)

Exp: Torque about "C"

Swaying couple $=(1-c)mr\omega^2\frac{b}{2}\cos\theta-(1-c)mr\omega^2\frac{b}{2}\cos(90+\theta)$

Swaying couple α b



40. The power of a governor is the work done at

(A) the governor balls for change of speed

(B) the sleeve for zero change of speed

(C) the sleeve for a given rate of change of change

(D) each governor ball for given percentage change of speed

Key: (C)

Exp: Power of Governor:

The work done by the governor on the sleeve to its equilibrium position for the fractional change in speed of governor is known as power of governor. It is actually a work done.

Power = Main force × Sleeve movement.

41. Copper has FCC structure; its atomic radius is 1.28A and atomic mass is 63.5. The density of copper will be

(A) $8.9\times10^3\ kg/mm^3$ (B) $8.9\times10^3\ kg/m^3$

(C) $8.9\times10^3\ kg/m^3$ (D) $8.9\times10^3\ g/mm^3$

Key: (A)

42. A plane intersects the coordinate axes at $x=\frac{2}{3}, y=\frac{1}{3}$ and $z=\frac{1}{2}$. What is the Miller index of this plane?

(A) 932 (B) 432 (C) 423 (D) 364

Key: (D)

Exp: $\text{Miller index} = \left(\frac{1}{x}:\frac{1}{y}:\frac{1}{z}\right)$

$$=\left(\frac{3}{2}:\frac{3}{1}:\frac{2}{1}\right)=(3:6:4)\simeq(364)$$

43. What is the diameter of the largest sphere is terms of lattice parameter a, which will fit the void at the centre of the cube edge of a BCC crystals?

(A) 0.134a (B) 0.25a (C) 0.433a (D) 0.5a

Key: (C)

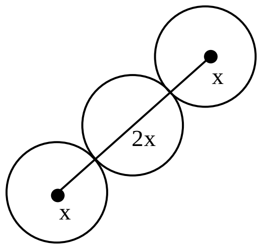
Exp: For BCC

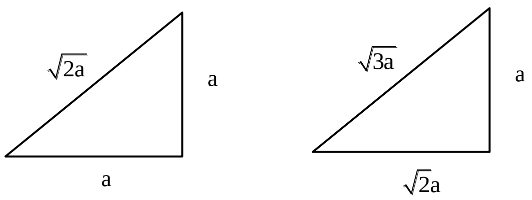
$x+2x+x=\sqrt{3}a$

$\therefore 4x=\sqrt{3}a$

$x=0.433a$

Hence radius to be 0.433a





Diameter will be 0.433×2=0.866.

Hence closest option is ‘C’.

44. If the atomic radius of aluminum is r, what is its unit cell volume?

(A) $\left(\frac{2r}{\sqrt{2}}\right)^3$ (B) $\left(\frac{4r}{\sqrt{2}}\right)^3$ (C) $\left(\frac{2r}{\sqrt{3}}\right)^3$ (D) $\left(\frac{4r}{\sqrt{3}}\right)^3$

Key: (B)

Exp: Unit cell volume $=\left(\frac{4r}{\sqrt{2}}\right)^3$

45. Consider the following statements regarding the behavior of dislocations:

1. Only edge dislocation and mixed dislocation can have glide motion.
2. A screw dislocation cannot have glide motion.
3. Dislocation moves in the direction perpendicular to that of shear stress.
4. Motion of dislocation occurs on slip plane that contains Burger's vector and direction vector.

Which of the above statements are correct?

(A) 1, 2 and 3 only (B) 1, 2 and 4 only
(C) 2, 3 and 4 only (D) 1, 2, 3 and 4

Key: (B)

Exp: Dislocations can move perpendicular & parallel, both to the direction of shear stress.

46. A binary alloy of Cu and Ni containing 20 wt% Ni at a particular temperature coexists with solid phase of 26 wt% Ni and liquid phase of 16 wt% Ni. What is the weight ratio of solid phase and liquid phase?

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

Key: (C)

Exp: Weight ratio of solid phase to liquid phase $=\frac{20-16}{26-20}=\frac{4}{6}=\frac{2}{3}$

47. Elements A and B form eutectic type binary phase diagram and the eutectic composition is 60 wt% B. If just below eutectic temperature, the eutectic phase contains equal amounts (by wt) of two solid phases, then the compositions of the two solid phases are

(A) 20 wt% B and 90 wt% B
(B) 30 wt% B and 90 wt% B
(C) 20 wt% B and 80 wt% B
(D) 30 wt% B and 80 wt% B

Key: (D)

48. Consider the following statements:

In a binary phase diagram

1. the freezing point of the alloy is minimum.
2. eutectic mixture solidifies at a constant temperature like pure metal

3. eutectic reaction is irreversible

4. at eutectic temperature, liquid of two metals will change into two solids

Which of the above statements are correct?

(A) 1, 2 and 3 only (B) 1, 3 and 4 only

(C) 1, 2 and 4 only (D) 1, 2, 3 and 4

Key: (C)

Exp: Eutectic reaction is reversible

49. At room temperature, $\alpha-$iron contains negligible amount of carbon, cementite contains 6.67 % C and pearlite contains 0.8% C. Pearlite contains how much cementite?

(A) 8% (B) 10% (C) 12% (D) 14%

Key: (C)

Exp: Let 'x' be the amount of cementite in pearlite, then

$$x \times \frac{6.67}{100} = 0.8$$

$$\therefore x = 11.99 \simeq 12\%$$

50. Two metals A and B are completely immiscible in solid and liquid state. Melting point of A is $800^\circ C$ and melting point of B is $600^\circ C$. They form eutectic at $200^\circ C$ with 40% B and 60% A. The 50% B alloy contains

(A) 83.33% B and 1.67% of eutectic

(B) 83.33% of eutectic and 16.67% B

(C) 50% B and 50% of eutectic

(D) 40% B and 60% of eutectic

Key: (B)

51. What is the interplanar spacing between (200), (220), (111) planes in an FCC crystal of atomic radius 1.246 A?

(A) $d_{(200)} = 1.762\ A^o, d_{(220)} = 1.24A^o$ and $d_{(111)} = 2.034A^o$

(B) $d_{(200)} = 1.24\ A^o, d_{(220)} = 1.762A^o$ and $d_{(111)} = 2.034A^o$

(C) $d_{(200)} = 2.034A^o, d_{(220)} = 1.24A^o$ and $d_{(111)} = 1.762A^o$

(D) $d_{(200)} = 2.5\ A^o, d_{(220)} = 4.2A^o$ and $d_{(111)} = 2.6A^o$

Key: (C)

Exp: Length of unit cell a for FCC is

$$a = \frac{4}{\sqrt{2}}R = 2\sqrt{2}R$$

Interplanar distance between planes for (200) is

$$d = \frac{a}{\sqrt{(2)^2 + 0^2 + 0^2}} = \frac{2\sqrt{2}R}{2}$$

$$= \sqrt{2} \times 1.246$$

$$= 1.76\ A^o.$$

For (220)

$$d = \frac{a}{\sqrt{(2)^2 + (2)^2 + 0}} = \frac{2\sqrt{2}R}{2\sqrt{2}} = 1.24A^o$$

For (100)

$$d = \frac{a}{\sqrt{(1)^2 + (1)^2 12}} = \frac{2\sqrt{2}R}{\sqrt{3}}$$

$$= \frac{2\sqrt{2} \times 1.246}{\sqrt{3}}$$

$$= 2.034A^o$$

52. Rotary swaging is process for shaping

(A) round bars and tubes (B) billets

(C) dies (D) rectangular blocks

Key: (C)

Exp: Rotary swaging is very complex and costly process & it is not necessary that only round object can be formed, such a costly process is used for making precise dies.

53. Consider the following statements:

In shell moulding

1. a single parting plane should be provided for mould
2. detachable patterns parts and cores could be included
3. minimum rounding radii of 2.5 mm to 3 mm should be used
4. draft angles of not less than 1^o should be used

Which of the above statements are correct?

(A) 1, 3 and 4 only (B) 1, 2 and 3 only

(C) 2, 3 and 4 only (D) 1, 2, 3 and 4

Key: (D)

Exp: All the statements are correct

54. A big casting is to have hole, to be produced by using a core of 10 cm diameter and 200 cm long. The density ρ_{metal} is $0.077\ N/cm^3$ and density ρ_{core} is $0.0165\ N/cm^3$. What is the upward force acting on the core prints?

(A) 200.5 N (B) 1100.62 N (C) 950.32 N (D) 350.32 N

Key: (C)

Exp: $F_B = V_c\{\rho_m - \rho_c\}$

$$= \frac{\pi}{4} \times 10 \times 10 \times 200\{0.077 - 0.0165\}$$

$$\therefore F_B = 949.85 \simeq 950\ N$$

55. Consider the following:

The purpose of lapping process is

1. to produce geometrically true surface

2. to correct minor surface imperfections
3. to improve dimensional accuracy
4. to provide very close fit between the constant surfaces

Which of the above are correct?

(A) 1, 2 and 3 only (B) 1, 3 and 4 only
(C) 2, 3 and 4 only (D) 1, 2, 3 and 4

Key: (B)

Exp: Surface imperfection cannot be corrected with any surface finish operation such as lapping.

56. Centre lathe is to be used to cut inch thread of 4 threads per inch. Lead screw of lathe has 3 mm pitch. Then change gear to be used is

(A) $\frac{1}{12}$ (B) $\frac{127}{60}$ (C) $\frac{30}{127}$ (D) $\frac{20}{80}$

Key: (B)

Exp: Change gear ratio $= \frac{P}{L} = r_{cg}$

P=pitch of screw thread to be cut

$= \frac{1}{4}\text{inch} = \frac{25.4}{4}\text{mm}$

L= pitch of lead screw =3

$r_{cg} = \frac{25.4}{4} \times \frac{1}{3}$

$= \frac{12.7}{6} = \frac{127}{60}$

57. Consider the following statements in respect of the oxidizing flame due to excess of oxygen in welding:

1. At high temperature, it combines with many metals to form hard and brittle oxides.
2. It causes the weld bead and the surrounding area to have a scummy appearance.
3. It has good welding effect in welding of copper-base metal.

Which of the above statements are correct?

(A) 1, 2 and 3 (B) 1 and 2 only
(C) 1 and 3 only (D) 2 and 3 only

Key: (A)

Exp: Oxidising frames are most suitable for ferrous material welding.

58. A cutter tip is initially at X=10 mm, Y=10 mm. In a rapid motion, using G00 code, it moves to X=160 mm, Y=120 mm. The X and Y axes have maximum speed of 10000 mm/min and 5000 mm/min respectively. Operating at maximum speed, what is the time it will take to reach the destination?

(A) 0.90s (B) 1.08s (C) 1.20 s (D) 2.16s

Key: (B)

Exp: Distance travelled $=\sqrt{(160-10)^2+(120-20)^2}=180.2\text{ mm}$

Velocity of travel $=\sqrt{(1000)^2+(5000)^2}=11180.34\text{ mm / min}$

Time taken $=\dfrac{180.28}{11180.34}=0.016\text{ min}=0.98\text{ sec}=1.08\text{ sec.(Approx.)}$

59. If n=0.5 and C=300 for the cutting speed and the tool life relation, when cutting speed is reduced by 25%, the tool life will be increased by

(A) 100% (B) 95% (C) 78% (D) 50%

Key: (C)

Exp: $V_1T_1^n=V_2T_2^n$

$$\frac{V_1}{V_2}=\left(\frac{T_2}{T_1}\right)^n$$

$$\therefore\frac{V_1}{0.75V_1}=\left(\frac{T_2}{T_1}\right)^{0.5}$$

$$\therefore T_2=1.78T_1$$

60. Which of the following statements are correct for temperature rise in metal cutting operation?

1. It adversely affects the properties of tool material.
2. It provides better accuracy during machining.
3. It causes dimensional changes in workpiece and affects accuracy of machining.
4. It can distort the accuracy of machine tool itself.

(A) 1 and 2 (B) 2 and 3

(C) 3 and 4 only (D) 1, 3 and 4

Key: (D)

Exp: Temperature rise in metal cutting operation can never give better accuracy during the machining process.

61. Consider the following:

The parallel fillet welded joint is designed for

1. tensile strength
2. compressive strength
3. bending strength
4. shear strength

Which of the above is/are correct?

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

Key: (A)

Exp: Parallel fillet weld is designed to take shear load only.

62. If the permissible crushing stress for the material of a key is double the permissible shear stress, then the sunk key will be equally strong in shearing and crushing if the key is a

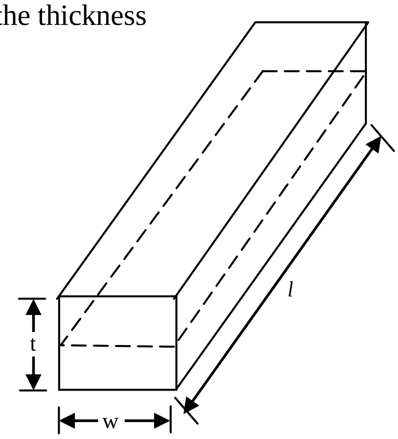
(A) rectangular key with width equal to half the thickness

(B) rectangular key with width equal to twice the thickness

(C) square key

(D) rectangular key with width equal to one-fourth the thickness

Key: **(C)**



Exp: Crushing area $= \frac{t}{2} \times l$

Shearing area $= w \times l$

F= Crushing stress × Crushing area

$F_1 = \sigma_c \times \left(\frac{t}{2} \times l\right)$

$F = \text{Shear stress} \times \text{Shearing area}$

$F_2 = \tau \times (w \times l)$

The key is equally strong in shearing and crushing if torque transmitted is same in both the crushing & shearing.

$\Rightarrow F_1 \times \frac{d}{2} = F_2 \times \frac{d}{2}$

$\sigma_c \frac{t}{2} \times l = \tau\, w \times l$

$\boxed{\frac{w}{t} = \frac{\sigma_c}{2\tau}}$

$\sigma_c = 2\tau$

$\boxed{w = t}$ square key

63. Very small quantity of carbon in iron as in steels forms interstitial solid solution mainly because atomic size(s) of

(A) carbon and iron are almost same

(B) iron is very much smaller than that of carbon

(C) carbon is very much smaller than that of iron

(D) None of the above

Key: **(C)**

Exp: Carbon is very small than iron so fits correctly even in the voids

64. In a cotter joint, the width of the cotter at the centre is 5 cm, while its thickness is 1.2 cm. The load acting on the cotter is 60 kN. The shear stress developed in the cotter is

(A) 50 N/mm^2 (B) 100 N/mm^2 (C) 120 N/mm^2 (D) 200 N/mm^2

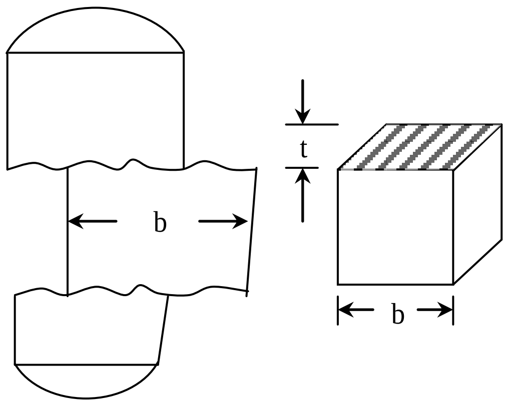
Key: **(A)**

Exp: Shear stress is cotter joint acts at midway between the width.

$$P = 2\tau \times b \times t$$

$$\therefore \text{Shear stress} = \frac{60 \times 10^3}{2 \times 5 \times 10^{-2} \times 1.2 \times 10^{-2}} = 50 \times 10^6 \text{ Pa}$$

$$\text{or shear stress} = 50 \frac{N}{mm^2}$$



65. The use of straight or curved external gear teeth in mesh with internal teeth in 'gear and spline couplings' is specifically employed accommodate

(A) torsional misalignment

(B) parallel misalignment

(C) angular misalignment

(D) substantial axial movements between shafts

Key: (C)

Exp: Straight or curved external gear teeth are used to correct the angular misalignment.

66. For a power screw having square threads with lead angle of 45^o and coefficient of friction of 0.15 between screw and nut, the efficiency of the power screw, neglecting collar friction, is given by

(A) 74% (B) 64% (C) 54% (D) 44%

Key: (A)

Exp: $\eta = \frac{\tan(\alpha)}{\tan(\alpha + \phi)}$

$\phi =$ angle of friction, $\alpha =$ Helix angle or lead angle

$\tan\phi = 0.15$

$\phi = 8.53^o$

$\eta = \frac{\tan(45)^o}{\tan(45 + 853)}$

$\eta = 74\%$

67. Aquaplaning occurs in vehicle tyres when there is continuous film of fluid between the tyre and the wet road. It leads to

(A) oscillatory motion of the vehicle

(B) jamming the brake of the vehicle

(C) jamming the steering mechanism of the vehicle

(D) loss of control of the vehicle

Key: (D)

Exp: Due to aquaplaning, tyre slips over the wet road and it becomes difficult to control the vehicle.

68. If the angle of wrap on smaller pulley of diameter 250 mm is 120^o and diameter of larger pulley is twice the diameter of smaller pulley, then the centre distance between the pulleys for an open belt drive is

(A) 1000 mm (B) 750 mm (C) 500 mm (D) 250 mm

Key: **(D)**

Exp: $\sin\alpha = \frac{(D-d)}{2C}$

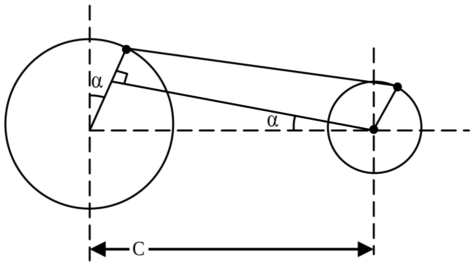
Angle of wrap on smaller pulley $= \pi - 2\times\alpha$

$$\frac{2\pi}{3} = \pi - 2\sin^{-1}\left(\frac{D-d}{2C}\right)$$

$$\frac{D-d}{2C} = \sin\left(\frac{\pi}{6}\right)$$

$$\frac{2\times 250 - 250}{2\times C} = \frac{1}{2}$$

$$C = 250\,mm$$



69. If the velocity ratio for an open belt drive is 8 and the speed of driving pulley is 800 r.p.m, then considering an elastic creep of 2% the speed of the driven pulley is

(A) 104.04 r.p.m (B) 102.04 r.p.m (C) 100.04 r.p.m (D) 98.04 r.p.m

Key: **(D)**

Exp: $\text{Velocity Ratio} = \frac{\text{Velocity of belt an driver}}{\text{Velocity of belt on driven}}$

$$\text{Velocity of belt on driven} = \frac{800}{8} = 100\,\text{r.p.m}$$

Elastic creep = velocity of belt at driven pulley

Velocity of driven pulley

$0.02 \times V_p = [100 - V_p]$

$$V_p = \frac{100}{1.02} = 98.04\,\text{r.p.m}$$

70. Two shafts A and B are of same material, and A is twice the diameter of B. The torque that can be transmitted by A is

(A) 2 times that of B (B) 8 times that of B

(C) 4 times that of B (D) 6 times that of B

Key: **(B)**

Exp: $\frac{T}{J} = \frac{\tau}{R}$

$$T = \tau.\frac{J}{R} = \tau.\frac{\frac{\pi}{32}d^4}{\frac{d}{2}} = \frac{\pi\tau.d^3}{16}$$

$$\therefore T \alpha d^3$$

$$T_A = T_B\left(\frac{2}{1}\right)^3 = 8T_B$$

71. A worm gear set is designed to have pressure angle of 30^o which is equal to the helix angle. The efficiency of the worm gear set at an interface friction of 0.05 is

(A) 87.9% (B) 77.9% (C) 67.9% (D) 57.9%

Key: (A)

Exp: $\eta = \frac{\tan\lambda.(\cos\phi - \mu\tan\lambda)}{\cos\phi\tan\lambda + \mu}$

$\tan\lambda = -\mu + \sqrt{1+\mu^2}$

$\tan\lambda = -(0.05) + \sqrt{1+(0.05)^2}$

$\tan\lambda = 0.9512$

$\eta = \frac{0.9512\left[\cos(30) - 0.05\times0.9512\right]}{\cos 30\times0.9512 + 0.05}$

$\eta = 89.1\%$

72. Consider the following statements:

The axes of spiral bevel gear are non-parallel and intersecting.

1. The most common pressure angle for spiral bevel gear is 20^o.
2. The most common spiral angle for spiral bevel gear is 35^o.
3. Spiral bevel gears are generally interchangeable.
4. Spirals are noisy and recommended for low speeds of 10 m/s.

Which of the above statements are correct?

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

Key: (A)

Exp: Commonly used pressure angle is 20^o, spiral gear operation is noisy hence recommended for low speed operation.

73. Consider the following statements:

In case of helical gears, teeth are cut at an angle to the axis of rotation of the gears.

1. Helix angle introduces another ratio called axial contact ratio.
2. Transverse contact ratio is equal to axial contact ratio in helical gears.
3. Large transverse contact ratio does not allow multiple teeth to share the load.
4. Large axial contact ratio will cause larger axial force component.

Which of the above statements are correct?

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

Key: **(C)**

Exp: Transverse contact ratio may not be equal to axial contact ratio.
Larger contact ratio means sharing of multiple teeth.

74. In an interference fit between a shaft and a hub, the state of stress in the shaft due to interference fit is

(A) only compressive radial stress

(B) a tensile radial stress and a compressive tangential stress

(C) a tensile tangential stress and a compressive radial stress

(D) a compressive tangential stress and a compressive radial stress

Key: **(D)**

Exp: For tight or shrink fit the bonding occurs between shaft & hole which causes compressive, tensile as well as radial stress.

75. In case the number of teeth on two bevel gears in mesh is 30 and 60 respectively, then the pitch cone angle of the gear will be

(A) $\tan^{-1}2$ (B) $\frac{\pi}{2}+\tan^{-1}2$

(C) $\frac{\pi}{2}-\tan^{-1}0.5$ (D) $\tan^{-1}0.5$

Key: **(D)**

Exp:

$\tan\phi = \frac{N_P}{N_G}$

N_P → No.of teeth of pinion

N_G → No.of teeth of gear

ϕ → Pitch lone angle

$$\phi = \tan^{-1}\left(\frac{30}{60}\right)$$

$$\phi = \tan^{-1}(0.5)$$

76. In skew bevel gears, the axes are

(A) non-parallel and non-intersecting, and teeth are curved

(B) non-parallel and non-intersecting, and teeth are straight

(C) intersecting, and teeth are curved and oblique

(D) intersecting, and teeth are curved and can be ground

Key: **(A)**

Exp: Skew bevel gears imply non-parallel, non-intersecting and curved them.

77. Consider that modern machines mostly use short bearings due to the following reasons:

1. l/d of the most modern bearings is in the range of $\frac{1}{4}$ to 2

2. No end leakage of oil from the bearing

3. Shaft deflection and misalignment do not affect the operation.
4. Can be applied to both hydrodynamic and hydrostatic cases

Which of the above are correct?

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

Key: (C)

Exp: End oil can only go in small bearing and not in large bearing, hence end leakage is only possible in small end bearing.
Small bearing is mostly suitable for hydrostatic bearing. Hydrodynamic bearing is used for long bearing where oil can't reach at end due to natural flow.

78. Consider the following statements in connection with thrust bearings:

1. Cylindrical thrust bearings have higher coefficient of friction than ball thrust bearings.
2. Taper rollers cannot be employed for thrust bearings.
3. Double-row thrust ball bearings is not possible.
4. Lower race, outer race and retainer are readily separable in thrust bearings.

Which of the above statements are correct?

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

Key: (D)

Exp: Taper Roller & Double row thrust bearings both are possible.

79. The behavior of metals in which strength of a metal is increased and the ductility is decreased on heating at a relatively low temperature after cold working is known as

(A) clustering (B) strain aging

(C) twinning (D) screw dislocation

Key: (B)

Exp: Strain aging-strain hardening achieved by low heating after the cold work operation.

80. If the equivalent load in case of a radial ball bearing is 500 N and the basic dynamic load rating is 62500 N, then L_{10} life of this bearing is

(A) 1.953 million of revolutions

(B) 3.765 million of revolutions

(C) 6.953 million of revolutions

(D) 9.765 million of revolutions

Key: (A)

Exp:

$$C = W\left(\frac{L}{10^6}\right)^{\frac{1}{k}}$$

Where C is the Equivalent dynamic load

W is the Basic dynamic load rating

$$\text{Where } k = \begin{cases} 3, & \text{for ball bearing} \\ \dfrac{10}{3} & \text{for roller bearing} \end{cases}$$

$$\left(\frac{62500}{500}\right)^3 = \frac{L}{10^6}$$

$L = 1.953\times10^6$ million of revolutions

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

Codes:

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

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

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

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

81. Statement (I): The cam in contact with a follower is a case of complete constraint.

Statement (II): The pair, cam and follower, by itself does not guarantee continuity of contact all the time.

Key: (C)

Exp: When the motion between a pair is limited to a definite direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion. Hence motion of follower is limited to move up and down irrespective of force acting on it cam is rotating given axis.

If follower jumps into the air by leaving the contact with cam, during this time cam rotates certain angle.

So it will no more be a mechanism. Hence it should lose contact all the time.

82. Statement (I): Involute pinions can have any number of teeth.

Statement (II): Involve profiles in mesh satisfy the constant velocity ratio condition.

Key: (D)

Exp: Minimum number of teeth on pinion to avoid interference is given as

$$N_{min} = \frac{2A_p}{\left[-1+\sqrt{1+G(G+2)\sin^2\phi}\right]}$$

where A_p = Addendum of pinion

G = Gear Ratio

ϕ = Pressure Angle

So there is always lower limit on number of teeth on Involute pinion to avoid undercutting (undercutting)

In involute profile, surfaces are convex outside, so if centre distance is changed then new point of contact will come. Hence it again satisfies the law of gearing. It always satisfy law of gearing while changing pressure angle or centre distance with specified range.

83. Statement (I): Hooke's joint connects two non-parallel non-intersecting shafts to transmit motion with a constant velocity ratio.

Statement (II): Hooke's joint connects two shafts the axes of which do not remain in alignment while in motion.

Key: (D)

Exp: Hooke's joint connects intersecting shafts.

84. Statement (I): Lewis equation for design of involute gear tooth predicts the static load capacity of a cantilever beam of uniform strength

Statement (II): For a pair of gears in mesh, pressure angle and module must be same to satisfy the condition of interchangeability and correct gearing.

Key: (B)

85. Statement (I): Tensile strength of CI is much higher than that of MS.

Statement (II): Percentage of carbon in CI is more than 1.5.

Key: (D)

Exp: Tensile strength of C.I is very smaller than that of mild steel.

86. Statement (I): Centrifugal clutches are designed to provide automatic and smooth engagement of load to driving member.

Statement (II): Since the operating centrifugal force is a function of square of angular velocity, the friction torque for accelerating a load is also a function of square of speed driving member.

Key: (A)

87. Statement (I): Heating the steel specimen in the furnace up to austenitize temperature followed by furnace cooling is termed annealing.

Statement (II): Annealed steel specimen possesses fine pearlitic structure.

Key: (B)

88. Statement (I): The susceptibility of a ferromagnetic material decreases with an increase in Curie temperature.

Statement (II): A critical temperature at which the alignment of magnetic moments vanishes is called Curie temperature.

Key: (C)

Exp: At Curie temperature alignment of magnetic moment changes does not vanish.

89. Statement (I): Fiberglass is polymer composite made of a plastic matrix containing fine fibers of glass.

Statement (II): Fiberglass acquires strength from the polymer and flexibility from the glass.

Key: (C)

90. Statement (I): Industrial rotors will not have uniform diameter throughout their lengths.

Statement (II): These rotors will have to accommodate transmission elements like pulleys and gears and supports like anti-friction bearings.

Key: (A)

Exp: Industrial rotors are not uniform, because of fitment of pulleys, gears, belt etc.

91. Statement (I): Cored induction furnace cannot be used for intermittent operation.

Statement (II): Cored induction furnace, through most efficient, requires a liquid metal charge while starting.

Key: (A)

Exp: Cored induction furnace takes time is starting

92. Statement (I): Low-carbon steel has high weldability and is more easily welded.

Statement (II): Higher carbon contents tend to soften the welded joints resulting in development of cracks.

Key: (A)

93. Statement (I): For cutting multi-start threads, the speed ratio is expressed in terms of the lead of the job thread and lead of the lead screw threads.

Statement (II): The speed of the job is reduced to one third or one-fourth of the job speed used in the turning operation.

Key: (B)

Exp: During multi-start thread cutting operation, speed is reduced to one-third to one-fourth of that in turning operation.

94. Statement (I): The Bauschinger effect is observed in tension test of mild steel specimen due to loss of mechanical energy during local yielding.

Statement (II): The Bauschinger effect is a function of section modulus of specimen under test.

Key: (C)

Exp: Bauschinger effect does not have any relation with suction modulus.

95. Statement (I): The ceramic tools used in machining of material have highly brittle tool tips.

Statement (II): Ceramic tools can be used on hard-to-machine work material.

Key: (B)

96. Statement (I): In chain drives, angle of articulation through which link rotates during engagement and disengagement, is greater for a small number of teeth.

Statement (II): The greater angle of articulation will increase the life of the chain.

Key: (C)

Exp: Greater angle of articulation will lead to breaking of chain & reduction in life of the chain.

97. Statement (I): The CNC is an NC system utilizing a dedicated stored program to perform all numerical control functions in manufacturing.

Statement (II): The DNC is a manufacturing process in which a number of process machines are controlled by a computer through direct connection and real time analysis.

Key: (B)

98. Statement (I): In interference fit, the outer diameter of the shaft is greater than the inner diameter of the hole

Statement (II): The amount of clearance obtained from the assembly of hole and shaft resulting in interference fit is called positive clearance.

Key: (C)

Exp: Clearance can be positive as well as negative

99. Statement (I): One of the most commonly used techniques for testing surface integrity of material is metallography.

Statement (II): Surface integrity of material does not contribute for the mechanical and metallurgical properties.

Key: (C)

Exp: Surface integrity does contribute for the mechanical & metallurgical properties.

100. Statement (I): The change in critical path requires rescheduling in a PERT network.

Statement (II): Some of the activities cannot be completed in time due to unexpected breakdown of equipment or non-availability of raw materials.

Key: (B)

101. A copper rod of 2cm diameter is completely encased in a steel tube of inner diameter 2 cm and outer diameter 4cm. Under an axial load, the stress in the steel tube is 100 N/mm^2. If $E_s = 2E_c$, then the stress in the copper rod is

(A) $50\ N/mm^2$ (B) $33.33\ N/mm^2$ (C) $100\ N/mm^2$ (D) $300\ N/mm^2$

Key: (A)

Exp: $d_c = 20\,mm,\ O.D_s = 40\ mm,\ ID_s = 20mm$

$\sigma_s = 100\ N/mm^2,\ E_s = 2E_c$

Since copper rod is completely encased in steel tube therefore, for any load the change in length will be same, i.e. $dl_c = dl_s$

$$\Rightarrow \frac{\sigma_c l_c}{E_c} = \frac{\sigma_s l_s}{E_s}$$

$$\Rightarrow \frac{\sigma_c}{E_c} = \frac{\sigma_s}{2E_c} \left(\because l_c = l_s\right)$$

$$\Rightarrow \sigma_c = \frac{\sigma_s}{2} = 50\ N/mm^2$$

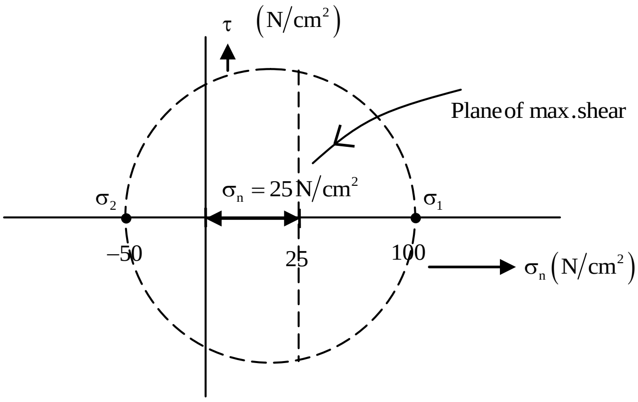
102. A system under biaxial loading induces principal stresses of $100\ N/cm^2$ tensile and $50\ N/cm^2$ compressive at a point. The normal stress at that point on the maximum shear stress plane is

(A) $75\ N/cm^2$ tensile (B) $50\ N/cm^2$ compressive

(C) $100\ N/cm^2$ tensile (D) $25\ N/cm^2$ tensile

Key: (D)

Exp:



103. In a biaxial state of stress, normal stresses are $\sigma_x = 900 N/mm^2$, $\sigma_y = 100\ N/mm^2$ and shear stress $\tau = 300\ N/mm^2$. The maximum principal stress is

(A) $800\ N/mm^2$ (B) $900\ N/mm^2$ (C) $1000\ N/mm^2$ (D) $1200\ N/mm^2$

Key: (C)

Exp: $\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$

$\therefore \sigma_1 = \frac{900 + 600}{2} + \sqrt{\left(\frac{900 - 100}{2}\right)^2 + 300^2}$

$\therefore \sigma_1 = 500 + 500 = 1000\ N/mm^2$

104. A constitutional diagram shows relationship among which of the following combinations in a particular alloy system?

(A) Temperature and composition

(B) Temperature and phases present

(C) Temperature, composition and phase present

(D) Temperature and pressure

Key: (C)

Exp: Constitutional diagram shows temperature, composition & the phase present

105. The state of stress at a point in a body is given by $\sigma_x = 100\ MPa$ and $\sigma_y = 200 MPa$. One of the principal stresses $\sigma_1 = 250\ MPa$. The magnitudes of the other principal stress and the shearing stresses τ_{xy} are respectively

(A) $50\sqrt{3}$ MPa and 50 MPa (B) 100 MPa and $50\sqrt{3}$ MPa

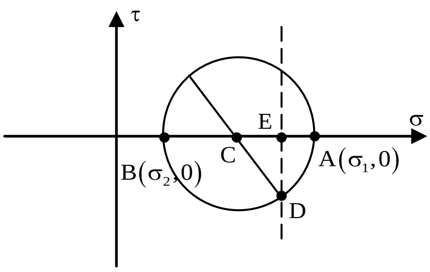
(C) 50 MPa and $50\sqrt{3}$ MPa (D) $50\sqrt{3}$ MPa and 100 MPa

Key: (C)

Exp: $\sigma_{mean} = \dfrac{\sigma_x + \sigma_y}{2}$

$= \dfrac{200+100}{2}$

$\sigma_{mean} = 150\,\text{MPa}$



Radius of Mohr circle $= (\sigma_1 - \sigma_{mean})$

$= (250 - 150)$

$= 100\,\text{MPa}$

other principle stress $(\sigma_2) = \sigma_{mean}$ − Radius of Mohr circle

$= 150 - 100$

$\sigma_2 = 50\,\text{MPa}$

Shear stress $(\tau_{xy}) = \sqrt{(CD)^2 + (CE)^2}$

$= \sqrt{(100)^2 - (50)^2}$

$\tau_{xy} = 50\sqrt{3}\,\text{MPa}$

106. Consider the following statements regarding powder metallurgy:

1. Refractory materials made of tungsten can be manufactured easily.
2. In metal powder, control of grain size results in relatively much uniform structure.
3. The powder heated in die or mould at high temperature is then pressed and compacted to get desired shape and strength.
4. In sintering, the metal powder is gradually heated resulting in coherent bond.

Which of the above statements are correct?

(A) 1, 2 and 3 only (B) 1, 2 and 4 only
(C) 2, 3 and 4 only (D) 1, 2, 3 and 4

Key: (C)

Exp: Manufacturing of tungsten is not so easy process by powder metallurgy

107. The magnitudes of principal stresses at a point are 250 MPa tensile and 150 MPa compressive. The magnitudes of the shearing stress on a plane on which the normal stress is 200 MPa tensile and the normal stress on a plane at right angle to this plane are

(A) $50\sqrt{7}$ MPa and 100 MPa (tensile)

(B) 100 MPa and 100 MPa (compressive)

(C) $50\sqrt{7}$ MPa and 100 MPa (compressive)

(D) 100 MPa and $50\sqrt{7}$MPa (tensile)

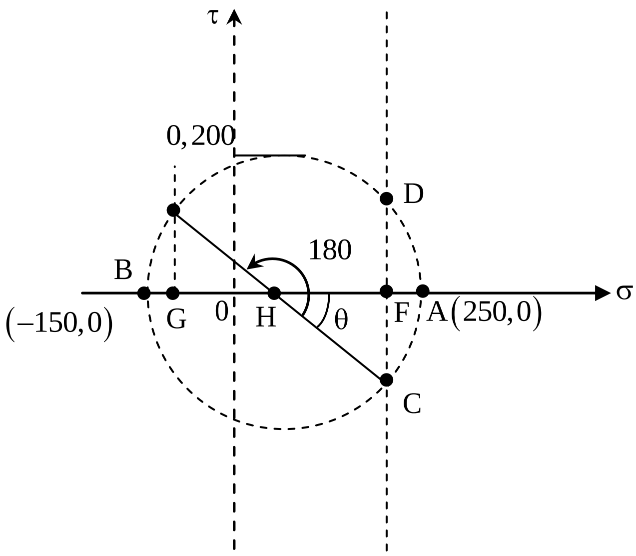
Key: (C)

Exp: Centre:

$\sigma = \dfrac{(\sigma_1 + \sigma_2)}{2}$

$$= \frac{250 + (-150)}{2}$$

$\sigma = 50$ MPa



$$\text{Radius} = \frac{(\sigma_1 - \sigma_2)}{2}$$

$$= \frac{250 - (-150)}{2}$$

$= 200$ MPa

Normal stress (GH)

$$\cos\theta = \frac{HF}{HC} = \frac{HG}{HE}$$

$HF = HG$

$150 = 0G + 0H$

$150 = 0G + 50$

$0G = 100$ (compressive)

$$\text{Shear stress}(EG) = \sqrt{(EH)^2 - (GH)^2}$$

$$= \sqrt{(200)^2 - (150)^2}$$

$= 50\sqrt{7}$ MPa

108. The state of stress at a point is given by $\sigma_x = 100$ MPa, $\sigma_y = -50$ MPa and $\tau_{xy} = 100$ MPa. The centre of Mohr's circle and its radius will be

(A) $(\sigma_x = 75\text{ MPa}, \tau_{xy} = 0)$ and 75 MPa

(B) $(\sigma_x = 25\text{ MPa}, \tau_{xy} = 0)$ and 125 MPa

(C) $(\sigma_x = 25\text{ MPa}, \tau_{xy} = 0)$ and 150 MPa

(D) $(\sigma_x = 75\text{ MPa}, \tau_{xy} = 0)$ and 125 MPa

Key: (B)

Exp: $C \equiv \left(\frac{\sigma_x + \sigma_y}{2}, 0\right) \equiv \left(\frac{100 - 50}{2}, 0\right) \equiv (25, 0)$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2} = \sqrt{\left(\frac{100 + 50}{2}\right)^2 + (100)^2}$$

$\therefore R = 125$ MPa

109. Consider the following statements related to Mohr's circle for stresses in case of plane stress:

1. The construction is for variations of stress in a body.
2. The radius of the circle represents the magnitude of the maximum shearing stress.
3. The diameter represents the difference between the two principal stresses.

Which of the above statement are correct?

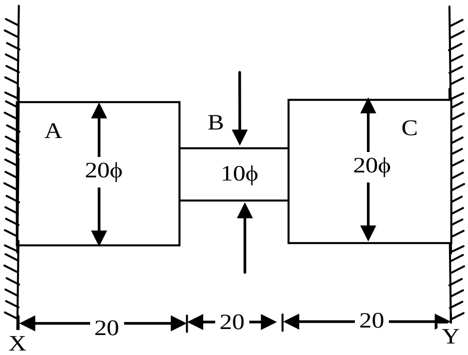
(A) 1, 2 and 3 (B) 2 and 3 only

(C) 1 and 3 only (D) 1 and 2 only

Key: (A)

Exp: All the statements are correct

110. The figure shows a steel piece of diameter 20 mm at A and C, and 10 mm at B. The lengths of three sections A, B and C are each equal to 20 mm. The piece is held between two rigid surfaces X and Y. The coefficient of linear expansion $\alpha = 1.2\times10^{-5}/^{o}C$ and Young's modulus $E = 2\times10^{5}$ MPa for steel:



When the temperature of this piece increases by $50^{o}C$, the stresses in sections A and B are

(A) 120 MPa and 480 MPa (B) 60 MPa and 240 MPa

(C) 120 MPa and 120 MPa (D) 60 MPa and 120 MPa

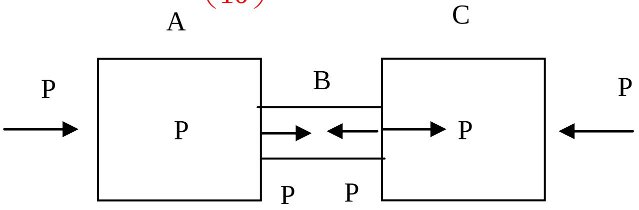
Key: (A)

Exp: Thermal stress $= E\alpha\Delta T$

$$= 2\times10^{5}\times1.2\times10^{-5}\times50 = 120\text{ MPa} \text{ (stress in A \& C).}$$

Stress in 'B' shall be as such that forces remain same

Hence stress in B $= 120\times\left(\frac{20}{10}\right)^{2} = 480\text{ MPa}$



111. For a material following Hooke's law, the values of elastic and shear moduli are 3×10^{5} MPa and 1.2×10^{5} MPa respectively. The value for bulk modulus is

(A) 1.5×10^{5} MPa (B) 2×10^{5} MPa

(C) 2.5×10^{5} MPa (D) 3×10^{5} MPa

Key: (B)

Exp: $E = 3\times10^{5}\text{ MPa}, G = 1.2\times10^{5}\text{ MPa}$

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

$$\Rightarrow 3EK + EG = 9KG$$

$$\Rightarrow K = \frac{EG}{9G-3E} = 2\times10^5 \text{ MPa}$$

112. At a point in a body, $\varepsilon_1 = 0.0004$ and $\varepsilon_2 = -0.00012$. If $E = 2\times10^5$ MPa and $\mu = 0.3$, the smallest normal stress and the largest shearing stress are

(A) 40 MPa and 40 MPa
(B) 0 MPa and 40 MPa
(C) 80 MPa and 0 MPa
(D) 0 MPa and 80 MPa

Key: (B)

Exp: $\varepsilon_1 = 0.0004, \varepsilon_2 = -0.00012$

$E = 2\times10^5 \text{ MPa}, \nu = 0.3$

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

$$\Rightarrow \sigma_1 = \frac{2\times10^5}{\left(1-(0.3)^2\right)}\left(0.0004 - (0.3\times0.00012)\right)$$

$$= 80\text{MPa}$$

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

$$= \frac{2\times10^5}{(1-0.3^2)}\left(-0.00012 + (0.3\times0.0004\ \right)$$

$$= 0 \text{ MPa}$$

$\therefore$ The smallest normal stress is 0 MPa.

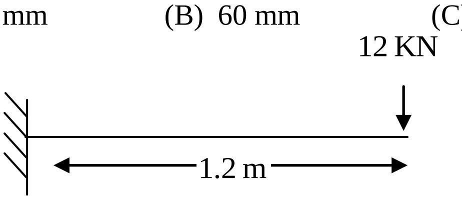
$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2} = \frac{80-0}{2} = 40 \text{ MPa}$$

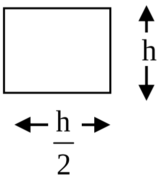
113. A cantilever of length 1.2 m carries a concentrated load of 12 kN at the free end. The beam is of rectangular cross-section with breadth equal to half the depth. The maximum stress due to bending is not to exceed 100 N/mm^2. The minimum depth of the beam should be

(A) 120 mm
(B) 60 mm
(C) 75 mm
(D) 240 mm

Key: (A)

Exp:





$$I = \frac{bd^3}{12} = \frac{h}{2}\times\frac{h^3}{12}$$

$$\sigma_{b\,max} = 100 \text{ N/mm}^2$$

Maximum bending moment $= 12\times1.2 = 14.4$ KN – m

$$\frac{M}{I}=\frac{\sigma_b}{y}\Rightarrow\frac{14.4\times10^3\times10^3}{\frac{h}{2}\times\frac{h^3}{12}}=\frac{100}{h/2}$$

$$\Rightarrow h_{min}=120\text{ mm}$$

114. Two strain gauges fixed along the principal directions on a plane surface of a steel member recorded strain values of 0.0013 tensile and -0.0013 compressive respectively. Given that the value of $E=2\times10^5$ MPa and $\mu=0.3,$ the largest normal and shearing stress at this point are

(A) 200 MPa and 200 MPa
(B) 400 MPa and 200 MPa
(C) 260 MPa and 260 MPa
(D) 260 MPa and 520 MPa

Key: (A)

Exp: $\varepsilon_1=0.0013, \varepsilon_2=-0.0013$

$$E=2\times10^5\text{ MPa}, \nu=0.3$$

$$\sigma_1=\frac{E}{(1-\nu^2)}(\varepsilon_1+\nu\varepsilon_2)=\frac{2\times10^5}{(1-(0.3)^2)}(0.0013-(0.3\times0.0013))$$

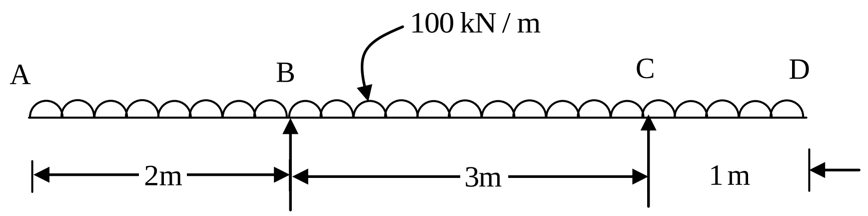
$$=200\text{ MPa}$$

$$\sigma_2=\frac{E}{(1-\nu^2)}(\varepsilon_2+\nu\varepsilon_1)=\frac{2\times10^5}{(1-(0.3)^2)}(-1.0013+(0.3\times0.0013))$$

$$=-200\text{ MPa}$$

$$\therefore\tau_{max}=\frac{\sigma_1-\sigma_2}{2}=200\text{MPa}$$

115. A beam ABCD, 6 m long, is supported at B and C, 3 m apart with overhangs AB= 2m, and CD=1m. It carries a uniformly distributed load of 100 kN/m over its entire length:



The maximum magnitudes of bending moment and shear forces are

(A) 200 kN-m and 250 kN
(B) 200 kN-m and 200 kN
(C) 50 kN-m and 200 kN
(D) 50 kN-m and 250 kN

Key: (B)

Exp: Taking moment about B

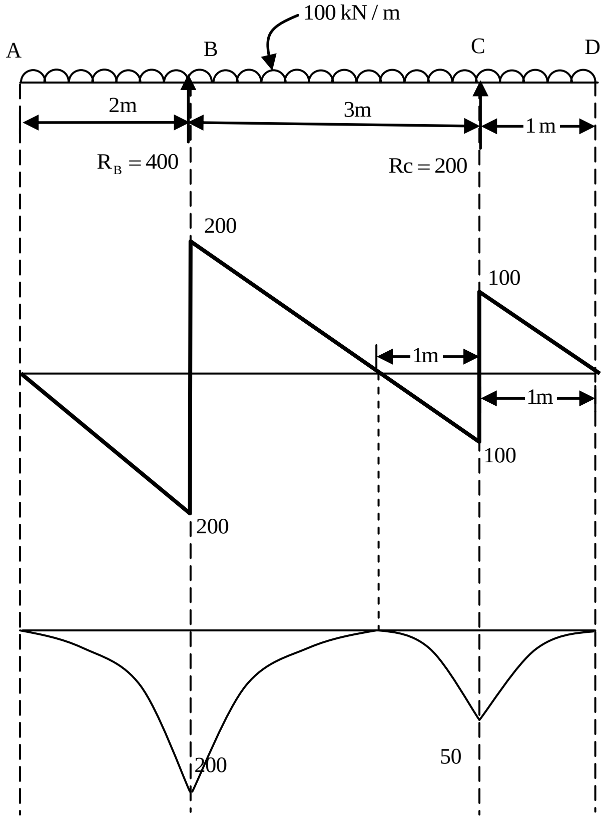
$$R_c\times3=100\times6\times1\Rightarrow R_c=200\text{kN}$$

$$R_B=100\times6-R_c$$

$$=400\text{kN}$$

From the figure maximum magnitude of shear force is 200 KN.

and bending moment is 200 kNm.



116. A solid circular cross-section cantilever beam of diameter $\phi = 100\,\text{mm}$ carries a shear force of 10 kN at the free end. The maximum shear stress is

(A) $\frac{4}{3\pi}$ Pa (B) $\frac{3\pi}{4}$ Pa (C) $\frac{3\pi}{16}$ Pa (D) $\frac{16}{3\pi}$ Pa

Key: (D)

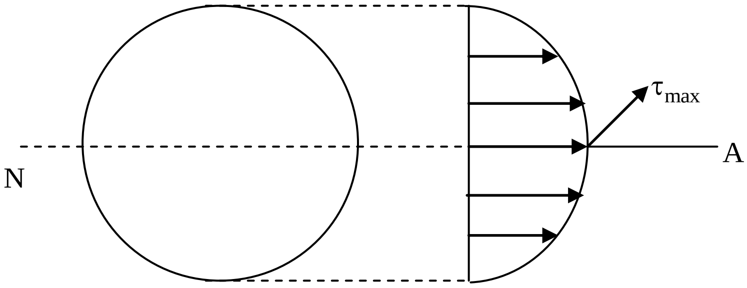
Exp: Shear force $= P = 10\text{kN}$

diameter $= 100$ mm

$$\text{Average shear stress} = \frac{P}{A} = \frac{10\times10^3}{\frac{\pi}{4}\times100^2} = \frac{4}{\pi}\text{MPa}$$

Maximum shear stress for circular section is

$$\frac{4}{3}\times\tau_{avg} = \frac{16}{3\pi}\text{MPa}$$



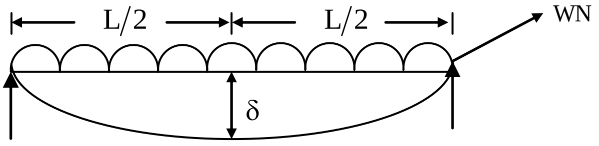
117. A beam of length L simply supported at its ends carrying a total load W uniformly distributed over its entire length deflects at the centre by δ and has a maximum bending stress σ. If the load is substituted by a concentrated load W_1 at mid-span such that the deflection at the centre remains unchanged, the magnitude of the load W_1 and the maximum bending stress will be

(A) 0.3W and 0.3σ (B) 0.6W and 0.6σ

(C) 0.3W and 0.6σ (D) 0.6W and 0.3σ

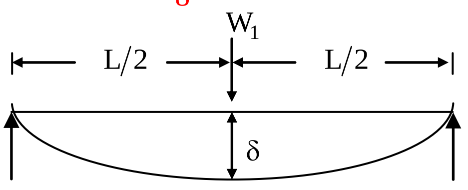
Key: (D)

Exp:



$$\delta = \frac{W \times L^3}{EI} \times \frac{5}{384}$$

$$\text{Maximum B.M} = \frac{WL}{8} \qquad ...(1)$$



$$\delta = \frac{W_1 L^3}{48EI}$$

$$\Rightarrow \frac{W \times L^3}{EI} \times \frac{5}{384} = \frac{W_1 \times L^3}{48EI}$$

$$\text{Maximum B.M} = \frac{W_1 L}{4} \qquad ...(2)$$

$$\Rightarrow W_1 = 0.6W$$

$$\frac{M}{I} = \frac{\sigma_b}{y} \Rightarrow M \alpha \sigma_b \Rightarrow \frac{M_1}{M_2} = \frac{\sigma_{b_1}}{\sigma_{b_2}}$$

$$\Rightarrow \frac{\frac{WL}{8}}{\frac{W_1 L}{4}} = \frac{\sigma}{\sigma_{b_2}}$$

$$\Rightarrow \frac{W}{2 \times 0.6w} = \frac{\sigma}{\sigma_{b_2}}$$

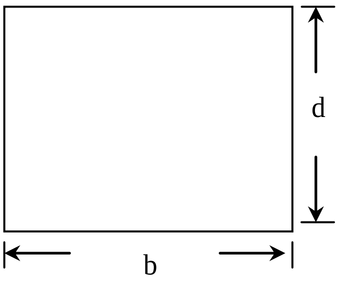
$$\Rightarrow \sigma_{b_2} = 1.2\sigma$$

118. For a rectangular section beam, if the beam depth is doubled, keeping the width, length and loading same, the bending stress is deceased by a factor

(A) 2 (B) 4 (C) 6 (D) 8

Key: (B)

Exp:



$$\frac{M}{I}=\frac{\sigma_b}{y}\Rightarrow \sigma_b \alpha \frac{1}{z}$$

$$\Rightarrow \frac{\sigma_{b_1}}{\sigma_{b_2}}=\frac{z_2}{z_1}=\frac{b\times\frac{4d^2}{6}}{\frac{bd^2}{6}}=4$$

$$\Rightarrow \sigma_{b_2}=\frac{\sigma_{b_1}}{4}$$

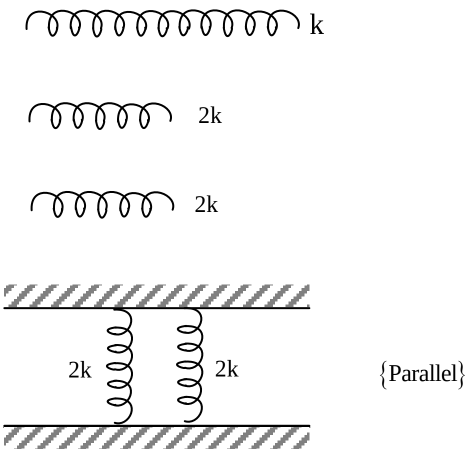
$\therefore$ Bending stress decreaes by 4 times

119. A helical compression spring of stiffness K is cut into two pieces, each having equal number of turns and kept side-by-side under compression. The equivalent spring stiffness of this new arrangement is equal to

(A) 4K (B) 2K (C) K (D) 0.5 K

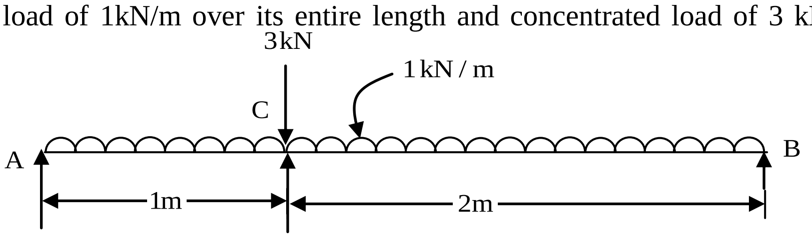
Key: (A)

Exp:



$$k' = 2k + 2k = 4k$$

120. A beam AB simply supported at its ends A and B, 3 m long, carries a uniformly distributed load of 1kN/m over its entire length and concentrated load of 3 kN, at 1 m from A:

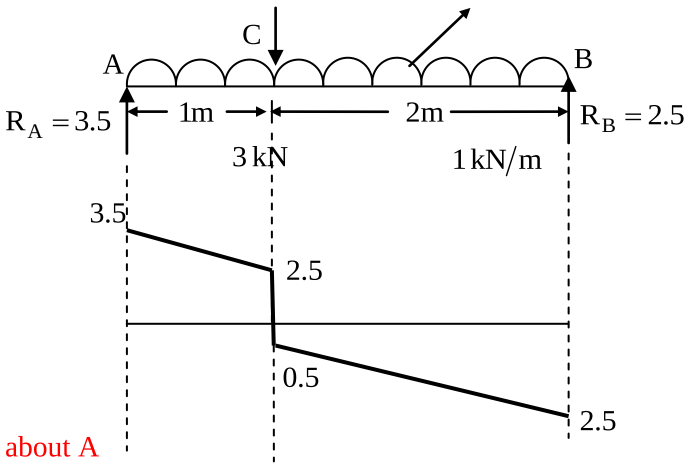


If ISJB 150 with $I_{xx} = 300\,cm^4$ is used for the beam, the maximum value of bending stress is

(A) 75 MPa (B) 85 MPa (C) 125 MPa (D) 250 MPa

Key: (A)

Exp:



Taking moment about A

$$R_B \times 3 = 1\times3\times1.5 + 3\times1$$
$$\Rightarrow R_B = 2.5\,kN$$
$$R_A = 3 + (1\times3) - 2.5$$
$$= 3.5\,kN$$

For simply supported beam bending moment will be maximum where shear force charges its sign i.e., at C

$\therefore$ Bending moment at $C = 3.5\times1 - 1\times1\times0.5$

$$= 3\,kNm$$

$I_{nn} = 300 Cm^4$, for ISJB depth $= d = 150$ mm

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\Rightarrow \frac{3\times10^3\times10^3}{300\times10^4} = \frac{\sigma_b}{\frac{150}{2}} \Rightarrow \sigma_b = 75\,MPa$$