GATE – 2015 – Mechanical Engineering (ME)

01-02-15

1. Five teams have to compete in a league, with every team playing every other team exactly once, before going to next round. how many matches will have to be held to complete the league round of matches?

(A)20 (B)10 (C)8 (D)5

Ans: (B)

02. Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Apparent lifelessness _____ dormant life

(A) harbours (B) leads to (C) supports (D) affects

Ans: (B)

03. Choose the statement where underlined word is used correctly.

(A) When the teacher eludes to different authors, he is being elusive.

(B) When the thief keeps eluding the police, he is being elusive.

(C) Matters that are difficult to understand identify or remember are allusive.

(D) Mirages can be allusive, but a better way to express them is illusory.

Ans: (B)

04. Fill in the blanks with the correct idiom/phrase.

That boy from the town was a _____ in the sleepy village.

(A) dog out of herd (B) sheep from the heap

(C) fish out of water (D) bird from the flock

Ans: (C)

05. Tanya is older than Eric. Cliff is older than Tanya.

Eric is older than Cliff.

If the first two statements are true, then the third statement is:

(A)True (B)False (C)Uncertain (D)Data insufficient

Ans: (B)

06. Right triangle PQR is to be constructed in the *xy*-plane so that the right angle is at P and line PR is parallel to the x-axis. The *x* and *y* coordinates of P, Q, and R are to be integers that satisfy the inequalities: $-4 \le x \le 5$ and $6 \le y \le 16$. How many different triangles could be constructed with these properties?

(A)110 (B)1,100 (C) 9,900 (D)10,000

Ans: (C)

07. A coin is tossed thrice. Let X be the event that head occurs in each of the first two tosses. Let Y be the event that a tail occurs on the third toss. Let Z be the event that two tails occur in three tosses. Based on the above information, which one of the following is TRUE?

(A)X and Y are not independent (B) Y and Z are dependent

(C)Y and Z are independent (D)X and Z are independent

Ans: (C)

08. Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statement:

I. No manager is a leader. II. All leaders are executives

Conclusions:

I. No manager is an executive. II. No executive is a manager.

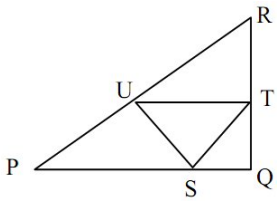
(A) Only conclusion I follows. (B) Only conclusion II follows.

(C) Ncither conclusion I nor II follows. (D) Both conclusions I and II follow.

Ans: (D)

09. In the given figure angle Q is a right angle,

PS:QS=3: 1 ,RT:QT=5:2 and PU:UR=1:1 If area of triangle QIS is 20cm2, then the area triangle PQR in crn is_____



Ans: 280

10. Select the appropriate option in place of underlined part of the sentence.

<u>Increased productivity necessary</u> reflects greater efforts made by the employees.

(A) Increase in productivity necessary (B) Increase productivity is necessary

(C) Increase in productivity necessarily (D) No improvement required.

Ans: (C)

Mechanical Engineering

01. Three parallel pipes connected at the two ends have flow-rates Q_1, Q_2, and Q_3 respectively, and the corresponding frictional head losses are $h_{L1,}$ h_{L2} and h_{L3} respectively. The correct expression for total flow rate (Q) and frictional head loss across the two ends (h_L) are

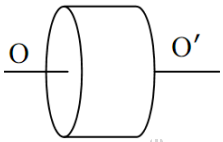
(A) $Q = Q_1+Q_2+Q_3$; $h_L = h_{L1} + h_{L2} + h_{L3}$ (B) $Q = Q_1+Q_2+Q_3$; $h_L = h_{L1} = h_{L2} = h_{L3}$

(C) $Q = Q_1 = Q_2 = Q_3$; $h_L + h_{L1} + h_{L2} + h_{L3}$ (D) $Q = Q_1 = Q_2 = Q_3$; $h_L = h_{L1}$ $h_{L2} = h_{L3}$

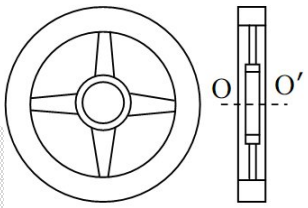
Ans: (B)

02. For the same material and the mass, which of the following configurations of flywheel will have maximum mass moment of inertia about the axis of rotation OO' passing through the center of gravity.

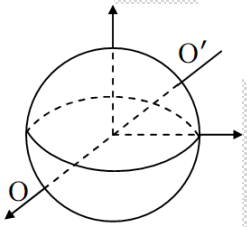
(A) Solid Cylinder



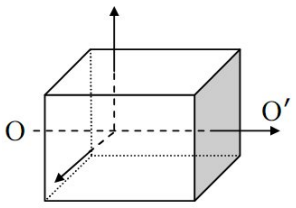
(B) Rimmed Wheel



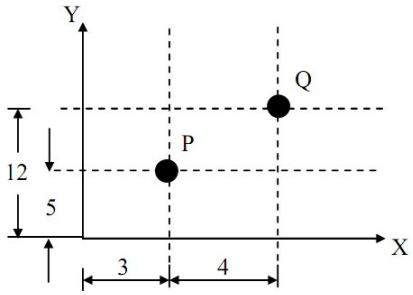
(C) Solid sphere



(D) Solid Cube



03. A drill is positioned at point P and it has to proceed to point Q. The coordinates of' point Q in the incremental system of defining position of' a point in CNC part program will be.



(A) (3, 12) (B) (5, 7) (C) (7, 12) (D) (4,7)

Ans: (D)

04. A rigid container of volume 0.5 m^3 contains 1.0 kg of water at 120^0C $\left(v_f = 0.00106 m^3/kg,\ v_g = 0.8908 m^3/kg\right)$. The state of water is

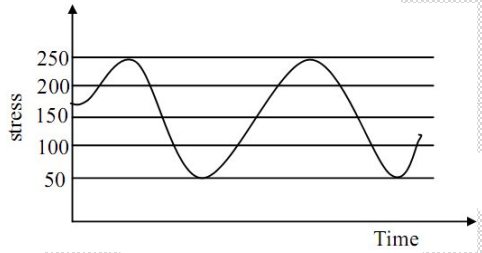
(A) Compressed liquid (B) saturated liquid

(C) A mixture of' saturated liquid and saturated vapor

(D) Superheated vapor

Ans: (C)

05. For the given fluctuating fatigue load, the value of' stress amplitude and stress ratio are respectively.



(A) 100MPa and 5 (B) 250MPa and 5

(C) 100MPa and 0.20 (D) 250MPa and 0.20

Ans: (C)

06. In full mould (cavity-less) casting process, Pattern is made of

(A) Expanded polystyrene (B) Wax

(C) Epoxy (D) Plaster of Paris

Ans: (A)

07. Which of the following statements are TRUE for damped vibrations?

P. For a system having critical damping, the value of damping ratio is unity and system does not undergo a vibratory motion.

Q. Logarithmic decrement method is used to determine the amount of damping in a physical system.

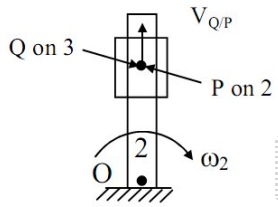
R. In case of damping due to dry friction between moving surfaces resisting force of constant magnitude acts opposite to the relative motion.

S. For the case of viscous damping, drag force is directly proportional to the square of relative velocity.

(A) P and Q only (B) P and S only (C) P, Q and R only (D) Q and S only

Ans: (C)

08. In the figure, link 2 rotates with constant angular velocity ω_2. A slider link 3 moves outwards with a constant relative velocity $V_{Q/P}$, where Q is a point on slider 3 and p is a point on link 2. The magnitude and direction of Coriolis component of acceleration is given by



(A) $2\omega_2\ V_{Q/P}$; direction of $V_{Q/P}$ rotated by 90^0 in the direction of ω_2

(B) $\omega_2\ V_{Q/P}$ direction of $V_{Q/P}$ rotated by 90^0 in the direction of ω_2

(C) $2\omega_2\ V_{Q/P}$ direction of $V_{Q/P}$ rotated by 90^0 opposite to the direction of ω_2

(D) $\omega_2\ V_{Q/P}$ direction of $V_{Q/P}$ VQ'P rotated by 90^0 opposite to the direction of ω_2 2

Ans: (A)

09. An air-standard Diesel cycle consists of' the following process:

1-2: Air is compressed isentropically.

2-3: heat is added at constant pressure.

3-4: Air expands isentropically to the original volume.

4-5: Heat is rejected at constant volume.

If' y and T denote the specific heat ratio and temperature, respectively, the efficiency of the cycle is

(A) $1-\dfrac{T_4-T_1}{T_3-T_2}$ (2) $1-\dfrac{T_4-T_1}{\gamma\left(T_3-T_2\right)}$ (3) $1-\dfrac{\gamma\left(T_4-T_1\right)}{T_3-T_2}$ (4) $1-\dfrac{T_4-T_1}{\left(\gamma-1\right)\left(T_3-T_2\right)}$

Ans: (B)

10. If $P\left(X\right)=\dfrac{1}{4}$, $P\left(Y\right)=\dfrac{1}{3}$, *and* $P\left(X\cap Y\right)=\dfrac{1}{2}$, the value of $P\left(\dfrac{Y}{X}\right)$ is

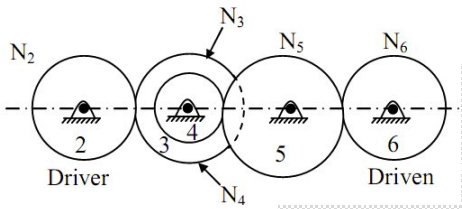
(1) $\dfrac{1}{4}$ (2) $\dfrac{4}{25}$ (3) $\dfrac{1}{3}$ (4) $\dfrac{29}{50}$

Ans: (C)

11. A cylindrical tank with closed ends is filled with compressed air at a pressure of 500kPa, the inner radius of the tank is 2m and it has wall thickness of 10 mm. The magnitude of maximum in–plane shear stress (in MPa) is____

Ans: 25

12. A gear train is made up of five spur gears as shown in the figure. Gear 2 is driver and gear 6 is driven member. N_2, N_3, N_4, N_5 and N_6 represent number of teeth on gears 2, 3, 4, 5, and 6 respectively. The gear(s) which act(s) as idler(s) is, arc



(A) Only 3 (B) Only 4 (C) Only 5 (D) both 3and5

Ans: (C)

13. The ratio of' momentum diffusivity (v) to thermal diffusivity (a), is called

(A) Prandtl number (B) Nusselt number (C) Blot number (D) Lewis number

Ans: (A)

14. The lowest eigen value of the 2×2 matrix $\begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$ is _____

Ans: 2

15. Which two ot' the following joining processes are autogeneous?

(i) Diffusion welding (ii) Electro slag welding

(iii) Tungsten inert gas welding (iv) Friction welding

(A) (i) and (iv) (B) (ii) and (iii) (C) (ii) and (iv) (D) (i) and (iii)

Ans: (A)

16. Couette flow is characterized by

(A) Steady, incompressible, laminar flow through a straight circular pipe

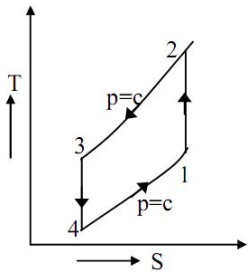
(B) Fully developed turbulent flow through a straight circular pipe

(C) Steady, incompressible, laminar flow between two fixed parallel plates

(D)Steady, incompressible, laminar flow between one fixed plate and the other moving with a constant velocity

Ans: (D)

17. The thermodynamic cycle shown in figure ($T - s$ diagram) indicates.



(A) Reversed Carnot cycle
(B) Reversed Brayton cycle
(C) Vapor compression cycle
(D) Vapor absorption cycle

Ans: (B)

18. In the notation (a/b/c) : (d/e/f) for summarizing the characteristics of queuing situation, the letters 'b' and 'd' respectively for

(A) Service time distribution and queue discipline
(B) Number of servers and size of calling source
(C) Number of servers and queue discipline
(D) Service time distribution and maximum number allowed in system

Ans: (A)

19. In a machining operation, if the generatrix and directrix both are straight lines, the surface obtained is

(A) Cylindrical
(B) helical
(C) Plane
(D) Surface of' revolution

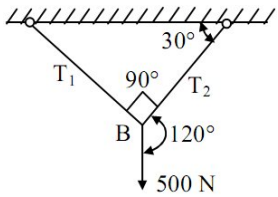
Ans: (C)

20. Let ϕ be an arbitrary smooth real valued scalar function and $\vec{V}$ be an arbitrary smooth vector valued function in a three-dimensional space. Which one of' the following is an identity?

(A) $Curl\left(\phi\vec{V}\right) = \nabla\left(\phi Div\,\vec{V}\right)$
(B) $Div\,\vec{V} = 0$
(C) $Div\,Curl\,\vec{V} = 0$
(D) $Div\left(\phi\vec{V}\right) = \phi Div\,\vec{V}$

Ans: (C)

21. A weight of 500N is supported by two metallic ropes as shown in the figure. The values of tensions T_1 and T_2 are respectively.



(A) 433N and 250N (B) 250N and 433N (C) 353.5N and 250N (D) 250N and 353.5N

Ans: (A)

22. Saturated vapor is condensed to saturated liquid in a condenser. The heat capacity ratio is $C_r = \frac{C_{\min}}{C_{\max}}$. The effectiveness (s) of the condenser is.

(A) $\frac{1-\exp\left[-NTU\left(1+C_r\right)\right]}{1+C_r}$ (B) $\frac{1-\exp\left[-NTU\left(1-C_r\right)\right]}{1-C_r\exp\left[-NTU\left(1-C_r\right)\right]}$

(C) $\frac{NTU}{1+NTU}$ (D) $1-\exp\left(-NTU\right)$

Ans: (D)

23. The value of $\lim_{x\to 0}\left(\frac{-\sin x}{2\sin x + x\cos x}\right)$ is _____

Ans: 0.333

24. The strain hardening exponent n of stainless steel SS 304 with distinct yield and UTS values undergoing plastic deformation is

(A)n<0 (B) n = 0 (C) 0<n<1 (D) $n = 1$

Ans: (C)

25. Using a unit step size, the value of' integral $\int_1^2 x\ln x dx$ by trapezoidal rule is

Ans: 0.6931

26. Steam enters a turbine at 30bar, 300^0C $\left(u = 2750kJ/kg,\ h = 2993kJ/kg\right)$ and exits the turbine as saturated liquid at l5kPa $\left(u = 225kJ/kg,\ h = 226kJ/kg\right)$. Heat loss to the surrounding is $50kJ/kg$ of steam flowing through the turbine. Neglecting changes in kinetic energy and potential energy, the work output of the turbine (in kJ/kg of steam) is

Atis: 2717

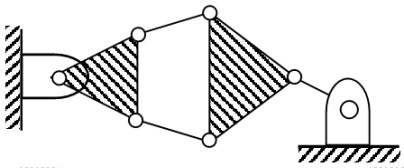
27. Refrigerant vapor enters into the compressor of a standard vapor compression cycle at -10^0C $(h = 402kJ/kg)$ and leaves the compressor at $50^0C(h = 432kJ/kg)$. It leaves the condenser at $30^0C(h = 237kJ/kg)$. The COP of the cycle is _____

Ans: 5.5

28. For ball bearings, the fatigue life L measured in number of revolutions and the radial load F arc related by $FL^{1/3} = K$, where K is a constant. It withstands a radial load of 2 kN for a life of 540 million revolutions. The load (in kN) for a life of one million revolutions is

Ans: 16.286

29. The number of degree of freedom of the linkage shown in figure is



(A) -3 (B) 0 (C) I (D)2

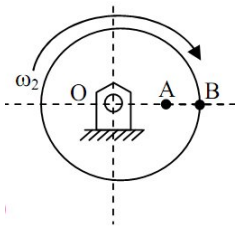
Ails: (C)

30. The dimensions of a cylindrical side riser (height = diameter) for a 25cm × 15cm x5cm steel casting are to be determined. For the tabulated shape factor values given below, the diameter of the riser (in cm) is_____

shape factor	2	4	6	8	10	12
Riser Volume / Casting volume	1.0	0.70	0.55	0.50	0.40	0.35

Ans: 10.6

31. Figure shows a wheel rotating about O_2. Two points A and B located along the radius of' wheel have speeds of 80m/s and 140 m/s respectively. The distance between the points A and B is 300 mm. The diameter of the wheel (in mm) is _____



Ans: 1400

32. In a CNC milling operation. the tool has to machine the circular arc from point (20, 20) to (10, 10) at sequence number 5 of the CNC part program. If the center of the arc is at

(20,10) and the machine has incremental mode of defining position coordinates, the correct tool path command is

(A)N 05 G90 G01 X-10 Y-10 R10 (B)N 05 G91 G03 X-10 Y-10 R10

(C)N 05 G90 G03 X-20 Y-20 R10 (D)N 05 G91 G02 X-20 Y-20 R10

Ans: (B)

33. A brick wall $\left(k = 0.9\frac{W}{m.K}\right)$ of thickness 0.18m separates the warm air in a room the cold ambient air. On a particular winter day, the outside air temperature is -5^0C and the room needs to be maintained at 27^0C. The heat transfer coefficient associated with is $20\frac{W}{m^2K}$ Neglecting ink outside air convective resistance of the air inside the room, the heat loss in $\left(\frac{W}{m^2}\right)$ is.

(A) 88 (B) 1 10 (C) 128 (D) 160

Ans: (C)

34. Air in a room is at 35^0C and 60% relative humidity (RH). The pressure in the room is 0.1 MPa. The saturation pressure of water at 35^0C is 5.63 kPa. The humidity ratio of the air (in grain/kg of dry air) is_____

Ans: 2 1.745

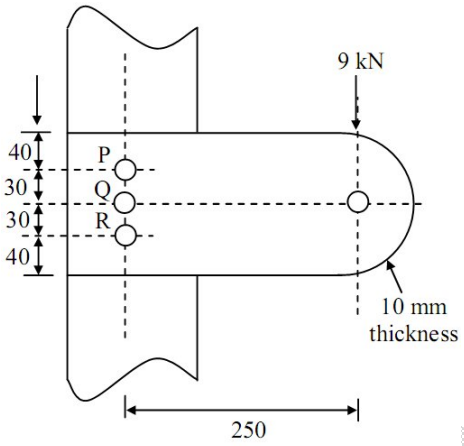
35. A mixture of ideal gases has the following composition by mass:

N_2	O_2	CO_2
60%	30%	10%

If the universal gas constant is 8314 J/k mol-K, the characteristic gas constant of the mixture (in J/kg-K) is_____

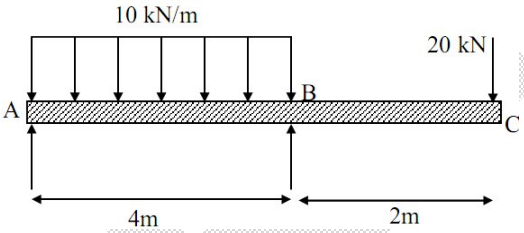
Ans: 274.996

36. A cantilever bracket is bolted to a column using three M12 $\times$1.75 bolts P, Q and R. The value of maximum shear stress developed in the bolt P(in MPa) is



Ans: 332.54

37. For the overhanging beam shown in figure the magnitude of maximum bending moment (in kN-m) is _____



Ans: 40

38. The annual requirement of rivets at a ship manufacturing company is 2000 kg. The rivets are supplied in units of 1kg costing Rs. 25 each. If it costs Rs. 100 to place an order and the annual cost of carrying one unit is 9% of its purchase cost, the cycle length of the order (in days) will be _____

Ans: 76.996

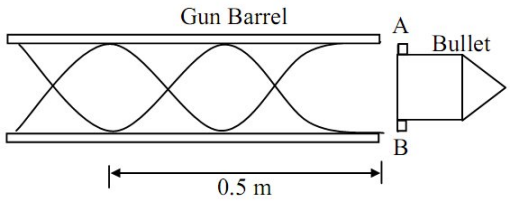
39. Ratio of' solidification time of a cylindrical casting (height = radius) to that of a cubic casting of side two times the height of cylindrical casting is _____

Ans: 0.5625

40. One side of a wall is maintained at 400K and the other at 300K. The rate of heat transfer through the wall is 1000W and the surrounding temperature is 25^0C. Assuming no generation of heat within the wall, the irreversibility (in W) due to heat transfer through the wall is _____

Ans: 248.33

41. A bullet spin as the shot is fired from a gun. For this purpose, two helical slots as shown in the figure are cut in the barrel. Projections A and B on the bullet engage in each of the slots.



Helical slots are such that one turn of helix is completed over a distance of 0.5m. If velocity of bullet when it exits the barrel is 20m/s, its spinning speed in rad/s is_____

Ans: 251.32

42. The torque (in N-m) exerted on the crank shaft of a two stroke engine can be described as $T = 10000 + 1000\sin 2\theta - 1200\cos\theta$, where θ is the crank angle as measured from inner dead center position. Assuming the resisting torque to be constant, the power (in kW) developed by' the engine at 100 rpm is _____

Ans: 104.32

43. A shaft of length 90 mm has a tapered portion of length 55 mm. The diameter of the taper is 80 mm at one end and 65 mm at the other. If the taper is made by tailstock set over method, the taper angle and the set over respectively are.

(A) $15^0 32'$ and 12.16 mm (B) $18^0 32'$and 15.66mm

(C) $1\ 1^0 22'$ and 10.26 mm (D) $10^0 32'$and 14.46mm

Ans: (A)

44. Which of the following statement are TRUE, when the cavitation parameter $\sigma = 0$?

(i) The local pressure is reduced to vapor pressure. (ii) Cavitatios starts

(iii) Boiling of liquid starts (iv) Cavitations stops

(A) (i),(ii) and (iv) (B) only(ii)and(iii) (C) only (i) and (iii) (D) (i). (ii) and (iii)

Ans: (D)

45. For the linear programming problem:

Maximize $Z = 3X_1 + 2X_2$

Subject to

$-2X_1 + 3X_2 \le 9$

$X_1 - 5X_2 \ge -20$

$X_1, X_2 \geq 0$

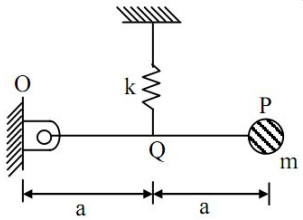
The above problem has

(A) Unbounded solution (B) Infeasible solution

(C) alternative optimum solution (D) degenerate solution

Ans: (A)

46. Figure shows a single degree of freedom system. The system consists of a mass less rigid bar OP hinged at O and a mass m at end P. The natural frequency of' vibration of the system is



(A) $f_n = \frac{1}{2\pi}\sqrt{\frac{k}{4m}}$ (B) $f_n = \frac{1}{2\pi}\sqrt{\frac{k}{2m}}$ (C) $f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (D) $f_n = \frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

Ans: (A)

47. Lap lace transform of the function $f(t)$ is given by $f(s) = L\{f(t)\} = \int_0^\infty f(t)e^{-st}dt$. Lap lace transform of the function shown below is given by.

(A) $\frac{1-e^{-2x}}{s}$ (B) $\frac{1-e^{-2x}}{2s}$ (C) $\frac{2-e^{-2x}}{s}$ (D) $\frac{1-2e^{-2x}}{s}$

Ans: (C)

48. The value of $\int_c \left[\left(3x-8y^2\right)dx+\left(4y-6xy\right)dy\right]$, (Where C is the region bounded by $x=0$, $y=0$ and $x+y=1$) is _____

Ans: 1.666

49. Orthogonal turning of a mild steel tube with a tool of rake angle 100 is carried out at a feed of 0.14 mm/rev. If the thickness of the chip produced is 0.28mm, the values of shear angle and shear strain will be respectively.

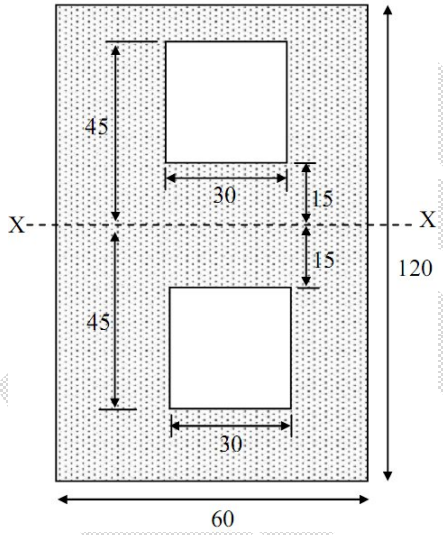
(A) $28^0 20'$ and 2.19 (B) $22^0 20'$ and 3.53 (C) $24^0 30'$ and 4.19 (D) $37^0 20'$ and 5.19

Ans: (A)

50. Newton-Raphson method is used to find the roots of the equation, $x^3 + 2x^2 + 3x - 1 = 0$. If the initial guess is $X_0 = 1$, then the value of x after 2nd iteration is

Ans: 0.3044

51. The value of moment of inertia of the section shown in the figure about the axis–XX is



All dimensions are in 'mm'

(A) $8.5050 \times 10^6 mm^4$ (B) $6.8850 \times 10^6 mm^4$

(C) $7.7625 \times 10^6 mm^4$ (D) $8.5725 \times 10^6 mm^4$

Ails: (B)

52. For a given matrix $P = \begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$, where $i = \sqrt{-1}$, the inverse of matrix P is

(A) $\frac{1}{24}\begin{bmatrix} 4-3i & i \\ -i & 4+3i \end{bmatrix}$

(B) $\frac{1}{25}\begin{bmatrix} i & 4-3i \\ 4+3i & -i \end{bmatrix}$

(C) $\frac{1}{24}\begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$

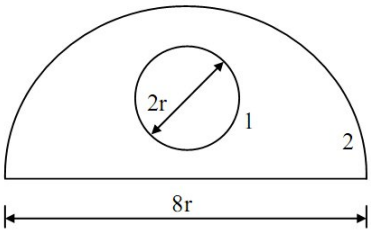
(D) $\frac{1}{25}\begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$

Ans: (A)

53. A Prandtl tube (Pitot-static tube with C =1) is used to measure the velocity of water. The differential manometer reading is 10 mm of liquid column with a relative density of 10. Assuming g = 9.8 m/s^2, the velocity of water (in m/s) is _____

Ans: 1.328

54. A solid sphere 1 of radius 'r' is placed inside a hollow, closed hemispherical surface 2 of radius '4r'. The shape factor F_{2-1} is.



(A) 1/12 (B) 1/2 (C)2 (D) 12

Ans: (A)

55. In a rolling operation using rolls of diameter 500mm, if a thick plate cannot be reduced to less than 20mm in one pass, the coefficient of friction between the roll and the plate is __

Ans: 0.1414