GATE 2023 MECHANICAL ENGINEERING

APTITUDE

Q1. Planting: Seeds :: Raising :
(a) Child
(b) Temperature
(c) Lift
(d) Height

Q2. He did not manage to fix the car himself, so he _____ in the garage
(a) got fixed
(b) got it fixed
(c) gets fixed
(d) getting it fixed

Q3. Consider the following inequalities
$p^2 - 4q < 4$
$3p + 2q < 6$
where p and q are positive integers.
The value of (p + q) is

Q4. Minute hand and second hand arm of a clock cross each other _____times between 9:15AM to 9:45AM
(a) 15
(b) 30
(c) 29
(d) 31

Q5. How many pair of sets (S.T.) are possible among the subsets of (1, 2, 3, 4, 6) that satisfy the conditions that S is a subset of T?
(a) 729
(b) 728
(c) 664
(d) 665

Q6. An opaque pyramid is shown below, with a square base and isosceles faces, is suspended in the path of parallel beam of light, such that its shadow is cast on a screen oriented perpendicular to the direction of the light beam. The pyramid can reoriented in any direction within the light beam. Under these conditions, which one of the shadows PQRS is not possible

Q7. Which of the following sentence sequence in the given options creates a coherent narrative?
(a) I could not bring myself to knock
(b) There was a murmur of unfamiliar voice coming from the big drawing room and the door was firmly shut
(c) The passage was dark for a bit but then if suddenly opened into a bright kitchen
(d) I decided I would rather wonder down the passage

Q8. The smallest perimeter that a rectangle with area of 4 square units can have is_____units

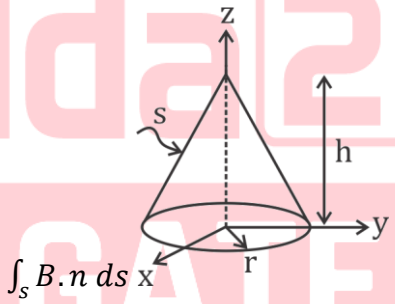
Q9.

Q10.

Engineering Mathematics

Q1. Find the inverse transform of $\frac{1}{s^2-s}$

Q2. A vector field
$B(x, y, z) = x\hat{\imath} + \hat{\jmath}y - 2z\hat{k}$
is defined over a conical region having height $h = 2$, base radius $r = 3$ and axis aong z, as shown in figure. The base of the cone lies in the x-y plane and is centred at origin.
If n denotes the unit outward normal to the curved surface S of the cone, the value of intergral.



$\int_s B.n\, ds$
equals _____.

Q3. The value of k that makes the complex-valued function
$f(z) = e^{-kx}(\cos 2y - i\, sin\, 2y)$
analytic, where, $z = x + 1y$ is

Q4. The initial value problem
$\frac{dy}{dt} + 2y = 0, y(0) = 1$
is solved numerically using the forward Euler's method with a constant and positive time step of Δt. Let y_n represent the numerical obtained after n steps. The condition $|y_{n+1}| \leq |y_n|$ is satisfied if and only if Δt des not exceed _____.

Q5. A machine produces defective component with probability of 0.015 and total defective component is 200. it follows Poisson distribution. find mean and variance

Q6. Consider second order linear ordinary diff. equation $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}-y=0, x\geq 1$ with initial conditions $y(x=1)=6, \frac{dy}{dx}_{x=1}=2$. The value of y at x=2 equals _____

Q7. The figure shows the plot of a function over the interval (-4,4). Which one of the following options given correctly identify the functions?

Mechanical Engineering

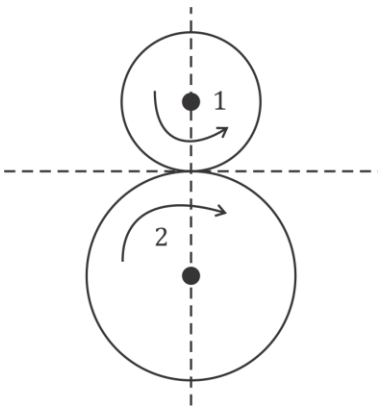
Q1. A cylindrical transmission shaft of length 1.5m and diameter 100mm is made of a linear elastic material with a shear modulus of 80 GPa. While operating at 500 rpm, the angle of twist across its length is found to be 0.5 degrees.
The power transmitted by the shaft at this speed is _____ kW. (Rounded off two decimal places)
Take $\pi = 3.14$.
Ans: 2392.45

Q2. Consider a mixture of two ideal gases, x and y with molar masses $\bar{m}_x$ = 10 kg/k mol and $\bar{m}_y$ = 20 kg/k mol respectively in a container. The total pressure in the container is 100 KPa. The total volume of the container is 10 m^3 and the temperature of the contents of container is 300k. If mass of gas-x in the container is 2 kg, then the mass of gas-y in the container is _____ kg.
Assume: that the universal gas constant is 8314 J K mol^{-1} K^{-1}
Ans: 4

Q3. The principal stresses at a point P in a solid are 70 MPa, –70 MPa, and 0. The yield stress of material is 100 MPa.
Which prediction(s) about material failure at P is/are correct
(a) Maximum normal stress theory predicts that material fails.
(b) Maximum normal stress theory predicts that material does not fail.
(c) Maximum shear stress theory predicts that the material does not fail.
(d) Maximum shear stress theory predicts that material fails.
Ans: B and D

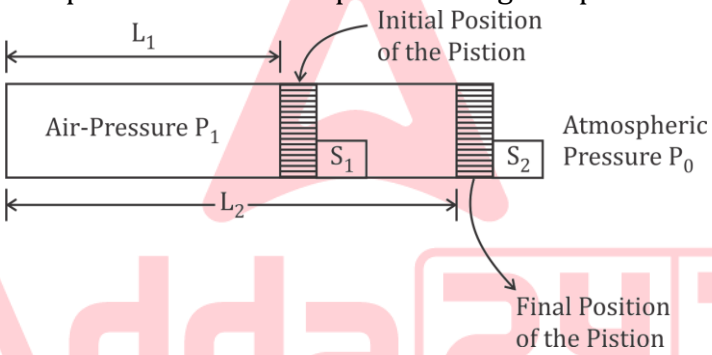
Q4. A heat engine extracts heat (Q_H) from a thermal reservoir at a temperature of 1000K and rejects heat (Q_L) to a thermal reservoir at a temperature of 100K. While producing work (W), which one of the combination of (Q_H, Q_L and W) given is allowed?
(a) $Q_H = 6000$ J, $Q_L = 600$ J, $W = 5500$ J
(b) $Q_H = 2000$ J, $Q_L = 750$ J, $W = 1250$ J
(c) $Q_H = 2000$ J, $Q_L = 500$ J, $W = 1000$ J
(d) $Q_H = 2000$ J, $Q_L = 500$ J, $W = 1000$ J
Ans: B

Q5. Two meshing spur gears and 2 with diametric pitch of 8 teeth per mm and an angular velocity $\frac{|W_2|}{|W_1|} = 1/4$, have their centres 30mm apart. The number of teeth on the driver (gear 1) is _____



Ans: 96

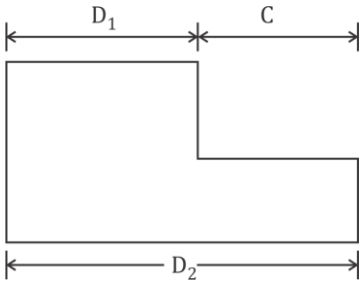
Q6. $P_1 >> P_0$, where P_0 is atmospheric pressure. The stop S_1 is instantaneously removed and the piston moves to the position L_2, where the equilibrium pressure of air inside the cylinder is $P_2 >> P_0$
What is the work done by the piston on the atmosphere during this process?



(a) 0
(b) $P_1 A\ L_1\ L_n\ L_1/L_2$
(c) $P_0 A(L_2 - L_1)$
(d) $\left(\frac{P_2 L_2 - P_1 L_1}{1-\gamma}\right) A$

Ans: D

Q7. A part produced in high volumes is dimensioned as shown. The machining process making this part is known to be statistically in control based on sampling data. The sampling data shown that D_1 follows a normal distribution with mean of 20mm and a standard deviation of 0.3mm. While D_2 follows a normal distribution with a mean of 35mm and a standard deviation op 0.4mm . An inspection of dimension C is carried out in a sufficiently large number of parts.
To be considered under six-sigma process control, the upper-limit of dimension C should be _____ mm.



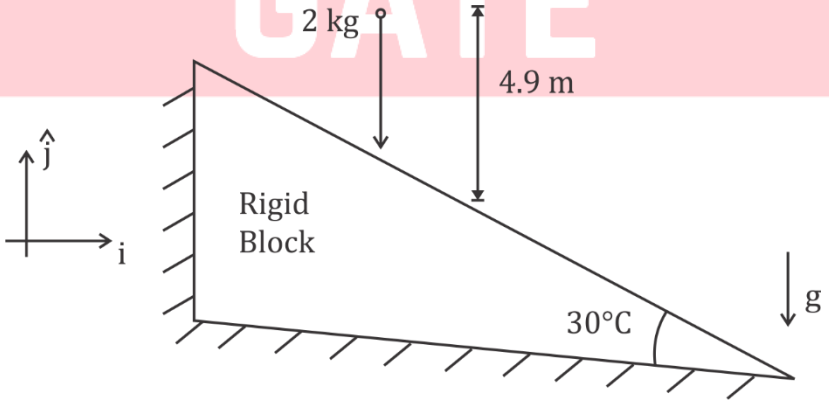
Ans: 16.5

Q8. Two Surfaces P and Q are to be joined together in which of the given joining operations, there is no melting of two surfaces P and Q for Creating the joint
(a) Arc Welding
(b) Spot Welding
(c) Brazing
(d) Adhesive Bonding
Ans: D

Q9. The atomic radius of a hypothetical face centered FCC metal is $\frac{\sqrt{2}}{10}mm$. The atomic weight of the metal is 24.092 g/mol. Taking avagadro's number to be 6.023×10^{23}atoms/mol. The density of metal is _____ kg/m^3
Ans: 2500

Q10. The figure shows a wheel rolling without slipping on horizontal plane with angular velocity ω_1. A rigid bar PQ is pinned to the wheel at P while the end Q slides on the floor. What is the angular velocity ω_2 of the bar PQ ?
(a) $\omega_2 = 2\omega_1$
(b) $\omega_2 = 0.5\omega_1$
(c) $\omega_2 = 0.25\omega_1$
(d) $\omega_2 = \omega_1$
Ans: C

Q11. A spherical ball weighing 2kg is dropped from a height of 4.9m on to an immovable rigid block as shown in figure. If the collision is perfectly elastic. What is the momentum vector of the ball (in kgm/s) just after impact.
Take the acceleration due to gravity to be $g = 9.8m/s$. Options have been given rounded off to one decimal place
(a) 19.6



Ans:

Q12. Consider an isentropic flow of air (ratio of specific heat = 1.4) through a duct as shown in figure. The variations in the flow across the cross-section are negligible. The flow condition at location 1 are given as follows:

$$P_1 = 100kPa, \rho = 1.2\frac{kg}{m^3}, u_1 = 400m/s$$

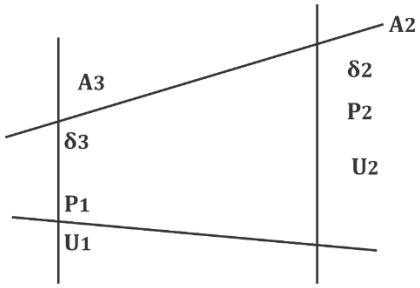
The duct cross sectional area at location 2 is given by $A_2 = 2A_1$ where A_1 denotes the duct cross sectional area at location 1 . Which one of the given statements about the velocity u_2 and pressure P_2 at location 2 is correct

(a) $u_2 < u_1, P_2 < P_1$

(b) $u_2 < u_1, P_2 > P_1$

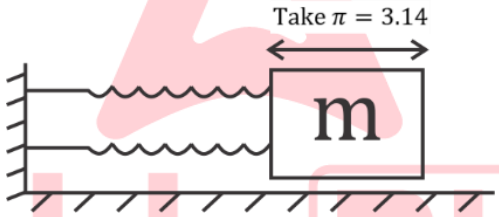
(c) $u_2 > u_1, P_2 > P_1$

(d) $u_2 > u_1, P_2 < P_1$



Ans: B

Q13. A figure shows a block of mass m=20kg attached to a pair of identical linear springs each having a spring constant k= 1000N/m. The block oscillates on a frictionless horizontal surface. Assuming free vibrations, the time taken by the block to complete ten oscillations is ____seconds. Take $\pi = 3.14$



Ans: 15.91

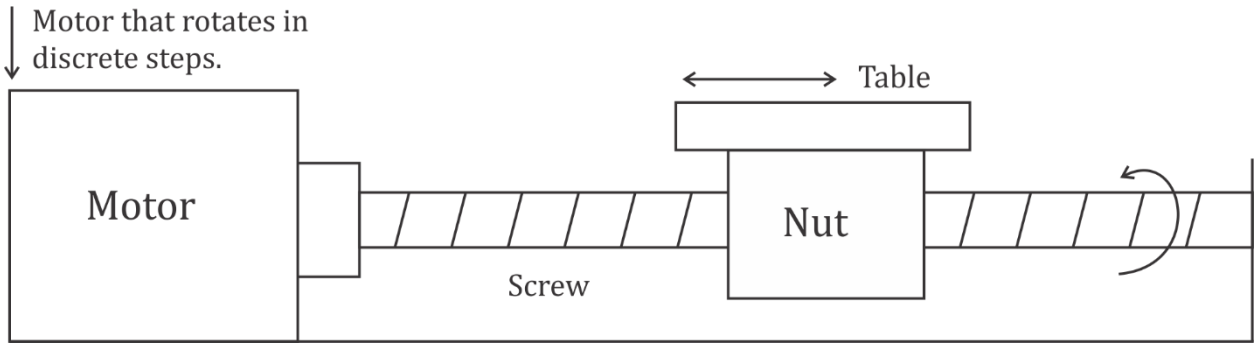
Q14. A CNC machine has one of its linear positioning axes as shown in figure. Consisting of a motor rotating a lead screw, which in turn moves a nut horizontally on which a table is mounted. The motor moves in discrete rotational steps of 50 steps per revolution. The pitch of the screw is 5mm and total horizontal traverse length of the table is 100mm. What is the total number of controllable locations at which table can be positioned on this axis

(a) 200

(b) 1000

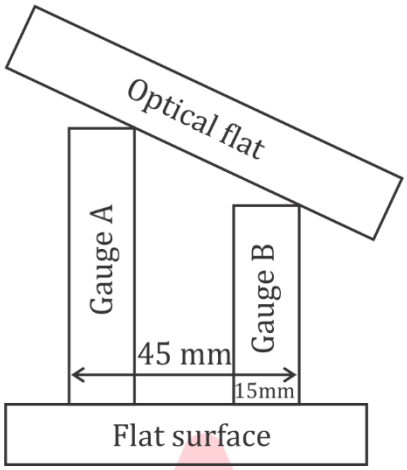
(c) 2

(d) 5000



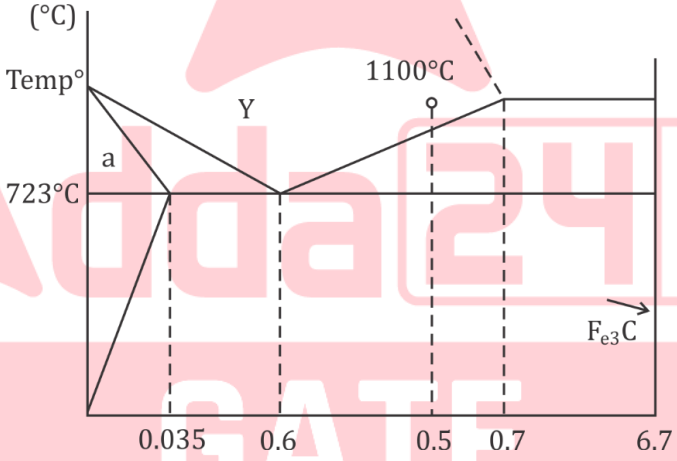
Ans: C

Q15. An optical flat is used to measure the height difference between a reference slip gauge A and a slip gauge B. Upon reviewing via the optical flat using a monochromatic light if wavelength 0.8um. 12 fringes were observed over a length of 15mm of gauge B. If the gauges are placed 45mm apart the height difference of the gauge is _____.



Ans: 18

Q16. A steel plate with 1.5% carbon (no other alloying element is present) is slowly cooled from 1100°C to just below the eutectoid temp 723°C. A part of iron cementite phase diagram is shown in the figure. The ratio of the pro-eutectoid cementite Content to the total cementite content on the microstructure that develops just below the eutectoid temp. is____.



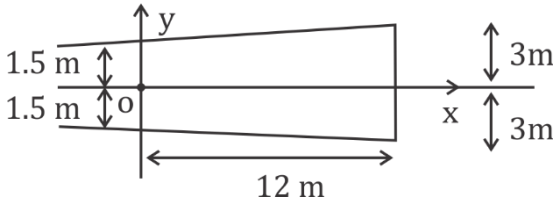
Ans: 0.538

Q17. An explosion at time t=0 releases energy E at the origin in a space filled with a gas of density(ρ). Subsequently a hemispherical blast wave propagates radially outward as shown in figure. Let R denote the radius of the front of the hemispherical blast wave. The radius R follows the relationship $R = kt^a E^b \rho^c$ where k is dimensionless constant. The value of exponent is

_____.

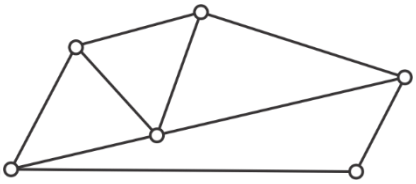
Ans: -1

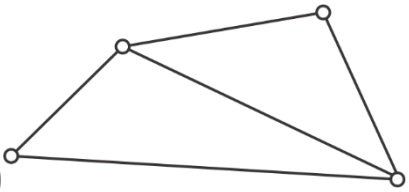
Q18. The area moment of inertia about the y axis of a linearly tapered section shown in the figure is _____m^4.

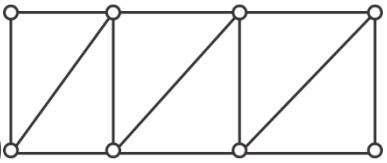


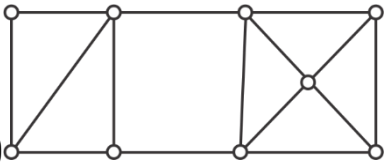
Ans: 3024

Q19. In options shown frames consisting of rigid bars connected by pin joints. Which of the frames is non rigid

(a)


(b)


(c)


(d)


Q20. Air density $\rho = 1.2\ {}^{kg}/_{m^3}$, $v = 1.5 \times 10^{-5}\ \frac{m^2}{s}$ flows over a flat plate with a free stream velocity of 2m/s. The wall shear stress of a location 15mm from the leading edge is $\tau_{\omega.}$ What is the wall shear stress at a location 30mm from the leading edge.

(a) $\frac{\tau_{\omega.}}{2}$

(b) $2\tau_{\omega.}$

(c) $\sqrt{2}\tau_{\omega.}$

(d) $\frac{\tau_{\omega.}}{\sqrt{2}}$

Ans: D

Q21. The velocity field of a certain 2-D flow is given by V(x,y) = K(xi-yj) where $k = 2s^{-1}$. The coordinates x and y are in meters. Assume gravitational effect to be negligible. If the density of the fluid is 1000 ${}^{kg}/_{m^3}$, and the pressure of the origin is 1ookPa. The pressure at location (2m,2m) is _____

Ans: 84

Q22. Consider a unidirectional fluid where the velocity field is given by V(x,y,z,t)= 4(x,t)I, where u(0,t) =1, if the spatially homogeneous density field varied with t as s(t) = $1 + 0.2e^{-t}$, the value of u(2,1) is _____

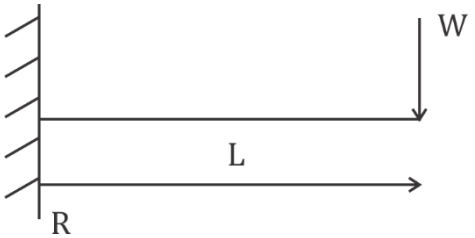
Ans: 1.12

Q23. The figure shows two fluid held by a hinged gate. The atm pressure is $P_a = 100kPa$. The moment per unit width about the base of hinge is _____

Ans: 57.2

Q24. The effective stiffness of a cantilever beam of length L and flexural rigidity EI subjected to transverse lip load W is

MCQ (1)



(a) $\frac{2\,EI}{L^3}$

(b) $\frac{3EI}{L^3}$

(c) $\frac{L^3}{3EI}$

(d) $\frac{L^3}{2EI}$

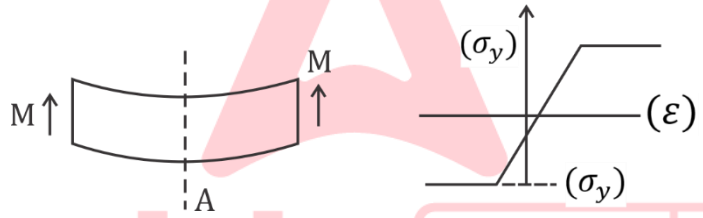
Ans: B

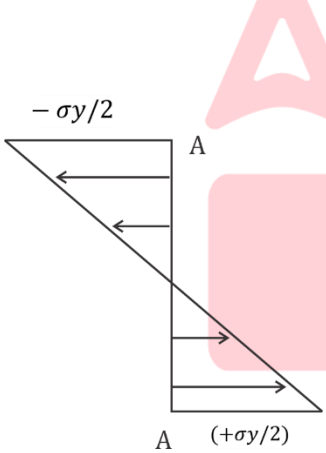
Q25. Consider a counter flow heat exchanger with inlet temperature of two fluids as 300k and 350k. The heat capacity rates are 1000 and 400W/k and effectiveness as 0.5. Actual heat transfer rate is_____

Ans: 10

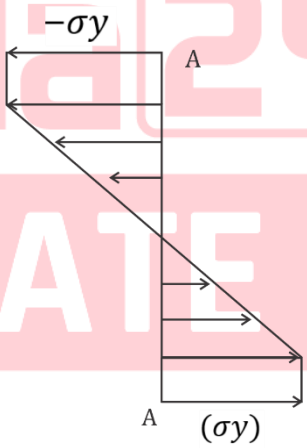
Q26. A beam is undergoing 14 % bending as shown in fig, the stress (σ) strain (ε) (42 ve F.cr the material also given. The yield strength of the material is σ_y which of the options given represent(s) the bending stress distribution at cross section A – A after plastic yielding.

MSQ (1)

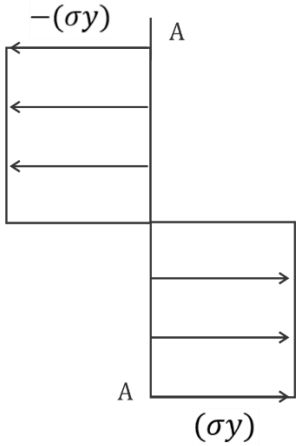




(a)



(b)



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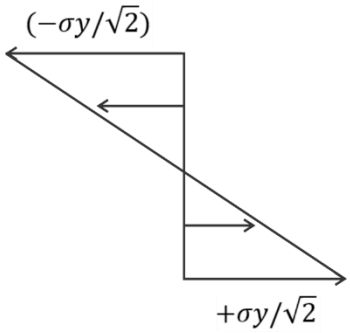
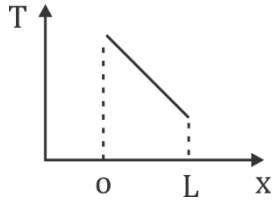


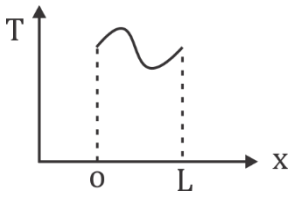
(d)

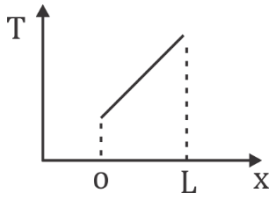
Ans: A and C

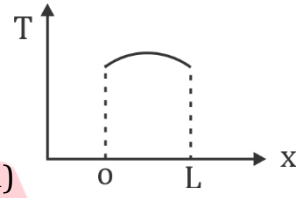
Q27. Sider a laterally insulated red of length L and constant thermal conductivity. Assuming one dimensional heat conduction in the rad, which of the following steady state temp profile(s) can occur without heat generation

MSQ (1)

(a) 

(b) 

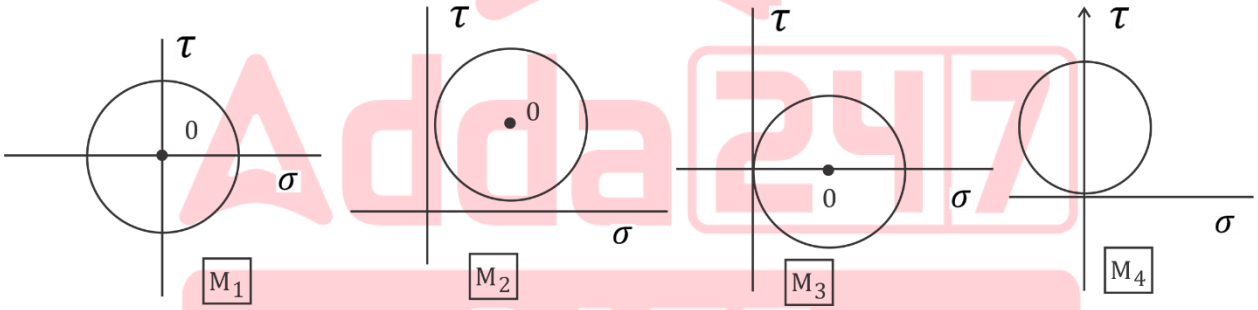
(c) 

(d) 

Ans:

Q28. Which of the following shown is/are valid Mohr circle representation of a plane stress state in a material ethe center of each circle is indicated by O

[MSQ (1)]



(a) M_4

(b) M_2

(c) M_3

(d) M_1

Ans:

Q29. A cylindrical red of length b and diameter d is placed inside a cube encloser of side length L. S denote the inner surface of the cube the view factor $F_{S.S}$ is

MCQ (2)

(a) $1 - \frac{ndh+nd^2/2}{6L^2}$

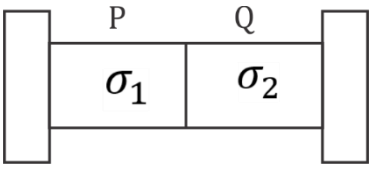
(b) $\frac{ndh+nd^2/2}{6L^2}$

(c) 0

(d) 1

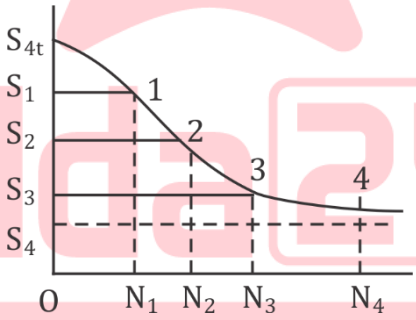
Ans: A

Q30. Cylindrical bars P and Q have identical length and radius, but are composed of different linear elastic materials, the young modulus and coefficient of thermal expansion of Q are twice of P. Assume the bars to be perfectly bonded at the interface, and their weights to be negligible
The bars are held between rigid supports as shown in fig and the temp is raised by AT. Assume that the s tress in each bar is homogeneous and unequal. Denote the magnitudes of stress in P and Q by σ_1 and σ_2 respectively.
MSQ (2)



Which of the following statement is/are
(a) Interface between P and Q moves to left after hearing
(b) Interface between P and Q moves right after hearing
(c) $\sigma_1 < \sigma_2$
(d) $\sigma_1 = \sigma_2$
Ans: A and D

Q31. The SN curve from a fatigue test for steel is shown which of the following option gives endurance limit
MCQ (1)



(a) S_{4t}
(b) S_3
(c) S_2
(d) S_4
Ans: D

Q32. Ignoring the small elastic region, the true stress true strain variation of a material beyond yielding follows equation $\sigma = 400\epsilon^{0.3} mPa$. The engineering ultimate strength value of this material is _____
Ans:

Q33. In metal casting process to manufacture parts, both pattern and mould provided shape by dictating where the material should and should not go which

Q34. In an ideal orthogonal cutting experiment cutting velocity V=1m/s, $\alpha = 5°, \varphi = 45°$, applying the ideal orthogonal cutting model, consider two shear planes PQ and RS close to each other as they approach the thin shear zone plane RS sheared w.r.t PQ. Assuming that perpendicular distance between PQ and RS is $25\mu m$. What is the value of shear strain that the material undergone at the shear zone?

Q35. A cylindrical rod of length h and dia d is placed inside a cubic enclosure of side L. S donates he inner surface of the cube. The view-factor FSS is

(a) $1-\frac{(rdh+\frac{rd^2}{2})}{6l^2}$

(b) $\frac{rdh+\frac{rd^2}{2}}{6l^2}$

(c) 0

(d) 1

Q36. A very large metal plate of thickness d and thermal conductivity k is cooled by stream of air at T=300K. T_p(Centre line temperature). In which case lumped parameter model is used to study the heat transfer in metal plate.

(a) $h=100, k=1000, d=1mm, T_p=325K$

(b) $h=100, k=100, d=1m, T_p=325K$

(c) $h=1000, k=1, d=1mm, T_p=350K$

(d) $h=10, k=100, d=1mm, T_p=350K$

Q37. Consider incompressible laminar fluid flow of constant property Newtonian fluid in an isothermal circular tube. The flow is steady with fully developed temperature and velocity profiles. The Nusselt number for this flow depends on

(a) the prandlt number but not Reynold number

(b) the Renault number but not the prandlt number

(c) neither the Reynold number nor the prandlt number

(d) both the reynold number and prandlt number

Q38. Which of the following is not correct ?

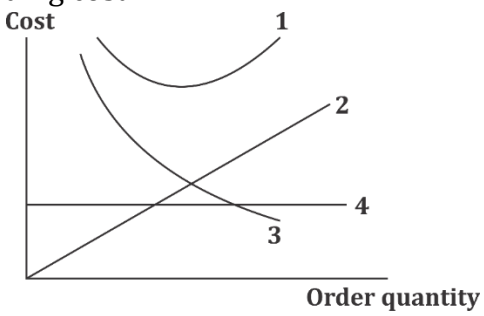
(a) Any real gas behaves as an ideal gas at low pressure high temperature

(b) For real gas going through adiabatic reversible process(PV=C)

(c) For ideal gas h$\neq f(\rho)$

(d) Ideal gas polytropic process $(PV^{1.5}=C)\ \frac{P}{R}=\frac{mT}{V}$ is the equation connecting P_{1V} and T at any point along the process

Q39. Match curve with corresponding cost:



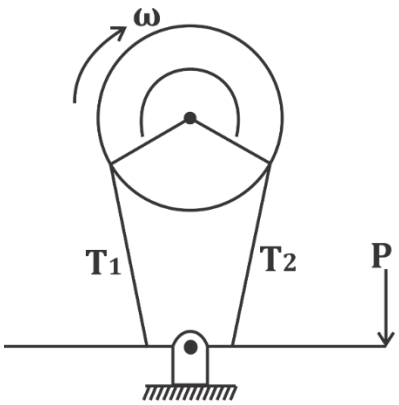
(a) Total cost

(b) Setup cost

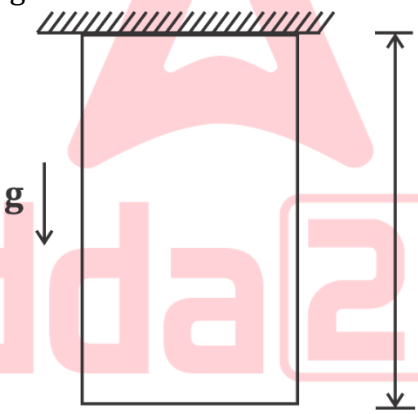
(c) Production cost

(d) Hosting cost

Q40. In the band brake shown above, the angle of contact is 270°, and coefficient of friction is 0.3. what will be the ratio of tight side tension to slack side tension?

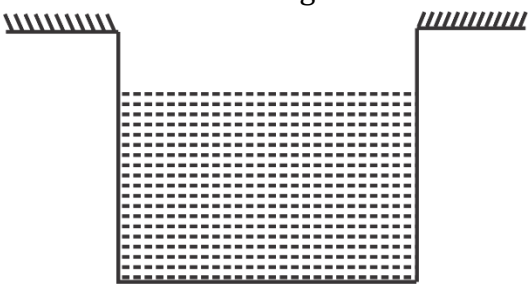


Q41. L = 5 m
A = 10 m^2
E = 70 GPa
P = 2700 kg/m^3
Elastic strain energy due to self-weight



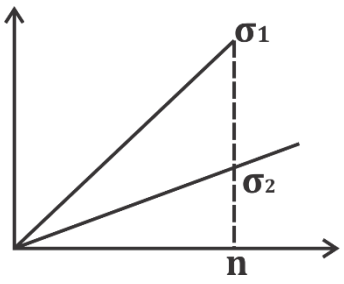
Q42. Consider the following objective function
$Z_{\max=45x_1} + 60x_2$
Subjected to constraints:
$x_1 \leq 45$
$x_2 \leq 50$
$10x_1 + 10x_2 \geq 600$
$25x_1 + 5x_2 \leq 750$
What would be the feasible region satisfying all ..... ?

Q43. A thin cylinder is filled with water as shown in figure below

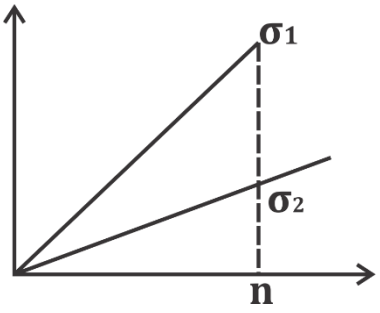


If $\sigma_L = \sigma_1$ *and* $\sigma_c = \sigma_2$ then, which of the following graph is correct?

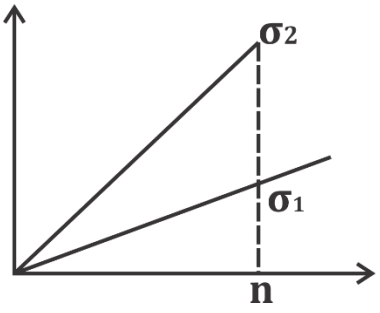
(a)



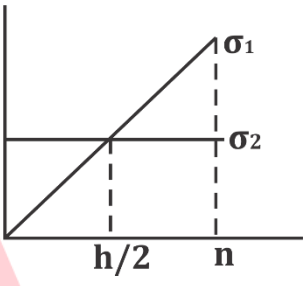
(b)



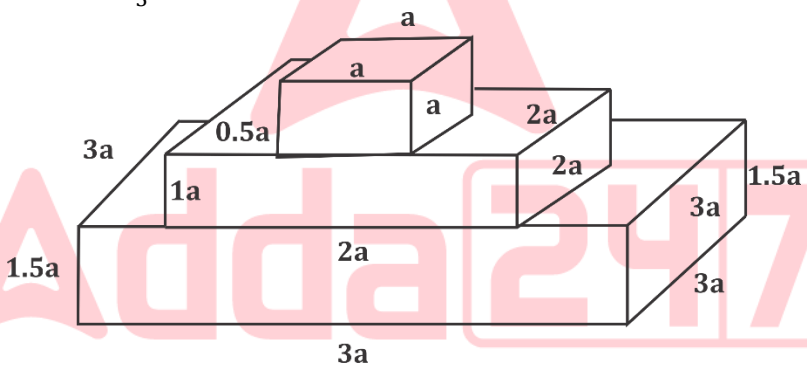
(c)



(d)



Q44. A part is produced as given below by additive manufacturing and nozzle diameter is given $\frac{a}{10}$ mm and feed rate through nozzle is $\frac{a}{5}$ mm/min then find the time taken to produced this part?



Q45. Which of the following is correct statement?

(a) Mould is used to make pattern.

(b) Pattern is used to make mould cavity.

(c) Molten metal is contact with mould cavity

(d) Molten metal come in contact with pattern.