GATE 2021 Examination* (Memory Based)
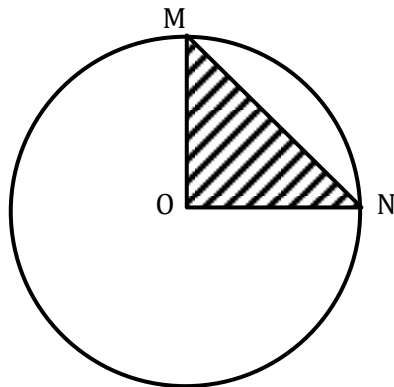
Mechanical Engineering

Test Date: 14th Feb 2021

Test Time: 09:30 am to 12:30 pm

Stream Name: Mechanical Engineering

General Aptitude

1. Let O is the centre of circle, M and N lie on circle.
    If area of right angle triangle MON = 50 cm^2, then the area of circle in cm^2 will be _____

    (A) 2π
    (B) 75 π
    (C) 50 π
    (D) 100 π
    [Ans. D]

2. Consider the following sentences:
    (i)   After his surgery, Roja hardly could work
    (ii) After his surgery, Roja could barely work
    (iii) After his surgery, Roja barely could work
    (iv) After his surgery, Roja could hardly work.
    (A) (ii) and (iv)
    (B) (iii) and (iv)
    (C) (i) and (iii)
    (D) (i) and (ii)
    [Ans. *]

3. The number of hens, ducks and goats in farm P are 65, 91 and 169 respectively. The total number of hens, ducks and goats in a nearby farm Q is 416. The ratio of hens:ducks:goats in farm Q is 5: 14: 13. All the hens, duck and goats are sent from farm Q to P. The new ratio of h: d: g in farms P is ___
   a. 5: 14: 13
   b. 21: 10: 26
   c. 10: 21: 26
   d. 5: 7: 13
   [Ans. C]

4. If
   "$\oplus$" means " $-$ "
   "$\otimes$" means " $\div$ "
   "$\triangle$" means " $+$ "
   "∇" means " $\times$ "
   Then the value of expression
   $\triangle_2 \oplus 3\triangle\big((4 \otimes 2)\nabla 4\big) =$
   (A) -0.5
   (B) 6
   (C) 7
   (D) (-1)
   [Ans. C]

5. The increased consumption of leafy vegetable in the recent months is a clear indication that the people in the state have begun to lead a health lifestyle.
   Which one of the following can be logically inferred.
   (A) The people in the state did not consume leafy vegetables earlier.
   (B) Consumption of leafy vegetables may not be the only indicator of healthy lifestyle
   (C) The people in the state have increased awareness of health hazards causing by consumption of junk food.
   (D) Leading a healthy lifestyle is related to a diet with leafy vegetables.
   **[Ans. D]**

6. Ms. X come out of the building though its front door to find her shadow due to the morning sun falling to her right side with the building to her back. From this it can be inferred that building is facing _____
   (A) S
   (B) W
   (C) E
   (D) N
   [Ans. D]

7. 5 persons P, Q, R, S and T are seating in a row not necessarily in same order. Q and R are separated by one person, and S should not be seated adjacent to Q. The number of distinct seating arrangements possible is _____.
   (A) 4
   (B) 10
   (C) 16
   (D) 8
   [Ans. B]

Technical

1. Consider the surface roughness profiles as shown in figure
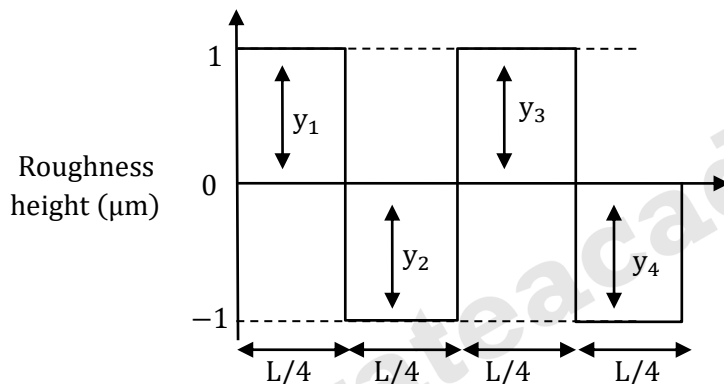
   The centre line average roughness (RA in μm) of the measured length L is
   (A) 1
   (B) 2
   (C) 4
   (D) 0
   [Ans. A]

2. In modern CNC m/c tods, the backlash has been eliminated by
   (A) Ratchet and binary
   (B) Rock and option
   (C) Preloaded ball screws
   (D) Slider crack mechanism
   [Ans. *]

3. In a gender operation of a metal sp energy consummation is J/mm³ if a grindiy whap with d = 200 mm is rotation of 3000 rpm to obtain MRR = 6000 mm³/min then the F_t_____N
[Ans. *]

4. An ortho and cutting operation is performed using a SPCT with rocket angle of 12° on a latue. During turning the F_c and F_F are 1000 N and 600 N. If t_c and uncut t_c during turning are 1.5 mm and 0.75 mm the F_{Shear} =_____N
[Ans. *]

5. A right solid circular cone standing on its base on a horizontal surface is of height H and base radius R. The cone is made of a material with spacial weight w and elastic modular E. The vertical deflation at the mid Hight of the cone due to self weight is given by _____.

   (A) $\dfrac{wH^2}{6E}$

   (B) $\dfrac{wRH}{6E}$

   (C) $\dfrac{wRH}{8E}$

   (D) $\dfrac{wH^2}{8E}$

   [Ans. D]

6. A single Jet Pelton wheel operates at 300 rpm. D_{men} = 2m. velocity of jet = 40 m/s, Q = 5 m³/sec. The Jet is deflected by angle of 165°. Neglect all losses, the power developed by Pelton wheel _____ MW.
[Ans. *]

7. A hot steal spherical ball is suddenly dipped into a low temp oil both. Which of the following dimensionless parameter are required to determine I.C. temperature of ball using Heisler chart?
   (A) Biot and Froude
   (B) Nur and Gr
   (C) Bi and Fo
   (D) Re and Pr.
   [Ans. *]

8. A rigid insulated tank is initially evacuated, it is connected through a value to a supply lines that carries air at P = C and T of 250 kPa and 400k, now the value is opened, and air is allowed to flow into the tank until the pressure inside the tank recaches 250 kPa at which point value is closed. Assume L_p, L_V, R and perfect gas. T_2 =? Final temp. of air inside the tor _____k.
[Ans. *]

9. A solid sphere (r = 10mm) is placed at the centroid of a hallow cubical enclosure of side = 30mm. The Quoter surface of sphere is 1 and inner surface of cube is 2. F_{22} =? _____
   [Ans. *]

10. A prismatic bar PQRST is subjected to axial loads. The segment having maximum and minimum axial stress respectively are _____.
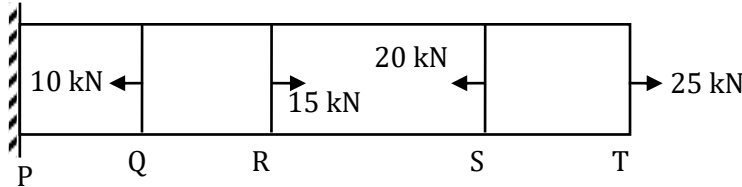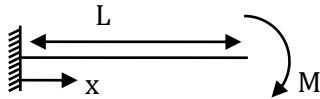

   (A) ST and PQ
   (B) QR and RS
   (C) QR and PQ
   (D) ST and RS
   [Ans. D]

11. The deflection of the beam at
    $x = \dfrac{L}{2}$ is _____.

   (A) $\dfrac{ML^2}{16EI}$
   (B) $\dfrac{ML^2}{2EI}$
   (C) $\dfrac{ML^2}{4EI}$
   (D) $\dfrac{ML^2}{8EI}$
   [Ans. D]

12. The resistance SPOT welding of 2, 1.55 mm thick metal sheets is performed od using welding current of 10000 A for 0.25 sec R 0.0001 Ω. Volte of welding regget = 70 mm^3. Considering the heat required to melt unit volte of metal is 12 J/mm^3 then η_{th} for welding process _____%
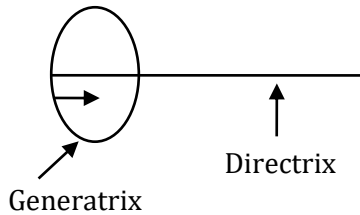   [Ans. *] Range: 31 to 35

13. Calculate braking torque for clockwise rotation of drum $\mu = 0.4$
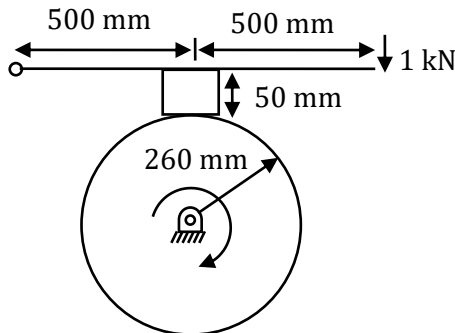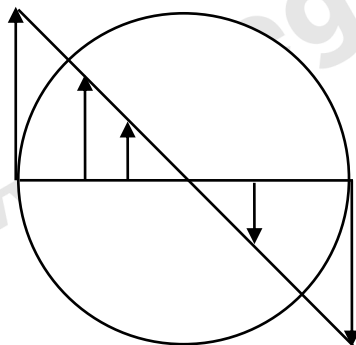

[Ans.] Range: 200 Nm to 200 Nm

14. In a machining operation, if a cutting tool traces the w/p such that the directrix is perpendicular to the plane of generatrix as shown in figure. The surface generated is

Directrix

Generatrix

(A) Spherical
(B) A surface of revolution
(C) Plane
(D) Cylindrical
[Ans. D]

15. Stress distribution in cross-section of helical spring

(A) Only torsional stress
(B) Only direct shear stress
(C) torsional + direct + shear stress
(D) _____
[Ans. C]

16. The XY table of NC m/c tool is to more from P(1, 1) to Q(51, 1) ; all wordings are in mm. The pitch of NC and the nut is 1.8°, then the total backlash of the table on moving from P to Q is _____mm
[Ans. *]

17. The correct sequence of machining operations to be performed to finish a large dia meter through hole is _____
D → Drilling
R → Reaming
B → Boring
(A) D, R, B
(B) B, R, D
(C) B, D, R
(D) D, B, R
[Ans. D]

18. A true centrifugal of casting operation needs to be performed horizontally to make copper tube sections with OD = 250 mm and ID = 230 mm g = 10 m/s, if G factor (ratio of centrifugal force to weight) of 60 is used for casting the tube, the rotational speed required is _____ rpm
[Ans. *] Range: 20 to 25

19. Consider a single m/c workstation to which jobs arrive according to a Poisson distribution with a mean arrival rate of 12 jobs/min. The process time of workstation is exponentially distributed with a mean of 4 min. The expected number of Jobs at the workstation at any given point of time is _____.
[Ans. *] Range: 4 to 4

20. Let $f(x) = x^2 - 2x + 2$ be a continuous function defined on $x \epsilon [1,3]$. The point x at which the tangent of f(x) becomes parallel to the straight line joining f(1) and f(3) is _____.
(A) 3
(B) 0
(C) 1
(D) 2
[Ans. D]

21. Let C represent the unit circle centered at origin in the complex plane, and complex variable, $z = x + iy$. The value of contour integral $\oint_c \frac{\cos h\, 3z}{2z}\, dz$ (where integration is taken c.c.w) is
(A) 2
(B) $2\pi i$
(C) πi
(D)   0
[Ans. C]

22. Customers arrive of a shop according to Poisson distribution with a mean of 10 customer/hour. The manager notes that no customer arrives for the first 3 minutes after the shop opens. The probability that a customer arrives within the next 3 min is _____
(A) 0.5
(B) 0.39
(C) 0.86
(D) 0.61
[Ans. *]

23. Consider a vector P in 2-D space. Let its direction (c.c.w angle with the x axis) be θ. Let P be an eigen vector of a 2×2 matrix A with corresponding eigen value $\lambda, \lambda > 0$. If we denote the magnitude of a vector v by $\|v\|$, identify the valid statement regarding P'. where $P' = AP$
(A) Direction of $P' = \theta, \|P'\| = \lambda\|P\|$
(B) Direction of $P' = \lambda\theta, \|P'\| = \|P\|$
(C) Direction of $P' = \lambda\theta, \|P'\| = \lambda\|P\|$
(D) Direction of $P' = \theta, \|P'\| = \|P\|/\lambda$
[Ans. A]

24. If y(x) satisfies the differential equation $\sin\frac{dy}{dx} + y\cos x = 1$, $y\left(\frac{\pi}{2}\right) = \frac{\pi}{2}$ then $y\left(\frac{\pi}{6}\right)$ is _____.
(A) 0
(B) $\pi/2$
(C) $\pi/3$
(D) $\pi/6$
[Ans. C]

25. The value of $\lim_{x \to 0} \left(\frac{1 - \cos x}{x^2}\right)$ is _____.
(A) 1/3
(B) 1
(C) 1/4
(D) 1/2
[Ans. D]

26. A rigid insulated tank is initially evacuated, it is connected through a value to a supply lines that carries air at $P = C$ and T of 250 kPa and 400k, now the value is opened, and air is allowed to flow into the tank until the pressure inside the tank recaches 250 kPa at which point value is closed. Assume L_p, L_V, R and perfect gas. $T_2 =$? Final temp. of air inside the tor _____k.
[Ans. *]

27. Consider a bio-nominal random variable x. If $x_1, x_2, \ldots x_n$ are independent and identically distributed samples from the distribution of x with sum $Y = \sum_{i=1}^{n} x_i$, then the distribution of Y of $n \to \infty$ can be approximated as
    (A) normal
    (B) Bernoulli
    (C) binomial
    (D) exponential
    [Ans. *]

28. The Dirac-Delta function $\left(\delta(t - t_o)\right)$ for $t, t_o \in R$, has the following property
    $$\int_a^b \phi(t)\ \delta(t - t_o)dt = \begin{cases} \phi(t_o) & a < t_o < b \\ 0 & \text{otherwise} \end{cases}$$
    The Laplace transform of D-D function $\delta(t - a)$ for $a > 0$; $L\left(\delta(t - a)\right) - F(s)$ is _____
    (A) e^{-sa}
    (B) 0
    (C) e^{sa}
    (D) ∞
    [Ans. A]

29. $\frac{dy}{dx} = -\pi y, y(0) = 1$ is solved numerically using the following scheme
    $$\frac{y(t_{n+1}) - y(t_n)}{h} = -\pi y(t_n), \begin{matrix} h = \text{time step} \\ n = 0, 1, 2, \ldots \end{matrix}$$
    This numerical scheme is stable for
    (A) For all $h > 0$
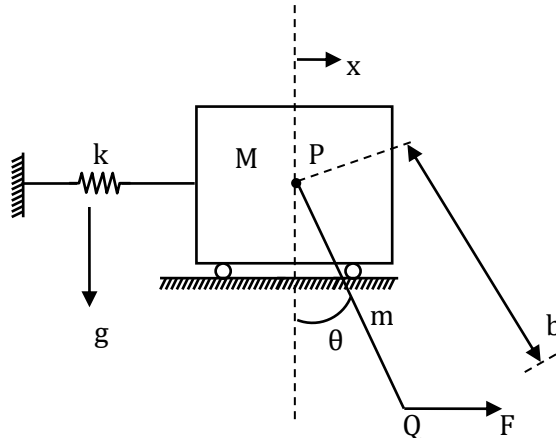   (B) $0 < h < 1$
    (C) $0 < h < 2/\pi$
    (D) $0 < h < \pi/2$
    [Ans. *]

30. Two smooth identical spheres $(R = 125\ mm)(W = 100\ N)$ rest in a horizontal channel having vertical walls. The distance between vertical walls is 400 mm. The reaction at point of contact between 2 spheres is _____N
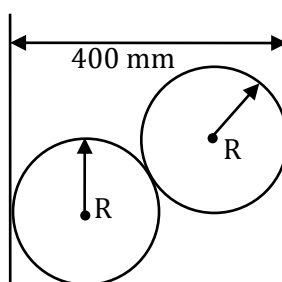
    [Ans. *] Range: 125 to 125

31. Consider a 2 DOF system as shown in figure.

Where PQ = rigid uniform rod of length (b) and mass (m)

Assume that the spring deflect only horizontally and force F is applied horizontally of Q. For this system the Lagrangian, L is

(A) $\frac{1}{2}(M + m)\dot{x}^2 + \frac{1}{6}mb^2\dot{\theta}^2 - \frac{1}{2}kx^2 + mg\frac{b}{2}\cos\theta$

(B) $\frac{1}{2}M\dot{x}^2 + \frac{1}{2}mb\dot{\theta}\dot{x}\cos\theta + \frac{1}{6}mb^2\dot{\theta}^2 - \frac{1}{2}kx^2 + mg\frac{b}{2}\cos\theta$

(C) $\frac{1}{2}m\dot{x}^2 + \frac{1}{2}Mb\dot{\theta}\dot{x}\cos\theta + \frac{1}{6}mb^2\dot{\theta}^2$

(D) $\frac{1}{2}(M + m)\dot{x}^2 + \frac{1}{2}mb\dot{\theta}\dot{x}\cos\theta + \frac{1}{6}mb^2\dot{\theta}^2 - \frac{1}{2}kx^2 + mg\frac{b}{2}\cos\theta$

[Ans. *]

32. Consider a single DOF system of mass M, supported on spring and dashpot. If the amplitude of the free vibration response reduces from 8 mm to 1.5 mm in 3 cycles. The damping ratio _____.

[Ans. *] 0.0883

33. Consider, fully developed, S.S. in compressors Laminar flow of a viscous fluid between d large horizontal Plates. The bottom plate is fixed the top plate moves constant U = 4m/s. Separation between the Plates is 5mm. There is no pressure gradient in the dir flow. S = 800 kg/m³ and V = 1.25×10^{-4} m²/s. The average shear stress fluid is _____ Pa.

[Ans. *] Range: 80 to 80

34. An uninsulated cylindrical wire of R = 1mm produces electric heating at a rate of 5w/m. The temp. of surface of wire is 75°C when $T_\infty = 25$°C when wire is coated with PVC of t = 1mm T_s reduces to 55°C. Assume some q_g and some h for both uninsulated and coated wire, the k of PVC is _____ w/m-k

[Ans. *]

35. The whit-worth QR mechanism is shown in figure.
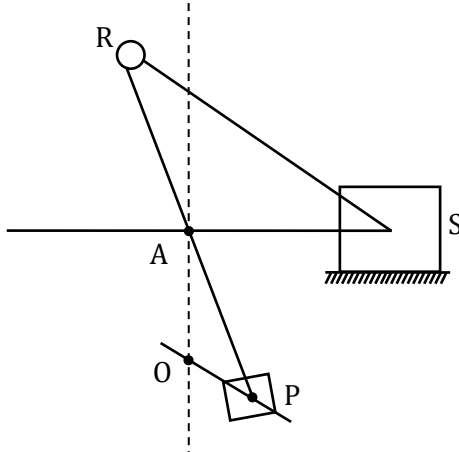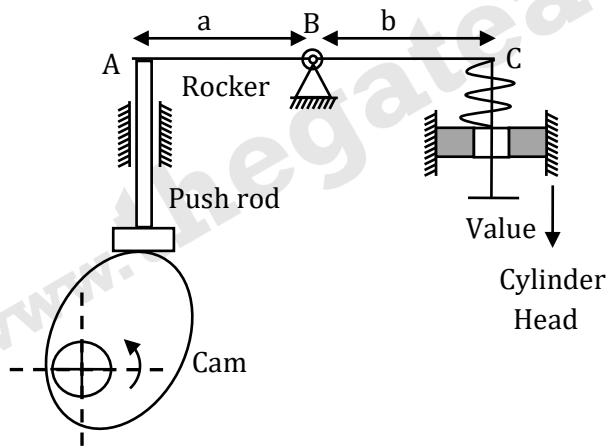

$OP = 300$ mm
$OA = 150$ mm
$AR = 160$ mm
$RS = 450$ mm
The QRR for mechanism is _____.
[Ans. *]Range: 2 to 2

36. A tappet valve mech. in an IC. Engine comprises a rocker arm ABC that is hinged at B as shown in figure. The rockers is assumed rigid and it oscillates about the hinge B. the MOI of rocker about B is 10^{-4} kg m², $a = 3.5$ cm, $b = 2.5$ cm.

A push rod pushes the rocker at location A, when moved vertically by a cam that rotates at N rpm. The pushrod is assumed massless and has a stiffness of 15 N/mm. At the other end c. the rocker pushes a valve against a spring of stiffness 10 N/mm. valve is moss-less and rigid. Resonance in the rocker system occurs when the com shaft runs of a speed of _____rpm.
(A) 496
(B) 4739
(C) 2369
(D) 790
[Ans. *]

37. A pressure measurement device fitted as a surface on a submarine, located at a depth H below the surface of an ocean, reads an P_{abs} of 4.2 Mpa. S_{sea} woter $= 1050 \, kg/m^3$, $P_{atm} = 101 \, kPa$, $g = 9.8 \, m/s^2$. The depth H is _____ m.

[Ans. *] 379.9

38. Consider a reciprocating engine with C.R or R and connecting rod of length L. The secondary unbalance force for this case is equivalent to primary unbalance force due to a virtual crank of _____
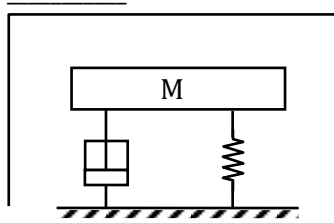
   (A) Radius R/4 rotating of half the engine speed
   (B) Radius L/2 rotating of twice the engine speed
   (C) Radius $L^2/4R$ rotating of half the engine speed
   (D) Radius $R^2/4L$ rotating of twice the engine speed

[Ans. D]

39. A cylindrical jet of water ($\rho = 100 \, kg/m^3$) impinges at the center of a flat circular Plate and spreads radially outward. The plate is resting on a linear spring with K $= 1kN/m$. The incoming Jet dia $= 1cm$. If the spring shows a steady defection of 1 cm upon impingement of Jet them the velocity of the incoming Jet is _____ m/s.
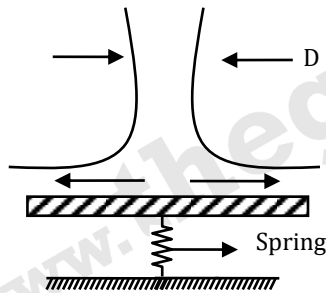
[Ans. *] 11.28

40. An ∞ long pin fin, attach to an isothermal hot surface, transfers heat at a steady rate of $\dot{Q}_1$ to the combient air. If k is doubled (everything else control) then heat transfer becomes $\dot{Q}_2$. $\dot{Q}_2/\dot{Q}_1$ is _____.
   (A) $1/\sqrt{2}$
   (B) 2
   (C) $\sqrt{2}$
   (D) 1/2

[Ans. *]

41. The RH of ambient air at 300 K is 50% with P_v. The P_{sat} is P_{sat}. The correct relation for air-water mixture is_____
    (A) $P_v = P_{sat}$
    (B) $P_v = 0.622\ P_{sat}$
    (C) $P_v = 0.5\ P_{sat}$
    (D) $P_v = 2\ P_{sat}$
    [Ans. *]

42. Super-heated steam of 1500 kPa, has $V = 2.75\ m^3/Kmp$ and compressibility factor (Z) of 0.95. The temp. of steam is _____°C
    (A) 249
    (B) 198
    (C) 522
    (D) 471
    [Ans. *]

43. For ideal reheat Rankine cycle → $W_P = 20\ \frac{kJ}{kg}$, $(W_T)_{HP} = 750\frac{kJ}{kg}$, $(W_T)_{LP} = 1500\frac{KJ}{kg}$, $\eta = 50\%$. At cond. Presume $h_c = 200\frac{kJ}{kg}$, $h_g = 2600\frac{kJ}{kg}$. X at the exit of low-pressure turbine?
    [Ans. *]

44. The fundamental thermodynamic relation for a rubber band is given by $dv = Tds + \tau dL$ where T = temp. abs, S = entropy and τ = tonsion in rubber bord and L = length of band. Which is correct?
    (A) $\left(\frac{\delta T}{\delta s}\right)_L = \left(\frac{\delta T}{\delta L}\right)_s$
    (B) $\tau = \left(\frac{\delta V}{\delta s}\right)_L$
    (C) $T = \left(\frac{\delta V}{\delta s}\right)_L$
    (D) $\left(\frac{\delta T}{\delta L}\right)_s = \left(\frac{\delta \tau}{\delta s}\right)_L$
    [Ans. *]

45. In the viscosity of T.P the equation of liquid vapor boundary in P-T phase diagram for ammonia is $\ln P = 24.35 - \frac{3063}{T}$ where $P(P_a)$ and $T(K)$. Similarly the solid-vapor boundary is given by $\ln P = 27.92 - \frac{3754}{T}$. The temperature at T. P is _____ K.
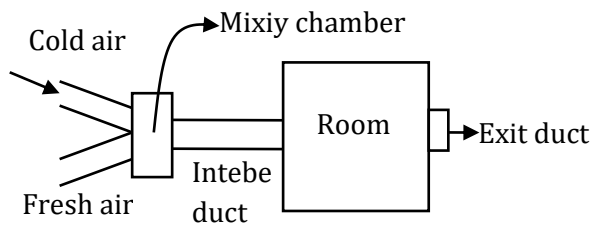   **[Ans. *]**

46. In which of the following pairs of cycle, both cycle have at least one isothermal process?
    (A) Bell-Coleman cycle and VLR cycle
    (B) Diesel and Otto cycle
    (C) Brayton and Rankine cycle
    (D) Carnot and sterling
    [Ans. *]

47. To maintain the quality of indoor air the intake duct supplies a mixture of mixing occurs. Cold air enters at 5°C and 105 kPa with $\dot{V} = 1.25 \text{ m}^3/\text{s}$ during steady state output fresh air enters at 34°C and 105 kPa. $(\dot{m})$ fresh air is 1.6 times of cold air. Air leaves the room temperature exit duct at 24°C Air, ideal gas, C_p, R, the rate heat gain by the air from the room is _____ kW.
    [Ans. *]

MORE QUESTIONS WILL COME