ACE
Engineering Academy
Leading Institute for ESE/GATE/PSUs

Hyderabad | Delhi | Ahmedabad | Bhopal | Pune | Bhubaneswar | Bengaluru
Lucknow | Patna | Chennai | Vijayawada | Vizag | Tirupathi | Kukatpally | Kolkata

GATE – 2019
Questions with Detailed Solutions

MECHANICAL ENGINEERING

Forenoon Session

All Queries related to **GATE- 2019** Solutions are to be sent to the following email address
hyderabad@aceenggacademy.com | Contact Us : 040-23234418,19,20

GENERAL APTITUDE

01. The sum and product of two integers are 26 and 165 respectively. The difference between these two integers is ____.

(A) 3 (B) 6

(C) 2 (D) 4

01. Ans: (D)

Sol: Assume two integers are a and b

$a + b = 26$

$ab = 165$

we have $(a+b)^2 = (a-b)^2 + 4ab$

$(26)^2 = (a-b)^2 + 4 \times 165$

$(a-b)^2 = 676 - 660 = 16$

$(a-b) = \sqrt{16} = 4$

$\therefore$ The difference between these two integers = 4

End of Solution

02. John Thomas, an ——— writer, passed away in 2018.

(A) dominant (B) prominent

(C) eminent (D) imminent

02. Ans: (C)

Sol: Eminent means successful, well known and respected.

End of Solution

03. ——— I permitted him to leave, I wouldn't have had any problem with him being absent, _____ I?

(A) Have, would (B) Had, wouldn't

(C) Have, wouldn't (D) Had, would

03. Ans: (D)

Sol: Conditional tense Type 3 (formula)

Had + V_3, would + have + V_3

In question tag, if the statement is negative, the question tag should be positive i.e. wouldn't have had, would?

End of Solution

04. The minister avoided any mention of the issue of women's reservation in the private in the private sector. He was accused of ______ the issue.

(A) tying (B) collaring

(C) skirting (D) belting

04. Ans: (C)

Sol: Skirting means to avoid (something) especially because it is difficult or will cause problems.

End of Solution

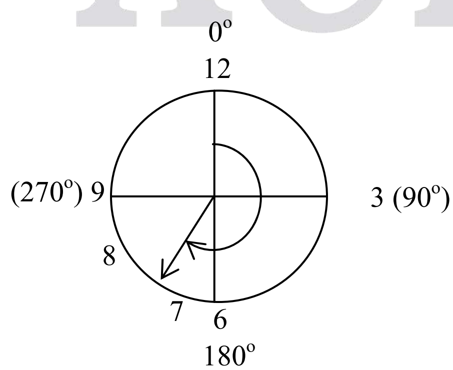
05. A worker noticed that the hour hand on the factory clock had moved by 225 degrees during her stay at the factory. For how long did she stay in the factory?

(A) 4 hours and 15 mins (B) 3.75 hours

(C) 8.5 hours (D) 7.5 hours

05. Ans: (D)

Sol: The worker stay in the factory $= 3+3+\frac{3}{2} = 7.5\,\text{hrs}$



06. A firm hires employees at five different skill levels P, Q, R, S, T. The shares of employment at these skill levels of total employment in 2010 is given in the pie chart as shown. There were a total of 600 employees in 2010 and the total employment increased by 15% from 2010 to 2016. The total employment at skill levels P, Q and R remained unchanged during this period. If the employment at skill level S increased by 40% from 2010 to 2016, how many employees were there at skill level T in 2016?

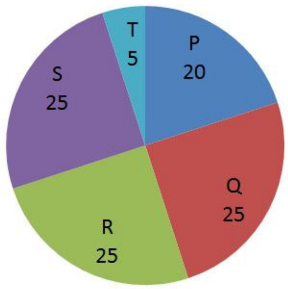
(A) 35

(B) 60

(C) 72

(D) 30

Percentage share of skills in 2010



06. Ans: (B)

Sol: The total employment in 2010 at all skill level = 600

Total employment increased from 2010 to 2016

$$= 15\% \text{ of } 600 = \frac{15}{100} \times 600 = 90$$

$\therefore$ The employment increased from 2010 to 2016 at S and T skill level = 90

(The total employment at skill levels P, Q and R remained unchanged during this period)

The employment at skill level 'S' in 2010

$= 25 \times 6 = 150$ $\qquad (\because 100\% = 600, 1\% = 6)$

The employment at skill level S increased by 40 % from 2010 to 2016 = 40% of 150

$$\frac{40}{100} \times 150 = 60$$

Increased number of employees at skill level T from 2011 to 2016

= 90 – 60 = 30

Total employee at level T in 2016 = 600× 5% + 30

= 30 + 30 = 60

07. A person divided an amount of Rs. 100,000 into two parts and invested in two different schemes. In one he got 10% profit and in the other he got 12%. If the profit percentages are interchanged with these investments he would have got Rs.120 less. Find the ratio between his investments in the two schemes.

(A) 47 : 53 (B) 9 : 16

(C) 11 : 14 (D) 37 : 63

07. Ans: (A)

Sol: Total investment Rs. 100,000/-

First scheme	**Second scheme**
Investment = x	Investment = x
Profit = $10\%(\uparrow)$	Profit = $10\%(\uparrow)$

Case-I

10% of x + 12% of (100,000 – x)

= 12% of 100,000 – 2% of x

Case-II

(If profit percentages are interchanged 12% of x + 10% of (100,000 – x)

10% of 100,000 + 2% of x

The difference between case-I and Case-II = 120

12% of 100,000 – 2% of x – (10% of 100,000 + 2% of x) = 120

2% of 100,000 – 4% of x = 120

2000 – 4% of x = 120

4% of x = 1880

$$x = \frac{1880 \times 100}{4} = 47{,}000$$

The amount invested in first scheme = Rs. 47,000/-

The amount invested in 2nd scheme = Rs. 100,000 – 47,000 = 53,000

$$= \frac{47000}{53000} = \frac{47}{53} = 47:53$$

08. M and N had four children P, Q, R and S. Of them, only P and R were married. They had children X and Y respectively. If Y is a legitimate child of W, which one of the following statements is necessarily FALSE?

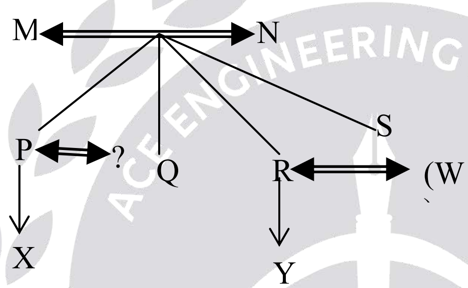
(A) W is the wife of P (B) W is the wife of R

(C) M is the grandmother of Y (D) R is the father of Y

08. Ans: (A)

Sol:

From given, data, the following blood relations tree can be formed



From the given information, R and W are the married couples so, option '1' is necessarily FALSE. Remaining all other options are may be true.

∴ option '1' is correct

End of Solution

09. Under a certain legal system, prisoners are allowed to make one statement. If their statement turns out to be true then they are hanged. If the statement turns out to be false then they are shot. One prisoner made a statement and the judge had no option but to set him free. Which one of the following could be that statement?

(A) I did not commit the crime (B) I will be shot

(C) You committed the crime (D) I committed the crime

09. Ans: (B)

Sol: (I will be shot) The statement may be either way.

10. Congo was named by Europeans. Congo's dictator Mobuto later changed the name of the country and the river to Zaire with the objective of Africanising names of persons and spaces. However, the name Zaire was a Portuguese alternation of *Nzadi o Nzere*, a local Congo river in the 16^{th} and 17^{th} centuries.

Which one of the following statements can be inferred from the paragraph above ?

(A) The term *Nzadi o Nzere* was of Portuguese origin

(B) As a dictator Mobuto ordered the Portuguses to alter the name of the river to Zaire

(C) Mobuto was not entirely successful in Africanising the name of his country

(D) Mobuto's desire to Africanise names was prevented by the Portuguese

10. Ans: (C)

Sol: As it suggests, that all names are of European origin. Mobuto was not successful in Africanising the name of his country.

End of Solution

MECHANICAL ENGINEERING

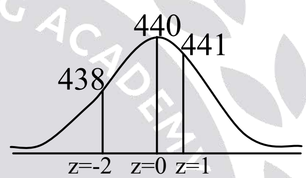
01. The lengths of a large stock of titanium rods follow a normal distribution with a mean (μ) of 440 mm and a standard deviation (σ) of 1mm. What is the percentage of rods whose lengths lie between 438 mm and 441 mm?

(A) 81.85 %
(B) 68.4 %
(C) 99.75%
(D) 86.64 %

01. Ans: (A)

Sol:

$$Z = \frac{x-\mu}{\sigma}$$



$$Z\ (x = 438) = \frac{438-440}{1} = -2$$

$P(Z = -2) = 2.28\%$

$$Z\ (x = 441) = \frac{441-440}{1} = 1$$

$P\ (Z = 1) = 84.13\ \%$

The percentage of rods whose lengths lie between 438 mm and 441 mm =

$= P\ (Z = 1) - P(Z = -2)$

$= 84.13\ \% - 2.28\ \% = 81.85\ \%$

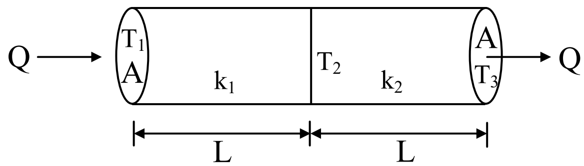
End of Solution

02. A slender rod of length L, diameter d (L >> d) and thermal conductivity k_1 is joined with another rod of identical dimensions, but of thermal conductivity k_2, to form a composite cylindrical rod of length 2L. The heat transfer in radial direction and contact resistance are negligible. The effective thermal conductivity of the composite rod is

(A) $\frac{2k_1k_2}{k_1+k_2}$
(B) $\sqrt{k_1k_2}$
(C) $k_1 + k_2$
(D) $\frac{k_1k_2}{k_1+k_2}$

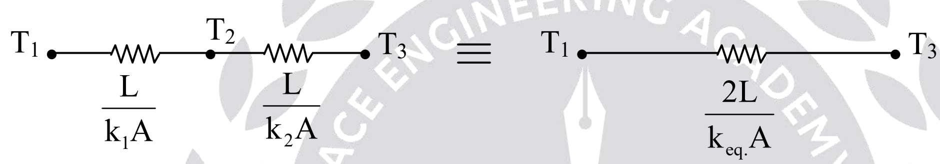
02. Ans: (A)

Sol:



Area is constant in the direction of heat flow. (similar like slab)

Thermal circuit :



Heat transfer rate, $(Q) = \dfrac{T_1 - T_3}{\dfrac{L}{k_1A} + \dfrac{L}{k_2A}} = \dfrac{T_1 - T_3}{\dfrac{2L}{k_{eq}A}}$

$$\frac{L}{k_1A} + \frac{L}{k_2A} = \frac{2L}{k_{eq}A}$$

$$\frac{2}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$k_{eq} = \frac{2k_1k_2}{k_1 + k_2}$$

End of Solution

03. Evaluation of $\int_2^4 x^3 dx$ using a 2-equal-segment trapezoidal rule gives a value of _____

03. Ans: 63

Sol: Let $y = f(x) = x^3$

x	2	3	4
y	8	27	64

Given n = 2 $\Rightarrow$ h = $\dfrac{4-2}{2} = 1$

By trapezoidal rule, we have

$$\int_2^4 x^3 dx = \frac{h}{2}\{(y_0 + y_n) + 2(y_1 + y_2 + ... + y_{n-1})\} = \frac{1}{2}\{(8+64)+2(27)\} = 63$$

End of Solution

04. During a high cycle fatigue test, a metallic specimen is subjected to cyclic loading with a mean stress of +140 MPa, and a minimum stress of – 70 MPa. The R-ratio (minimum stress to maximum stress) for this cyclic loading is ____ (round off to one decimal place)

04. Ans: - 0.2

Sol: $\sigma_{min} = -70$ MPa

$\sigma_{mean} = 140$ MPa

$$\Rightarrow \sigma_{mean} = \frac{\sigma_{min} + \sigma_{max}}{2} = 140$$

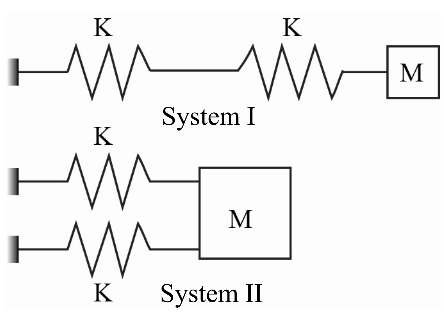
$$\Rightarrow \frac{-70 + \sigma_{max}}{2} = 140$$

$\Rightarrow \sigma_{max} = 350$ MPa

The R- ratio, $R = \dfrac{\sigma_{min}}{\sigma_{max}} = -\dfrac{70}{350} = -0.2$

End of Solution

05. The natural frequencies corresponding to the spring-mass systems I and II are ω_I and ω_{II}. respectively. The ratio $\dfrac{\omega_I}{\omega_{II}}$ is



(A) $\dfrac{1}{2}$

(B) 4

(C) 2

(D) $\dfrac{1}{4}$

SPARK BATCHES

@ HYDERABAD

GATE+PSUs - 2020

11th May & 9th June, 2019

ESE+GATE+PSUs - 2020

11th May & 9th June, 2019

Early Bird Discount ₹ 5000

(Register Before 31st Mar 2019)

@ DELHI

GATE+PSUs - 2020

11th May, 2019

ESE+GATE+PSUs - 2020

11th May, 2019

Early Bird Discount ₹ 3000

(Register Before 31st Mar 2019)

ACE ENGINEERING ACADEMY Since 1995

ACE
Engineering Academy
Leading Institute for ESE/GATE/PSUs

23 Years of Excellence

The Leader of IES/GATE Coaching

HYDERABAD | AHMEDABAD | DELHI | BHOPAL | PUNE | BHUBANESWAR | BANGALORE | LUCKNOW | PATNA | CHENNAI | VISAKHAPATNAM | VIJAYAWADA | TIRUPATI | KOLKATA

Hyderabad's Famous ACE ENGINEERING ACADEMY

Now @ AHMEDABAD

To Win The RACE.. Join ACE.. @ Sunrise Mall, Mansi Circle To Win The RACE.. Join ACE..

To Win the RACE..
Join ACE...

Most Expert Faculties | Innovative Learning Skills | Best Test Practice | Online Test Series

Programs Offered :

CLASSROOM COACHING | POSTAL COACHING | INTERVIEW GUIDANCE
ONLINE TEST SERIES | CLASSROOM TEST SERIES

+079 4890 2228 | 9160499966 www.aceenggacademy.com

05. Ans: (A)

Sol: System: I

$$k_{eq} = \frac{k.k}{k+k} = \frac{k}{2}$$

$$\omega_{n_1} = \sqrt{\frac{k}{2m}}$$

System - II

$$k_{eq} = 2k \quad \omega_{n_2} = \sqrt{\frac{2k}{m}}$$

$$\frac{\omega_{n_1}}{\omega_{n_2}} = \frac{\sqrt{\frac{k}{2m}}}{\sqrt{\frac{2k}{m}}} = \sqrt{\frac{k}{2m} \times \frac{m}{2k}} = \frac{1}{2}$$

End of Solution

06. A spur gear with 20° full depth teeth is transmitting 20 kW at 200 rad/s. The pitch circle diameter of the gear is 100 mm. The magnitude of the force applied on the gear in the radial direction is

(A) 0.36 kN
(B) 1.39 kN
(C) 0.73 kN
(D) 2.78 kN

06. Ans: (C)

Sol: $\phi = 20^o, P = 20\,kW, \omega = 200\,rad/s, d = 100\,mm = 0.1m$

Torque = Power / ω

$$T = \frac{20000}{200} = 100\,Nm$$

$$\text{Now, } T = F_T \times \frac{d}{2}$$

$$\Rightarrow 100 = F_T \times \frac{0.1}{2}$$

$$\Rightarrow F_T = 2000\text{ N}$$

$$\frac{F_R}{F_T} = tan\,\phi$$

$\Rightarrow F_R = 2000 \times \tan 20°$

$\Rightarrow F_R = 727.94\text{ N} = 0.73\text{ kN}$

End of Solution

07. Air of mass 1 kg, initially at 300 K and 10 bar, is allowed to expand isothermally till it reaches a pressure of 1 bar. Assuming air as an ideal gas with gas constant of 0.287 kJ/kg.K, the change in entropy of air (in kJ/kg.K, round off to two decimal places) is _____

Ans: 0.66

Sol: Given data:

$m = 1\text{kg},\ T_1 = 300\text{K},\ P_1 = 10\text{ bar}$

$T_2 = 300\text{K},\ P_2 = 1\text{bar}$

$$dS = \frac{dQ}{T} = \frac{mRT\ell n\frac{P_1}{P_2}}{T} = mR\ell n\frac{P_1}{P_2}$$

$$= 1 \times 0.287 \times \ell n 10 = 0.66\ kJ/kg.K$$

End of Solution

08. In a casting process, a vertical channel through which molten metal flows downward from pouring basin to runner for reaching the mold cavity is called

(A) riser (B) sprue

(C) blister (D) pin hole

08. Ans: (B)

Sol: Vertical channel is called sprue and the horizontal channel is called runner.

End of Solution

09. During a non-flow thermodynamic process (1-2) executed by a perfect gas, the heat interaction is equal to the work interaction ($Q_{1-2} = W_{1-2}$) when the process is

(A) Isentropic (B) Isothermal

(C) Adiabatic (D) Polytropic

09. Ans: (B)

Sol: Given , $Q_{1-2} = W_{1-2}$

$\therefore\ \Delta U_{1-2} = 0$

$\Rightarrow c_V[T_2 - T_1] = 0$

$\Rightarrow T_1 = T_2$

So, the process is isothermal.

End of Solution

10. Water flows through a pipe with a velocity given $\vec{V} = \left(\frac{4}{t} + x + y\right)\hat{j}$ m/s, where $\hat{j}$ is the unit vector in the y direction, t (> 0) is in seconds, and x and y are in meters. The magnitude of total acceleration at the point (x, y) = (1, 1) at t = 2 s is _______ m/s^2.

10. Ans: 3

Sol: $\vec{V} = \left(\frac{4}{t} + x + y\right)\hat{j}$

$\therefore\ u = 0,$

$v = \left(\frac{4}{t} + x + y\right)$

$w = 0$

$$a_x = u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} + \frac{\partial u}{\partial t} = 0 + 0 + 0 + 0 = 0$$

$$a_z = u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z} + \frac{\partial w}{\partial t} = 0 + 0 + 0 + 0 = 0$$

$$a_y = u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z} + \frac{\partial v}{\partial t}$$

$$= v\frac{\partial v}{\partial y} + \frac{\partial v}{\partial t}$$

$$= \left(\frac{4}{t} + x + y\right).(1) + \left(\frac{-4}{t^2}\right)$$

$$= x + y + \frac{4}{t} - \frac{4}{t^2}$$

$$= 1 + 1 + \frac{4}{2} - \frac{4}{2^2}$$

$$= 3$$

$$|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2} = \sqrt{0^2 + 3^2 + 0^2} = 3 \text{ m/s}^2$$

End of Solution

11. For the equation $\frac{dy}{dx} + 7x^2y = 0$, if y(0) = 3/7, then the value of y(1) is

(A) $\frac{3}{6}e^{-3/7}$

(B) $\frac{7}{3}e^{-3/7}$

(C) $\frac{7}{3}e^{-7/3}$

(D) $\frac{3}{7}e^{-7/3}$

11. Ans: (D)

Sol: Given $\frac{dy}{dx} + 7x^2y = 0$ ---------- (1)

With $y(0) = \frac{3}{7}$ ---------- (2)

Now, (1) is written as

$$\Rightarrow \int \frac{1}{y}dy + \int 7x^2 dx = C$$

$$\Rightarrow \log y + \frac{7x^3}{3} = C$$

$$\Rightarrow y = e^{-\frac{7x^3}{3} + C} \text{ -------- (3)}$$

Using (2), (3) becomes

$$\frac{3}{7} = e^0.e^C \text{ (or) } e^C = \frac{3}{7} \text{ -------- (4)}$$

$\therefore$ The solution of (1) with (3) & (4) is given by

$$y = y(x) = e^{\frac{-7x^3}{3} + C} = e^{\frac{-7x^3}{3}}.e^C = \frac{3}{7}.e^{\frac{-7x^3}{3}}$$

Hence, $y(1) = y = \frac{3}{7}.e^{-\frac{7}{3}}$

12. The length, width and thickness of a steel sample are 400 mm, 40 mm and 20 mm, respectively. Its thickness needs to be uniformly reduced by 2 mm in a single pass by using horizontal slab milling. The milling cutter (diameter: 100 mm, width: 50 mm) has 20 teeth and rotates at 1200 rpm. The feed per tooth is 0.05 mm. The feed direction is along the length of the sample. If the over-travel distance is the same as the approach distance, the approach distance and time taken to complete the required machining task are

(A) 21 mm, 28.9 s
(B) 14 mm, 18.4 s
(C) 21 mm, 39.4s
(D) 14 mm, 21.4 s

12. Ans: (D)

Sol: Approach = $\sqrt{d(D-d)} = \sqrt{2(100-2)}$

$= \sqrt{196} = 14\,mm$

Here, AP = OR = 14 mm

Machine time = $\dfrac{L+AP+OR}{fZN} = \dfrac{400+14+14}{0.05\times 20\times 1200} = 0.356\,min = 21.4\,sec$

End of Solution

13. The table presents the demand of a product. By simple three-months moving average method, the demand-forecast of the product for the month of September is

Month	Demand
January	450
February	440
March	460
April	510
May	520
June	495
July	475
August	560

(A) 490
(B) 530
(C) 510
(D) 536.67

13. Ans: (C)

Sol: 3 month moving average method :

$$F_{sep} = \frac{D_{Aug} + D_{July} + D_{June}}{3}$$

$$= \frac{560 + 475 + 495}{3} = 510$$

End of Solution

14. Which one of the following welding methods provides the highest heat flux (W/mm^2)?

(A) Tungsten inert gas welding (B) Laser beam welding

(C) Plasma arc welding (D) Oxy-acetylene gas welding

14. Ans: (B)

Sol: Heat flux means power input in terms of heat per unit area. It will be maximum in Laser beam welding.

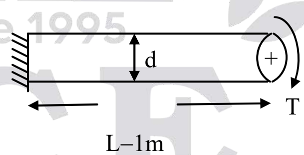
End of Solution

15. A cylindrical rod of diameter 10 mm and length 1.0 m is fixed at one end. The other end is twisted by an angle of 10° by applying a torque. If the maximum shear strain in the rod is $p \times 10^{-3}$, then p is equal to ____ (round off to two decimal places).

15. Ans: 0.87

Sol: d = 10mm

$$\theta = 10^\circ = 10^\circ \times \frac{\pi}{180} \text{radian}$$



$$R = \frac{d}{2} = 5\,\text{mm}$$

L = 1m,

$$\phi_{max} = P \times 10^{-3}$$

from torsion equation, $\frac{T}{J} = \frac{\tau_{max}}{R} = \frac{G\theta}{\ell}$

$$\Rightarrow \frac{\tau_{max}}{G} = \frac{R\theta}{\ell}$$

$$\phi_{max} = \frac{R\theta}{\ell}$$

$$P\times10^{-3} = \frac{5\times10^{o}\times\dfrac{\pi}{180}}{1000} = 0.8726\times10^{-3}$$

$\therefore$ P = 0.8726

End of Solution

16. Consider an ideal vapour compression refrigeration cycle. If the throttling process is replaced by an isentropic expansion process, keeping all the other processes unchanged, which one of the following statements is true for the modified cycle?

(A) Coefficient of performance is lower than that of the original cycle.

(B) Refrigerating effect is lower than that of the original cycle.

(C) Coefficient of performance is higher than that of the original cycle.

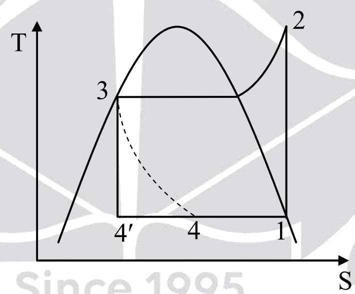
(D) Coefficient of performance is the same as that of the original cycle.

16. Ans: (C)

Sol: Due to isentropic expansion instead of throttling

1. R.E increases
2. Work input reduces

$\therefore$ $COP = \frac{R.E}{W_{in}}$



{3–4′ is isentropic expansion
3–4 is throttling}

End of Solution

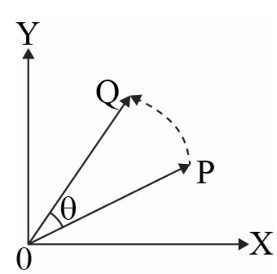
17. The position vector $\overrightarrow{OP}$ of point (20, 10) is rotated anti-clockwise in X-Y plane by an angle θ = 30° such that point P occupies position Q, as shown in the figure. The coordinates (x, y) of Q are

(A) (13.40, 22.32)

(B) (12.32, 18.66)

(C) (18.66, 12.32)

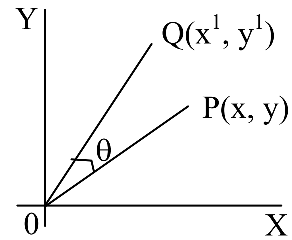
(D) (22.32, 8.26)



17. Ans: (B)

Sol: The matrix transformation in first quadrant is given by

Y=PX, where $\theta = 30$.



$$\Rightarrow \begin{bmatrix} x^1 \\ y^1 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} x^1 \\ y^1 \end{bmatrix} = \begin{bmatrix} \cos(30) & -\sin(30) \\ \sin(30) & \cos(30) \end{bmatrix} \begin{bmatrix} 20 \\ 10 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} x^1 \\ y^1 \end{bmatrix} = \begin{bmatrix} (20)\cos(30) & -(10)\sin(30) \\ (20)\sin(30) & +(10)\cos(30) \end{bmatrix} \begin{bmatrix} 20 \\ 10 \end{bmatrix}$$

$$\therefore \begin{bmatrix} x^1 \\ y^1 \end{bmatrix} = \begin{bmatrix} 12.32 \\ 18.66 \end{bmatrix}$$

$(x^1, y^1) = (12.32, 18.66)$

Hence, option (b) is correct.

End of Solution

18. As per common design practice, the three type of hydraulic turbines, in descending order of flow rate, are

(A) Francis, Kaplan, Pelton

(B) Pelton, Kaplan, Francis

(C) Pelton, Francis, Kaplan

(D) Kaplan, Francis, Pelton

18. Ans: (D)

Sol: Kaplan turbine has highest flow area hence it can handle highest discharge. On the other hand, Pelton turbine has lowest flow area hence it works on low discharge.

$\therefore Q_{Kaplan} > Q_{Francis} > Q_{Pelton}$

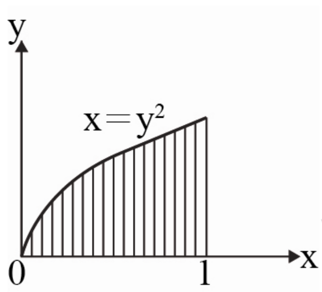
19. A parabola $x = y^2$ with $0 \le x \le 1$ is shown in the figure. The volume of the solid of rotation obtained by rotating the shaded area by 360° around the x-axis is

(A) π

(B) $\frac{\pi}{4}$

(C) 2π

(D) $\frac{\pi}{2}$



19. Ans: (D)

Sol: Given: $y^2 = x,\ 0 \le x \le 1$

The value of solid obtained by rotating the area bounded by the curves

$y^2 = x,\ 0 \le x \le 1$ about x-axis is

$$V = \int_a^b \pi y^2 dx$$

$$V = \int_0^1 \pi x dx$$

$$= \left(\frac{\pi x^2}{2}\right)_0^1$$

$$= \frac{\pi}{2}$$

End of Solution

20. Consider the matrix $P = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$

The number of distinct eigenvalues of P is

(A) 2

(B) 1

(C) 3

(D) 0

20. Ans: (B)

Sol: Given: $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$

It is an upper triangular matrix. It's diagonal elements are eigen values.

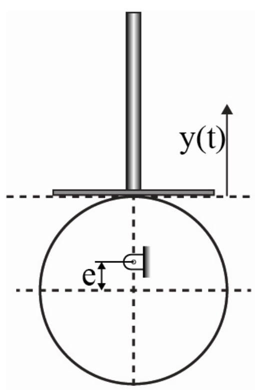
The eigen values of the matrix are 1, 1, 1.

$\therefore$ Number of distinct eigen values = 1

Hence, option (B) is correct.

End of Solution

21. A flat-faced follower is driven using a circular eccentric cam rotating at a constant angular velocity ω. At time t = 0, the vertical position of the follower is y(0) = 0, and the system is in the configuration shown below.



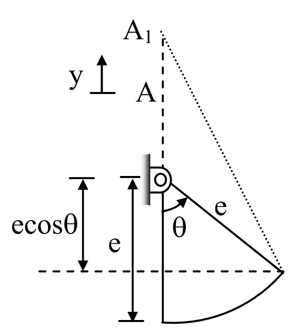
The vertical position of the follower faces y(t) is given by

(A) e sin $2\omega t$ (B) e sin ωt

(C) e $(1- \cos \omega t)$ (D) e $(1+ \cos 2\omega t)$

21. Ans: (C)

Sol:



$AA_1 = y = e(1 - \cos\theta)$

$= e(1 - \cos\omega t)$

22. For a hydro dynamically and thermally fully developed laminar flow through a circular pipe of constant cross-section, the Nusselt number at constant wall heat flux (Nu_q) and that at constant wall temperature (Nu_T) are related as

(A) $Nu_q < Nu_T$
(B) $Nu_q = Nu_T$
(C) $Nu_q = (Nu_T)^2$
(D) $Nu_q > Nu_T$

22. Ans: (D)

Sol: For laminar flow through circular tube :

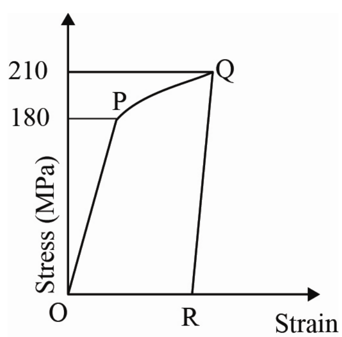
$Nu_q = 4.36$ (For constant heat flux)

$Nu_T = 3.66$ (For constant wall temperature)

$Nu_q > Nu_T$

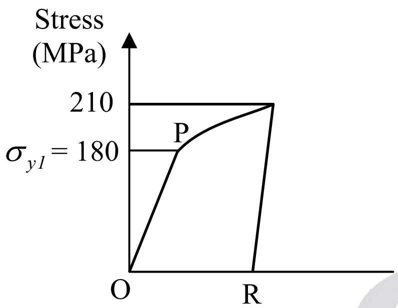
End of Solution

23. Consider the stress-strain curve for an ideal elastic-plastic strain hardening metal as shown in the figure. The metal was loaded in uniaxial tension starting from O. Upon loading, the stress-strain curve passes through initial yield point at P, and then strain hardens to point Q, where the loading was stopped. From point Q, the specimen was loaded to point R, where the stress is zero. If the same specimen is reloaded in tension from point R, the value of stress at which the material yields again is ______ MPa.

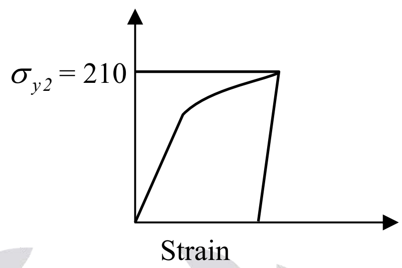


23. Ans: 210 MPa

Sol: Yield strength will increase to 210 MPa due to strain hardening.



First Loading



Second Loading

End of Solution

24. A block of mass 10 kg rests on a horizontal floor. The acceleration due to gravity is 9.81 m/s^2. The coefficient of static friction between the floor and the block is 0.2. A horizontal force of 10 N is applied on the block as shown in the figure. The magnitude of force of friction (in N) on the block is _______.

24. Ans: 10

Sol:

Maximum friction force, $f_{max} = \mu N = 0.2 \times 10 \times 9.81 = 19.62$ N

Applied force, $P = 10 \text{ N} < f_{max}$

$\therefore$ Friction force = Applied force = 10 N

25. A solid cube of side 1 m is kept at a room temperature of 32°C. The coefficient of linear thermal expansion of the cube material is 1×10^{-5}/°C and the bulk modulus is 200 GPa. If the cube is constrained all around and heated uniformly to 42°C, then the magnitude of volumetric (mean) stress (in MPa) induced due to heating is ___________.

25. Ans: 60

Sol: Since the block is heated uniformly and constrained in all directions, hydrostatic state of stress develops.

$\therefore$ Volumetric strain $\in_v = \dfrac{\sigma}{k} = 3\alpha\ (t)$

$\therefore$ $\sigma = 3\alpha\ t(k)$

$= 3\times1\times10^{-5}(42-32)\times200\times10^{3}$

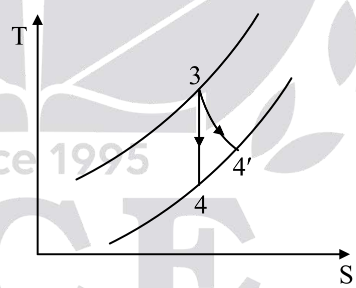
$\therefore$ $\sigma = 60$ MPa

End of Solution

26. A gas turbine with air as the working fluid has an isentropic efficiency of 0.70 when operating at a pressure ratio of 3. Now, the pressure ratio of the turbine is increased to 5, while maintaining the same inlet conditions. Assume air as a perfect gas with specific heat ratio $\gamma = 1.4$. If the specific work output remains the same for both the cases, the isentropic efficiency of the turbine at the pressure ratio of 5 is __________ (round off to two decimal places).

26. Ans: 0.515

Sol: Given, $r_{p1} = 3, r_{p_2} = 5$



$$W_{act} = \eta_s \times W_{isentropic}$$

$$= \eta_s \times c_p[T_3 - T_4]$$

$$= \eta_s \times c_p T_3\left[1 - \frac{1}{\frac{T_3}{T_4}}\right]$$

$$W_{act} = \eta_s \times c_p \times T_3\left[1 - \frac{1}{r_p^{\frac{\gamma-1}{\gamma}}}\right]$$

$(W_{act})_1 = (W_{act})_2$

$$\therefore\ \eta_{s_1} \times\left[1 - \frac{1}{3^{\frac{1.4-1}{1.4}}}\right] = \eta_{s_2} \times\left[1 - \frac{1}{5^{\frac{1.4-1}{1.4}}}\right] \quad \Rightarrow \eta_{s_2} = 0.515$$

27. In ASA system, the side cutting and end cutting edge angles of a sharp turning tool are 45° and 10°, respectively. The feed during cylindrical turning is 0.1 mm/rev. The center line average surface roughness (in μm, round off to one decimal place) of the generated surface is ____________.

27. Ans: 3.75

Sol: Peak to valley height

$$h_{max} = \frac{f}{\tan C_s + \cot C_e}$$

C_S = S.C.E.A, C_e = E.C.E.A

$$\Rightarrow h_{max} = \frac{0.1}{\tan 45^0 + \cot 10^0}$$

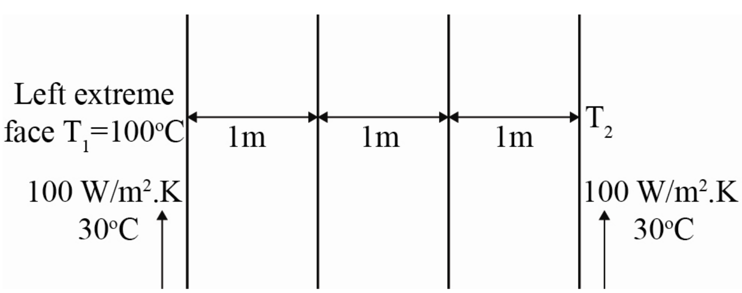
$$h_{max} = \frac{0.1}{1+5.67} = 0.015\,mm$$

The approximate value of centre line average

$$R_a = \frac{h_{max}}{4} = \frac{0.015}{4} = 0.00375\,mm = 3.75\ \mu m$$

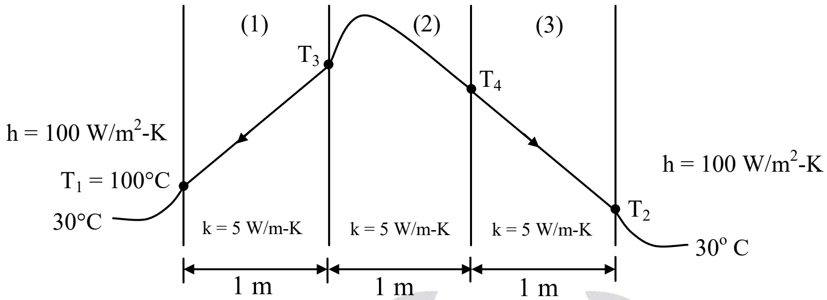
End of Solution

28. Three slabs are joined together as shown in the figure. There is no thermal contact resistance at the interfaces. The center slab experiences a non-uniform internal heat generation with an average value equal to 10000 Wm^{-3}, while the left and right slabs have no internal heat generation. All slabs have thickness equal to 1 m and thermal conductivity of each slab is equal to 5 $Wm^{-1}K^{-1}$. The two extreme faces are exposed to fluid with heat transfer coefficient 100 $Wm^{-2}K^{-1}$ and bulk temperature 30°C as shown. The heat transfer in the slabs is assumed to be one dimensional and steady, and all properties are constant. If the left extreme face temperature T_1 is measured to be 100°C, the right extreme face temperature T_2 is ____________°C.



28. Ans: 60

Sol:



Energy balance :

Heat generated in middle slab = heat loss by slab (1) and (3) to the surrounding

$$\dot{q} \times \text{volume} = \frac{(T_1 - 30)}{\frac{1}{hA}} + \frac{(T_2 - 30)}{\frac{1}{hA}}$$

$$10000 \times A \times 1 = hA(T_1 - 30 + T_2 - 30)$$

$$1000 \times 1 = 100\ (100 + T_2 - 60)$$

$T_2 = 60°C$

End of Solution

29. A gas is heated in a duct as it flows over a resistance heater. Consider a 101 kW electric heating system. The gas enters the heating section of the duct at 100 kPa and 27°C with a volume flow rate of 15 m^3/s. If heat is lost from the gas in the duct to the surroundings at a rate of 51 kW, the exit temperature of the gas is

(Assume constant pressure, ideal gas, negligible change in kinetic and potential energies and constant specific heat; C_P = 1 kJ/kg.K; R = 0.5 kJ/kg.K.)

(A) 37°C (B) 76°C

(C) 53°C (D) 32°C

29. Ans: (D)

Sol: By using steady flow energy equation,

$$\dot{m}\left[h_1 + \frac{V_1^2}{2000}\right] + \frac{dQ}{dt} = \dot{m}\left[h_2 + \frac{V_2^2}{2000}\right] + \frac{dW}{dt}$$

where, $\dot{m} = \frac{P_1V_1}{RT_1} = \frac{100\times15}{0.5\times300} = 10$

Thus,

$10[c_pT_1] + 101 - 51 = 10\times[c_p\times T_2]$ $\left[\because v_1 = 0, v_2 = 0 \text{ and } \frac{dW}{dt} = 0\right]$

$10\times1\times300 + 50 = 10\times1\times T_2$

$T_2 = 305\text{ K} = 32°\text{C}$

End of Solution

30. In orthogonal turning of a cylindrical tube of wall thickness 5 mm, the axial and the tangential cutting forces were measured as 1259 N and 1601 N, respectively. The measured chip thickness after machining was found to be 0.3 mm. The rake angle was 10^o and the axial feed was 100 mm/min. The rotational speed of the spindle was 1000 rpm. Assuming the material to be perfectly plastic and Merchant's first solution, the shear strength of the material is closest to

(A) 875 MPa (B) 200 MPa

(C) 722 MPa (D) 920 MPa

30. Ans: (C)

Sol: Axial cutting force = Feed Force = $F_F = 1259\text{N}$

Tangental Force $= F_c = 1601$ N

Chip thickness = $t_2 = 0.3\text{mm}$

Rake angle $\alpha_0 = 10^0$

Feed = 100 mm/min

Rotational speed = 1000 rpm

Feed in mm/rev, $f = \frac{100}{1000} = 0.1\text{mm/rev}$

Shear strength = $\tau_s = ?$

Since S.C. E A is not mentioned therefore it can be assumed to be zero $\therefore$ S.C.E.A $\psi_s = 0$ and hence

feed = uncut thickness = $t_1 = 0.1\text{mm s}$

$\therefore$ Chip thickness ratio r = $\frac{t_1}{t_2} = \frac{0.1}{0.3}$

Since S.C.E.A $C_S = 0$

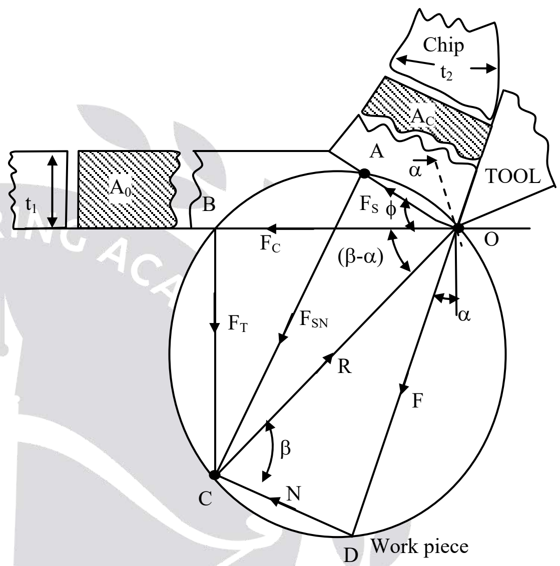
$\therefore$ Feed force = Thrust Force

$\Rightarrow F_T = 1259$ N

$$r = \frac{t_1}{t_2} = \frac{f}{t_2} = \frac{0.1}{0.3} = 0.333$$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} = \frac{0.333\cos 10}{1 - 0.333\sin 10}$$

$\Rightarrow \phi = 19.19°$



In Δ OBC

$$\tan(\beta - \alpha) = \frac{F_T}{F_C} = \frac{1259}{1601}$$

$$\Rightarrow \beta - \alpha = \tan^{-1}\left(\frac{1259}{1601}\right) = 38.18^\circ$$

From ΔOAC

Shear Force $F_S = R\cos(\phi + \beta - \alpha)$

$$= \sqrt{1601^2 + 1259^2}\cos(19.19 + 38.18)$$

$= 2036.73 \times 0.44$

$= 1098.22$ N

Assuming whole thickness of tube is being turned:

width of cut = thickness of Tube

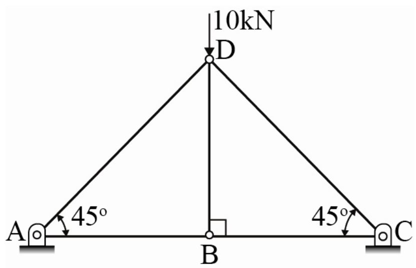
$\Rightarrow$ w = 5 mm

$$\Rightarrow \text{Shear Strength} = \frac{\text{Shear Force}}{\text{Shear Area}} = \frac{F_s}{(w \times t_1)/\sin\phi}$$

$$= \frac{1098.22\sin 19.19}{5 \times 0.1} = 721.98 \approx 722 \text{ MPa}$$


ACE ENGINEERING ACADEMY
Since 1995
ACE
HEARTY CONGRATULATIONS TO OUR
ESE 2018 RANKERS
AIR 1 SHASHANK E&T
AIR 1 CHIRAG JHA EE
AIR 1 VINAY PRAKASH CE
AIR 1 AMAN JAIN ME
AIR 2 CHERUKURI SAIDEEP E&T
AIR 2 SHADAB AHAMAD EE
AIR 2 PUNIT SINGH CE
AIR 2 CHIRAG SINGLA ME
AIR 3 RAMESH KAMULLA E&T
AIR 3 SRIJAN VARMA EE
AIR 3 PRAVEEN KUMAR CE
AIR 3 MAYUR PATIL ME
AIR 4 JAPJIT SINGH E&T
AIR 4 ANKIT GARG EE
AIR 4 AMIT KUMAR ME
AIR 5 NARENDRA KUMAR E&T
AIR 5 KARTHIK KOTTURU EE
AIR 5 RISHABH DUTT CE
AIR 5 VITTHAL PANDEY ME
AIR 6 KUMUD JINDAL E&T
AIR 6 RATIPALLI NAGESWAR EE
AIR 7 KARTIKEYA DUTTA E&T
AIR 7 TEKCHAND DESHWAL EE
AIR 7 ROHIT KUMAR CE
AIR 8 SURYASH GAUTAM E&T
AIR 8 RAVI TEJA MANNE EE
AIR 8 VIJAYA NANDAN CE
AIR 8 ROHIT BANSAL ME
AIR 9 SHANAVAS CP E&T
AIR 9 SOUVIK DEB ROY EE
AIR 9 ROOPESH MITTAL CE
AIR 10 PRATHAMESH E&T
AIR 10 MILAN KRISHNA EE
AIR 10 SRICHAND POONIYA CE
TOTAL SELECTIONS in Top 10 34
E&T TOP 10 10
EE TOP 10 10
CE TOP 10 8
ME TOP 10 6
and many more...

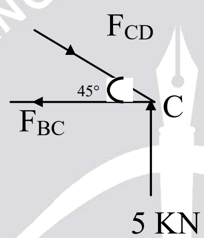
31. A truss is composed of members AB, BC, CD, AD and BD, as shown in the figure. A vertical load of 10 kN is applied at point D. The magnitude of force (in kN) in the member BC is __________.



31. Ans: 5

Sol: BD is a zero force member

F.B.D of joint C is shown below,



For equilibrium of joint C,

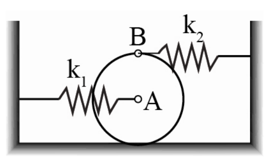
$\sum F_y = 0,\quad F_{CD} \cos 45 = 5$

$$\therefore F_{CD} = \frac{5}{\cos 45}$$

$\sum F_{x=0},\quad F_{BC} = F_{CD} \cos 45 = \dfrac{5}{\cos 45} \times \cos 45 = 5kN$

End of Solution

32. A uniform thin disk of mass 1 kg and radius 0.1 m is kept on a surface as shown in the figure. A spring of stiffness k_1 = 400 N/m is connected to the disk center A and another spring of stiffness k_2 = 100 N/m is connected at point B just above point A on the circumference of the disk. Initially, both the springs are unstretched. Assume pure rolling of the disk. For small disturbance from the equilibrium, the natural frequency of vibration of the system is ______ rad/s (round off to one decimal place).



32. Ans: 23.09

Sol: $I_P\ddot{\theta} + F_{s_1}.r\cos\theta + F_{s_2}(2r\cos\theta) = 0$

$$I_P\ddot{\theta} + k_1.x_{s_1}.r + k_2x_{s_2}.2r = 0$$

$$I_P\ddot{\theta} + k_1.r^2\theta + k_2 4r^2\theta = 0$$

$$I_P\ddot{\theta} + (k_1r^2 + 4k_2r^2)\theta = 0$$

$$I_{eq} = I_p = I_{cm} + m(r)^2$$

$$= \frac{mr^2}{2} + mr^2 = \frac{3}{2}mr^2$$

$$\omega_n = \sqrt{\frac{k_1r^2 + 4k_2r^2}{\frac{3}{2}mr^2}} = \sqrt{\frac{400 + (4\times 100)}{\frac{3}{2}\times 1}} = 23.09 \text{ rad/s}$$

End of Solution

33. A circular shaft having diameter $65.00^{+0.01}_{-0.05}$ mm is manufactured by turning process. A 50 μm thick coating of TiN is deposited on the shaft. Allowed variation in TiN film thickness is ± 5 μm. The minimum hole diameter (in mm) to just provide clearance fit is

(A) 65.10 (B) 65.01

(C) 65.12 (D) 64.95

33. Ans: (C)

Sol: Shaft $65^{+0.01}_{-0.05}$ mm

Locating $\rightarrow$ 0.05 ± 0.005 mm

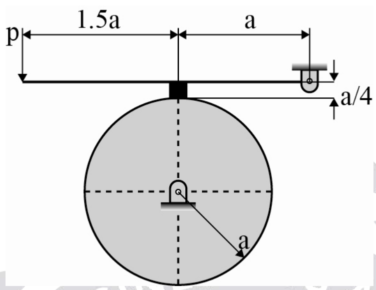
U.L = 65.01 + 2×0.055 = 65.12

L.L = 64.95 + 2×0.045 = 65.04

Min hole dia to provide clearance fit is

Upper limit of shaft after coating i.e. = 65.12 mm

34. A single block brake with a short shoe and torque capacity of 250 N-m is shown. The cylindrical brake drum rotates anticlockwise at 100 rpm and the coefficient of friction is 0.25. The value of a, in mm (round off to one decimal place), such that the maximum actuating force P is 2000 N, is _______.



34. Ans: 212.5

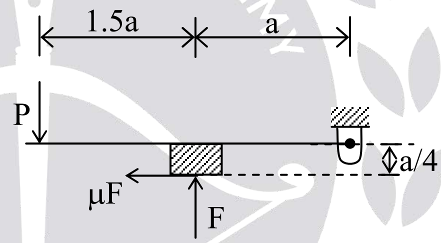
Sol: $\mu = 0.25$

76Torque = 250 Nm

$\mu F \times a = 250$

$\Rightarrow 0.25 \times F \times a = 250$

$\Rightarrow F \times a = 1000$ ------(i)



In FBD of block and lever, $\Sigma M_{fullcrum} = 0$

$$F \times a + \mu F \times \frac{a}{4} = P \times 2.5a$$

$$F \times a\left(1 + \frac{\mu}{4}\right) = P \times 2.5a$$

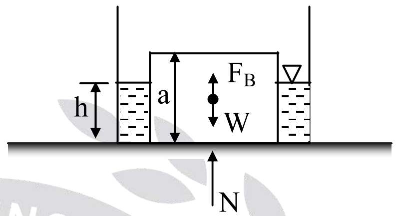
$$1000\left(1 + \frac{0.25}{4}\right) = 2000 \times 2.5a$$

$\Rightarrow a = 0.2125$ m = 212.5 mm

35. A cube of side 100 mm is placed at the bottom of an empty container on one of its faces. The density of the material of the cube is 800 kg/m^3. Liquid of density 1000 kg/m^3 is now poured into the container. The minimum height to which the liquid needs to be poured into the container for the cube to just lift up is ________ mm.

35. Ans: 80

Sol: $\sum F_y = 0$



$F_B - W + N = 0$

When the cube is just about to lift, N = 0

$\therefore\ F_B = W$

$\rho g\forall = \rho_s g\forall_s$

$1000\times a^2\times h = 800\times a^2\times a$

$\therefore\ h = 0.8a$

$= 0.8\times 100$

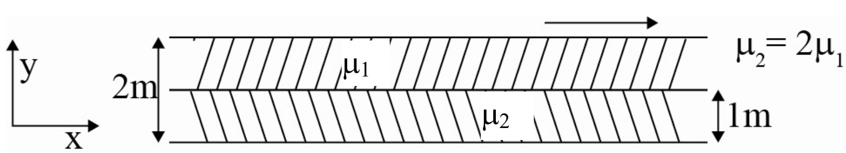
$= 80$ mm

End of Solution

36. Two immiscible, incompressible, viscous fluids having same densities but different viscosities are contained between two infinite horizontal parallel plates, 2 m apart as shown below. The bottom plate is fixed and the upper place moves to the right with a constant velocity of 3 m/s. With the assumptions of Newtonian fluid, steady, and fully developed laminar flow with zero pressure gradient in all directions, the momentum equations simplify to

$$\frac{d^2u}{dy^2} = 0$$

If the dynamic viscosity of the lower fluid, μ_2, is twice that of the upper fluid, μ_1, then the velocity at the interface (round off to two decimal places) is __________ m/s.

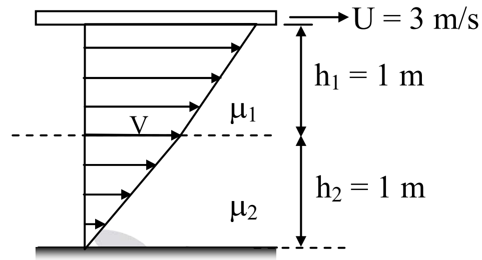


36. Ans: 1

Sol: The shear stress must be same at the interface of fluids.

$\tau_1 = \tau_2$

Let V be the velocity of the interface.



i.e. $\mu_1 \dfrac{U - V}{h_1} = \mu_2 \dfrac{V - 0}{h_2}$

$\mu_1 \dfrac{(3 - V)}{1} = 2\mu_1 \left(\dfrac{V}{1}\right)$

$3 - V = 2V$

$\therefore V = 1$ m/s

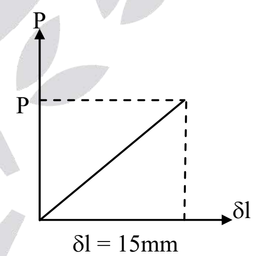
End of Solution

37. In a UTM experiment, a sample of length 100 mm, was loaded in tension until failure. The failure load was 40 kN. The displacement, measured using the cross-head motion, at failure, was 15 mm. The compliance of the UTM is constant and is given by 5×10^{-8} m/N. The strain at failure in the sample is ___________%.

37. Ans: 2

Sol: L = 100 mm

Failure load , P = 40 kN



Compliance of UTM = C = $\dfrac{\ell}{AE} = 5 \times 10^{-8} \dfrac{m}{N}$ = constant

and $\delta\ell = \dfrac{P\ell}{AE}$

$P = (\delta\ell)\dfrac{AE}{\ell}$

$40 \times 10^3 = (\delta\ell) \times \dfrac{1}{C}$

$\delta\ell = 40 \times 10^3 \times 5 \times 10^{-8} = 200 \times 10^{-5}$ m

Strain = $\in = \dfrac{\delta\ell}{\ell} = \dfrac{200 \times 10^{-5}}{0.1} = 2 \times 10^{-2}$

% Strain = $2 \times 10^{-2} \times 100\% = 2\%$

OUR GATE - 2018 TOP RANKERS

	TOP 10	TOP 100
EC	9	74
EE	7	69
CE	7	42
ME	4	54
CSIT	6	31
IN	11	78
PI	5	50

HEAD OFFICE :
HYDERABAD
Sree Sindhi Guru Sangat Sabha Association,
4-1-1236/1/A, King Koti, Abids, Hyderabad - 500001.
Address - II : # 204, Rahman Plaza, Abids, Hyderabad – 500001.
Contact No: 040-23234418/19/20, 040-24750437
E-Mail : hyderabad@aceenggacademy.com

DILSUKH NAGAR
Gaddiannaram,Dilsukhnagar, Hyderabad.
Contact No : 040 – 40209345, 040 – 40044451

KUKATPALLY
2nd floor, BSR Bellezza, Opp : JNTUH Campus, KPHB,
Kukatpally, Hyderabad- 500072.
Contact No: 040-6597 4465, 040-40199966, 93476 99966

DELHI
Address I : Plot No. 3, Kh.No. 264, Near Saket Metro Station,
Saidulajab, New Delhi-110030.
Address II : # 63, FNS House, Beside Oriental Bank of Commerce,
Near Hauz Khas Metro Station,Kalu Sarai,New Delhi-110016.
Contact No : 9205282121, 9205282123, 7838971777, 9205282120.

BHOPAL
G – 1, Plot no : 207, Zone II, M.P Nagar, M. P – 462013.
Contact No: 0755-2554512, 0755-2554612, 0755-4280242

PUNE
302, Vekatesh Villa, Upstairs JANATHA Sahakari Bank, Shivaji Nagar,
Pune, Maharashtra - 411005. Contact No : 020- 25535950, 09343499966

BHUBANESWAR
Plot No: 625/A, 3rd Floor, Janpath, Saheed Nagar, Bhubaneswar.
Contact No: 0674-2540340, 9861566244, 09379099966

LUCKNOW
A-7, Sector-J, Aliganj, Lucknow, Uttar Pradesh – 226024
Contact No. : 93421 99966, 8081 99 99 66, 0522 4046966

PATNA
1st Floor, N. P. Tower, Kankarbagh, PATNA – 800020.
Contact No. : 08252194512, 9308699966, 9212188818

BENGALURU
223, G R Arcade, 2nd floor, Malleswaram, Bangalore - 560003.
Contact No: 080-23466699,41526699, 09341299966.

CHENNAI
39, North Usman Road, T Nagar, Chennai - 600017.
Contact No : 044 – 42123289 , 9343799966

VISHAKAPATNAM
Door No. 48-14-91/6, 3rd Floor, Sri Nagar, Visakhapatnam – 530001.
Contact No : 0891-6616001, 08374808999

VIJAYAWADA
Opp Stella College, Near Benz Circle, Vijayawada – 520 008
Contact No. : 0866-2490001, 96760 76001

TIRUPATI
Plot No:10, AIR Bypass Road, Tirupathi – 517502.
Contact No : 0877-2244388, 9618155166, 09341499966

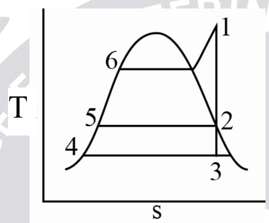
KOLKATA
3rd Floor, 369/4, EM Bypass, Avishar Shopping Mall,
Kolkata - 700078. Contact No : 8297899966, 8886899966

AHMEDABAD
Shop.No 231, 2nd Floor, Sunrise Mall, Near Mansi Circle,
Vasthrapur-Gujarat-380015. Contact No : 079 4890 2228, 9160499966

For Batch Details Visit : www.aceenggacademy.com

38. A stream power cycle with regeneration as shown below on the T-s diagram employs a single open feed water heater for efficiency improvement. The fluids mix with each other in an open feedwater heater. The turbine is isentropic and the input (bleed) to the feedwater heater from the turbine is at state 2 as shown in the figure. Process 3-4 occurs in the condenser. The pump work is negligible. The input to the boiler is at state 5. The following information is available from the steam tables:

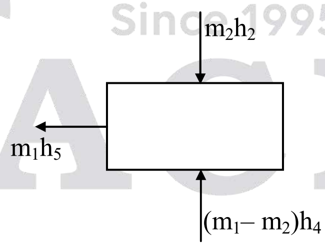
State	1	2	3	4	5	6
Enthalpy (kJ/kg)	3350	2800	2300	175	700	1000



The mass flow rate of steam bled from the turbine as a percentage of the total mass flow rate at the inlet to the turbine at state 1 is _______.

38. Ans: 20

Sol: Let 'm_1' kg of steam enters the turbine, 'm_2' kg of steam is bled from the turbine into the feed water heater and '$m_1 - m_2$' kg of steam enters the condenser.



From energy balance of open feed water heater,

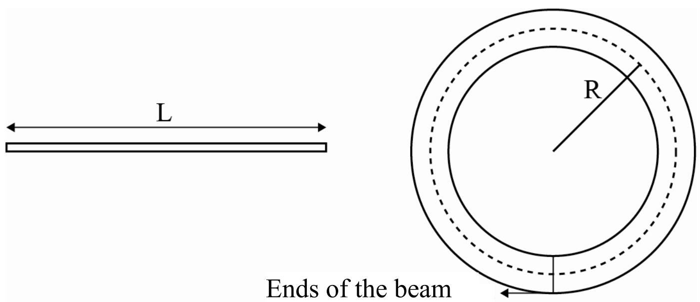
$m_2h_2 + (m_1 - m_2)h_4 = m_1h_5$

$$m_2 \times 2800 + (m_1 - m_2)175 = m_1 \times 700$$

$$2625\, m_2 = 525\, m_1$$

$\therefore$ Percentage of steam bled from the turbine $= \dfrac{m_2}{m_1} \times 100 = 0.2 \times 100 = 20\%$

39. Consider an elastic straight beam of length L = 10π m, with square cross-section of side a = 5 mm, and Young's modulus E = 200 GPa. This straight beam was bent in such a way that the two ends meet, to form a circle of mean radius R. Assuming that Euler-Bernoulli beam theory is applicable to this bending problem, the maximum tensile bending stress in the bent beam is _________ MPa.



39. Ans: 100

Sol: $L = 10\pi$ m

$a = 5$ mm

$E = 200$ GPa

Length of wire = $L = \pi D = 2\pi R$

$10\pi = 2\pi R$

$R = 5$ m

From bending equation, $\dfrac{M}{I} = \dfrac{f}{Y} = \dfrac{E}{R}$

$$\Rightarrow \frac{f}{y} = \frac{E}{R}$$

$$f_{max} = y_{max} \times \frac{E}{R}$$

$$= 2.5 \times \frac{200 \times 10^3}{5 \times 10^3} = 100 \text{ MPa}$$

40. The value of the following definite integral is _______ (round off to three decimal places)

$$\int_1^e (x \ln x)dx$$

40. Ans: 2.096

Sol: $\int_a^b f(x)g(x)dx = \left(f(x)\int g(x)dx\right)_a^b - \int_a^b f'(x)\left(\int g(x)dx\right)dx$

$$\int_1^e (x \ln x)dx = \int_1^e (\ln x)(x)dx$$

$$= \left(\ln x \int x dx\right)_1^e - \int_1^e \frac{1}{x}\left(\int x dx\right)dx$$

$$= \left(\left(\frac{x^2}{2}\right)\ln x\right)_1^e - \int_1^e \left(\frac{1}{x}\right)\left(\frac{x^2}{2}\right)dx$$

$$= \left[\left(\frac{e^2}{2}\right)\ln(e)\right] - \left(\frac{1}{2}\ln(1)\right) - \int_1^e \frac{x}{2}dx$$

$$= \frac{e^2}{2} - \left(\frac{x^2}{4}\right)_1^e$$

$$= \frac{e^2}{2} - \left(\frac{e^2}{4} - \frac{1}{4}\right)$$

$$= \frac{e^2}{2} - \frac{e^2}{4} + \frac{1}{4}$$

$$= \frac{2e^2 - e^2 + 1}{4}$$

$$= \frac{e^2 + 1}{4} = 2.096$$

41. A project consists of six activities. The immediate predecessor of each activity and the estimated duration is also provided in the table below:

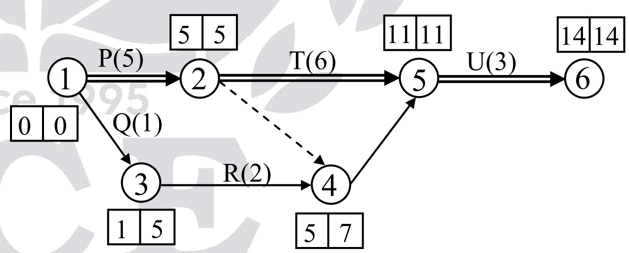
Activity	Immediate predecessor	Estimated duration (weeks)
P	-	5
Q	-	1
R	Q	2
S	P, R	4
T	P	6
U	S, T	3

If all activities other than S take the estimated amount of time, the maximum duration (in weeks) of the activity S without delaying the completion of the project is ________.

41. Ans: 6

Sol:

Path	Duration
P – T – U	14
P – Dummy – S – U	12
Q – R – S – U	10



Project completion time = 14 weeks

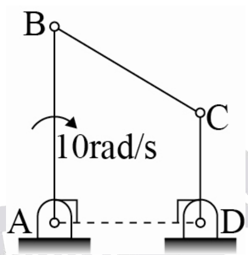
Total float of ‘S’ = 11 – 5 – 4 = 2 weeks

Maximum duration of activity ‘S’ without delaying the project completion time

= Total float + duration

= 2 + 4 = 6 weeks

42. In a four bar planar mechanism shown in the figure, AB = 5 cm, AD = 4 cm and DC = 2 cm. In the configuration shown, both AB and DC are perpendicular to AD. The bar AB rotates with an angular velocity of 10 rad/s. The magnitude of angular velocity (in rad/s) of bar DC at this instant is



(A) 25

(B) 0

(C) 10

(D) 15

42. Ans: (A)

Sol: AB = 5 cm

AD = 4 cm

DC = 2 cm

$\omega_{AB} = 10$ rad/s

$\because$ AB || DC

$\therefore$ AB. ω_{AB} = DC. ω_{DC}

$5\times10 = 2\times\omega_{DC}$

$\omega_{DC} = 25$ rad/s

End of Solution

43. The set of equations

$$x + y + z = 1$$

$$ax - ay + 3z = 5$$

$$5x - 3y + az = 6$$

has infinite solutions, if a =

(A) 4 (B) 3

(C) – 4 (D) – 3

43. Ans: (A)

Sol: The given system of equations can be expressed in the matrix form:

$$\begin{bmatrix} 1 & 1 & 1 \\ a & -a & 3 \\ 5 & -3 & a \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 5 \\ 6 \end{bmatrix}$$

AX = B form

Where $A = \begin{bmatrix} 1 & 1 & 1 \\ a & -a & 3 \\ 5 & -3 & a \end{bmatrix} X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \& B = \begin{bmatrix} 1 \\ 5 \\ 6 \end{bmatrix}$

The augmented matrix is

$$[A/B] = \left[\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ a & -a & 3 & 5 \\ 5 & -3 & a & 6 \end{array}\right]$$

$R_2 - aR_1$ & $R_3 - 5R_1$

$$[A/B] = \left[\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ 0 & -2a & 3-a & 5-a \\ 0 & -8 & a-5 & 1 \end{array}\right]$$

$aR_3 - 4R_2$

$$[A/B] = \left[\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ 0 & -2a & 3-a & 5-a \\ 0 & 0 & a^2-a-12 & 5a-20 \end{array}\right]$$

For infinite solutions $\rho(A/B) = \rho(A) <$ Number of unknowns

$\Rightarrow a^2 - a - 12 = 0$ & $5a - 20 = 0$

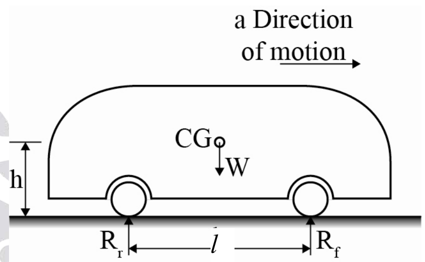
$\Rightarrow a = 4$

Hence, option (A) is correct.

ESE / GATE / PSUs - 2020
ADMISSIONS OPEN

CENTER	COURSE	BATCH TYPE	DATE
HYDERABAD - DSNR	GATE + PSUS – 2020	Regular Batches	26th April, 11th, 25th May, 09th, 24th June, 8th July 2019
HYDERABAD - DSNR	ESE + GATE + PSUs - 2020	Regular Batches	21st March, 26th April, 11th, 25th May, 09th, 24th June, 8th July 2019
HYDERABAD - DSNR	GATE + PSUs - 2020	Short Term Batches	29th April, 6th, 11th, 18th May 26th May, 2nd June, 2019
HYDERABAD - DSNR	GATE + PSUs - 2020	Morning/Evening Batch	24th February 2019
HYDERABAD - DSNR	ESE – 2019 STAGE-II (MAINS)	Regular Batch	17th Feb 2019
HYDERABAD - Abids	GATE + PSUS – 2020	Regular Batches	26th April, 11th, 25th May, 09th, 24th June, 8th July 2019
HYDERABAD - Abids	GATE + PSUs - 2020	Short Term Batches	29th April, 6th, 11th, 18th May 26th May, 2nd June, 2019
HYDERABAD - Abids	ESE + GATE + PSUs - 2020	Morning Batch	24th February 2019
HYDERABAD - Abids	ESE – 2019 STAGE-II (MAINS)	Regular Batch	17th Feb 2019
HYDERABAD - Abids	GATE + PSUs - 2020	Weekend Batch	24th February 2019
HYDERABAD - Abids	ESE+GATE + PSUs - 2020	Spark Batches	11th May, 09th June 2019
HYDERABAD - Kukatpally	GATE + PSUs - 2020	Morning/Evening Batch	24th February 2019
HYDERABAD - Kukatpally	GATE + PSUS – 2020	Regular Batches	17th May, 1st, 16th June, 1st July 2019
HYDERABAD - Kukatpally	GATE + PSUs - 2020	Short Term Batches	29th April, 6th, 11th, 18th May 26th May, 2nd June, 2019
HYDERABAD - Kothapet	ESE + GATE + PSUS – 2020	Regular Batches	21st March, 26th April, 11th, 25th May, 09th, 24th June, 8th July 2019
HYDERABAD - Kothapet	ESE+GATE + PSUs - 2020	Spark Batches	11th May, 09th June 2019
DELHI	ESE+GATE+PSUs - 2020	Weekend Batches	9th Mar 2019
DELHI	ESE+GATE+PSUs - 2020	Regular Evening Batch	18th Feb 2019
DELHI	ESE+GATE+PSUs - 2020	Regular Day Batch	11th May 2019
DELHI	ESE+GATE+PSUs - 2020	Spark Batch	11th May 2019
DELHI	GATE+PSUs - 2020	Short Term Batches	11th, 23rd May 2019
BHOPAL	ESE+GATE+PSUs - 2020	Regular Day Batch	01st Week of June 2019
BHUBANESWAR	GATE+PSUs - 2020	Weekend Batch	16th Feb 2019
BHUBANESWAR	GATE+PSUs - 2020	Regular Batch	02nd Week of May 2019
CHENNAI	GATE+PSUs - 2020 & 21	Weekend Batch	16th Feb 2019
CHENNAI	GATE+PSUs - 2020	Regular Batch	02nd Week of May 2019
BANGALORE	GATE+PSUs - 2020 & 21	Weekend Batch	23rd Feb 2019
BANGALORE	GATE+PSUs - 2020	Regular Batch	17th June 2019

44. A car having weight W is moving in the direction as shown in the figure. The center of gravity (CG) of the car is located at height h from the ground, midway between the front and rear wheels. The distance between the front and rear wheels is l. The acceleration of the car is a, and acceleration due to gravity is g. The reactions on the front wheels (R_f) and rear wheels (R_r) are given by



(A) $R_f = R_r = \dfrac{W}{2} - \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a$

(B) $R_f = \dfrac{W}{2} - \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a;\ R_r = \dfrac{W}{2} + \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a$

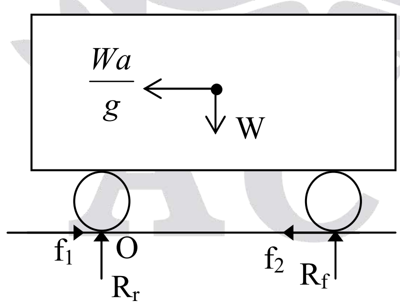
(C) $R_f = R_r = \dfrac{W}{2} + \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a$

(D) $R_f = \dfrac{W}{2} + \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a;\ R_r = \dfrac{W}{2} - \dfrac{W}{g}\left(\dfrac{h}{\ell}\right)a$

44. Ans: (B)

Sol: We analyse this problem in the frame of reference of car.

F.B.D of car is shown below,



As our frame of reference is accelerated hence, we have to apply a pseudo force 'ma' as shown above, where, f_1 and f_2 are friction forces on rear and front wheels respectively.

For vertical equilibrium,

$R_r + R_f = W$ ----(i)

$\Sigma M_0 = 0$,

$$W \times \frac{\ell}{2} - \frac{Wa}{g} \times h - R_f \times \ell = 0 \quad \text{------(ii)}$$

From (i) & (ii)

$$R_f = \frac{W}{2} - \frac{W}{g}\left(\frac{h}{\ell}\right)a$$

$$R_r = \frac{W}{2} + \frac{W}{g}\left(\frac{h}{\ell}\right)a$$

End of Solution

45. If one mole of H_2 gas occupies a rigid container with a capacity of 1000 litres and the temperature is raised from 27°C to 37°C, the change in pressure of the contained gas (round off to two decimal places), assuming ideal gas behaviour, is _________ Pa. (R = 8.314 J/mol.K)

45. Ans: 83.14

Sol: Volume , V = 1000 lit = 1m^3

For ideal gas, $PV = n\bar{R}T$

Differntiating above expression we get,

$$Vdp = n\vec{R}dT$$

$$1 \times dp = 1 \times 8.314 \times 10$$

$$\therefore dP = 83.14 \text{ Pa}$$

End of Solution

46. Match the following sand mold casting defects with their respective causes.

	Defect		**Cause**
P	Blow hole	1.	Poor collapsibility
Q	Misrun	2	Mold erosion
R	Hot tearing	3	Poor permeability
S	Wash	4	Insufficient fluidity

(A) P-3, Q-4, R-1, S-2

(B) P-4, Q-3, R-1, S-2

(C) P-2, Q-4, R-1, S-3

(D) P-3, Q-4, R-2, S-1

46. Ans: (A)

Sol: Blow hole $\Rightarrow$ Poor Permeability

Misrun $\Rightarrow$ Insufficient Fluidity

Hot tearing $\Rightarrow$ Poor Collapsibility

Wash $\Rightarrow$ Mold erosion

End of Solution

47. A harmonic function is analytic if it satisfies the Laplace equation. If u(x, y) = $2x^2 - 2y^2 + 4xy$ is a harmonic function, then its conjugate harmonic function v(x, y) is

(A) $-4xy + 2y^2 - 2x^2$ + constant
(B) $4xy - 2x^2 + 2y^2$ + constant
(C) $4y^2 - 4xy$ + constant
(D) $2x^2 - 2y^2 + xy$ + constant

47. Ans: (B)

Sol: Given u(x, y) = $2x^2 - 2y^2 + 4xy$

$$\frac{\partial u}{\partial x} = 4x + 4y, \frac{\partial u}{\partial y} = -4y + 4x$$

By C-R equations $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ & $\frac{\partial u}{\partial y} = \frac{-\partial v}{\partial x}$

$$\therefore \frac{\partial v}{\partial x} = \frac{-\partial u}{\partial y} = 4y - 4x \text{ ------ (1)}$$

$$\frac{\partial v}{\partial y} = \frac{\partial u}{\partial x} = 4x + 4y \text{ ----------(2)}$$

From (1), $V = \int (4y - 4x)dx + k(y)$

$V = 4xy - 2x^2 + K(y)$ ------- (4)

$$\therefore \frac{\partial v}{\partial y} = 4x + \frac{d}{dy}k(y) \text{ --------- (3)}$$

From (2) & (3), $\frac{d}{dy}k(y) = 4y$

$$\int \frac{d}{dy}k(y)dy = \int 4ydy$$

$K(y) = 2y^2 + C$

while C is arbitrary real constant.

$\therefore$ Conjugate harmonic of u is

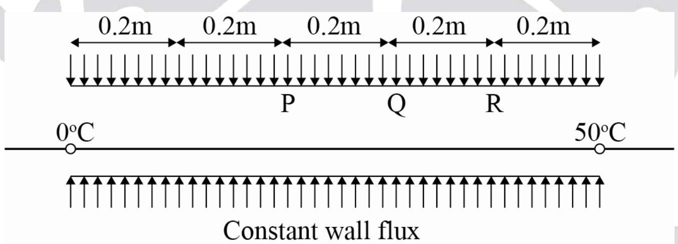
$V = 4xy - 2x^2 + 2y^2 + C$

Hence, option (B) is correct.

End of Solution

48. The wall of a constant diameter pipe of length 1 m is heated uniformly with flux q'' by wrapping a heater coil around it. The flow at the inlet to the pipe is hydrodynamically fully developed. The fluid is incompressible and the flow is assumed to be laminar and steady all through the pipe. The bulk temperature of the fluid is equal to 0^oC at the inlet and 50^oC at the exit. The wall temperatures are measured at three locations, P, Q and R, as shown in the figure. The flow thermally develops after some distance from the inlet. The following measurements are made :

Point	P	Q	R
Wall Temp (^oC)	50	80	90



Among the locations P, Q and R, the flow is thermally developed at

(A) P, Q and R

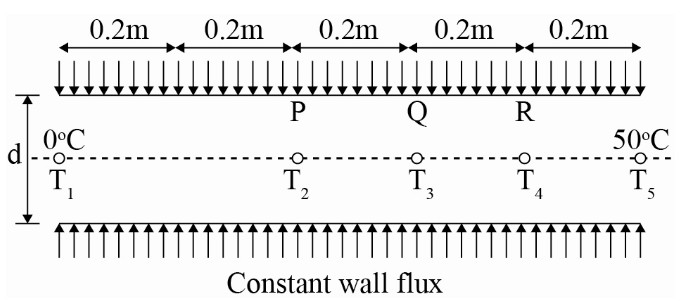
(B) P and Q only

(C) R only

(D) Q and R only

48. Ans: (D)

Sol:



Energy balance: between points 1 and 5 :

$$\dot{q}\times\pi d\times L=\dot{m}c_p(T_s-T_i)$$

$$\dot{q}\times\pi\times d\times 1=50\dot{m}c_p$$

$$\dot{q}=\frac{50\dot{m}c_p}{\pi d}$$

Similarly,

Energy balance between points 1 and 2 :

$$\dot{m}c_p(T_2-T_1)=\dot{q}\times\pi\times d\times 0.4$$

$$\dot{m}\times c_p\times(T_2-0)=\frac{50\dot{m}c_p}{\pi d}\times\pi d\times 0.4$$

T_2 = 20°C

Energy balance between points 1 and 3:

$$\dot{m}c_p(T_3-T_1)=\dot{q}\times\pi\times d\times 0.6$$

$$\dot{m}\times c_p\times(T_3-0)=\frac{50\dot{m}c_p}{\pi d}\times\pi d\times 0.6$$

T_3 = 30°C

Energy balance between points 1 and 4 :

$$\dot{m}c_p(T_4-T_1)=\dot{q}\times\pi\times d\times 0.8$$

$$\dot{m}\times c_p\times(T_4-0)=\frac{50\dot{m}c_p}{\pi d}\times\pi d\times 0.8$$

T_4 = 40°C

In constant heat flux condition :

Nu = 4.36 (constant)

$$\frac{hd}{k}=4.36$$

$h=4.36\dfrac{k}{d}$ = constant (because k and d are constant)

Heat flux $q = h\,\Delta T$

q = constant

h = constant

that means, ΔT = constant (for steady and fully developed flow).

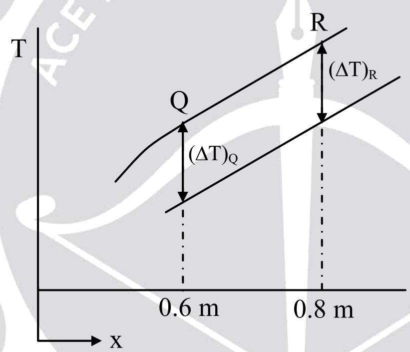
$(\Delta T)_P = T_p - T_2 = 50 - 20 = 30°C$

$(\Delta T)_Q = T_Q - T_3 = 80 - 30 = 50°C$

$(\Delta T)_R = T_R - T_4 = 90 - 40 = 50°C$

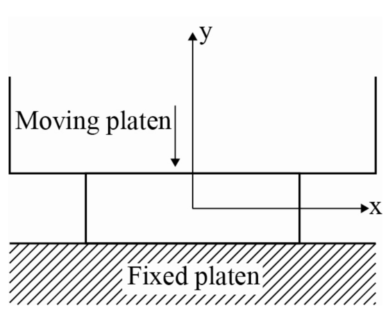
$(\Delta T)_Q = (\Delta T)_R = 50°C$

The flow is fully developed at locations Q and R.



End of Solution

49. A plane-strain compression (forging) of a block is shown in the figure. The strain in the z-direction is zero. The yield strength (S_y) in uniaxial tension/compression of the material of the block is 300 MPa and it follows the Tresca (maximum shear stress) criterion. Assume that the entire block has started yielding. At a point where σ_x = 40 MPa (compressive) and τ_{xy} = 0, the stress component σ_y is



(A) 340 MPa (compressive)
(B) 260 MPa (compressive)
(C) 340 MPa (tensile)
(D) 260 MPa (tensile)

49. Ans: (A)

Sol: $\tau_{xy} = 0$

Principal Stress, $\sigma_z = \dfrac{\sigma_x + \sigma_y}{2}$

$\therefore \sigma_x = \sigma_{max}, \sigma_y = \sigma_{min}$

$\therefore \sigma_x - \sigma_y = \sigma_0$

$-40 - \sigma_y = 300$

$\Rightarrow \sigma_y = -340\,MPa = 340\,MPa\,(Compression)$

End of Solution

50. At a critical point in a component, the state of stress is given as σ_{xx} = 100 MPa, σ_{xy} = 220 MPa, $\sigma_{xy} = \sigma_{yx}$ = 80 MPa and all other stress components are zero. The yield strength of the material is 468 MPa. The factor of safety on the basis of maximum shear stress theory is ________ (round off to one decimal place).

50. Ans: 1.78

Sol: $\sigma_x = 100\,MPa,\ \sigma_{yy} = 220\,MPa,\ \tau_{xzy} = 80\,MPa$

$S_{yt} = 468\,MPa$, F.S. = ? (MSST)

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2} = \frac{100+220}{2} \pm \sqrt{\left(\frac{100-220}{2}\right)^2 + 80^2}$$

$\sigma_1 = 257.08\,MPa,\ \sigma_2 = 62.9\,MPa,\ \sigma_3 = 0$

According to maximum shear stress theory,

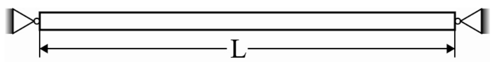
$$\tau_{max} = \frac{S_{yt}}{2 \times FS} = Max\left[\left|\frac{\sigma_1 - \sigma_2}{2}\right|, \left|\frac{\sigma_1}{2}\right|, \left|\frac{\sigma_2}{2}\right|\right]$$

$$\tau_{max} = \frac{257.08}{2} = 128.54\,MPa$$

$$128.54 = \frac{468}{2 \times FS}$$

FS = 1.78

51. Consider a prismatic straight beam of length L = π m, pinned at the two ends as shown in the figure. The beam has a square cross-section of side p = 6 mm. The Young's modulus E = 200 GPa, and the coefficient of thermal expansion $\alpha = 3 \times 10^{-6}\ K^{-1}$. The minimum temperature rise required to cause Euler buckling of the beam is ___________ K.



51. Ans: 1

Sol: L= π m

side = 6 mm,

E = 200 GPa,

$\alpha = 3\times10^{-6}$ K

Thermal thrust due to restricted expansion,

$P = (\sigma_{th})A = (E\ \alpha\ t)\ A$

Euler buckling load, $P_e = \dfrac{\pi^2 EI_{min}}{L_c^2}$

For hinged ends, $L_c = L$

$$\therefore\ Pe = \frac{\pi^2 E \dfrac{a^4}{12}}{L^2}$$

Condition for buckling, $P = P_e$

$$(E\alpha t)A = \frac{\pi^2 E}{L^2}\frac{a^4}{12}$$

$$(\alpha t)a^2 = \frac{\pi^2 a^4}{12L^2}$$

$$t = \frac{1}{\alpha}\times\frac{\pi^2 a^2}{12L^2}$$

$$= \frac{1}{3\times10^{-6}}\times\frac{\pi^2\times6^2}{12(\pi\times1000)^2}$$

t = 1°K

P

52. The rotor of a turbojet engine of an aircraft has a mass 180 kg and polar moment of inertia 10 $kg.m^2$ about the rotor axis. The rotor rotates at a constant speed of 1100 rad/s in the clockwise direction when viewed from the front of the aircraft. The aircraft while flying at a speed of 800 km per hour takes a turn with a radius of 1.5 km to the left. The gyroscopic moment exerted by the rotor on the aircraft structure and the direction of motion of the nose when the aircraft turns, are

(A) 162.9 N-m and the nose goes up

(B) 1629.6 N-m and nose goes up

(C) 162.9 N and the nose goes down

(D) 1629.6 N-m and the nose goes down

52. Ans: (D)

Sol: mass of rotor = 180 kg

$I = 10\ kg\text{-}m^2$

$\omega_s = 1100$ rad/s

v = 800 kmph

R = 1.5 km

	Axis	
Spin	+x	$+\hat{i}$
Precession	+y	$+\hat{j}$
Gyroscopic Reaction	+z	$+\hat{k}$

$I = I\omega_S\omega_p = 1629.62$ N-m

Nose goes down

End of Solution

53. Five jobs (J1, J2, J3, J4 and J5) need to be processed in a factory. Each job can be assigned to any of the five different machines (M1, M2, M3, M4 and M5). The time durations taken (in minutes) by the machines for each of the jobs, are given in the table. However, each job is assigned to a specific machine in such a way that the total processing time is minimum. The total processing time is _________ minutes.

	M1	M2	M3	M4	M5
J1	40	30	50	50	58
J2	26	38	60	26	38
J3	40	34	28	24	30
J4	28	40	40	32	48
J5	28	32	38	22	44

End of Solution

53. Ans: 146

Sol: Assignment model:

	M1	M2	M3	M4	M5	Row min
J1	40	30	50	50	58	30
J2	26	38	60	26	38	26
J3	40	34	28	24	30	24
J4	28	40	40	32	48	28
J5	28	32	38	22	44	22

	10	0	20	20	28
	0	12	34	0	12
	16	10	4	0	6
	0	12	12	4	20
	6	10	16	0	22
Column min	0	0	4	0	6

10	0	16	20	22
$\cancel{0}$	12	30	$\cancel{0}$	6
16	10	0	$\cancel{0}$	$\cancel{0}$
$\boxed{0}$	12	8	4	14
6	10	12	0	16

$\Rightarrow$

16	$\boxed{0}$	16	26	22
$\cancel{0}$	6	24	$\cancel{0}$	$\boxed{0}$
22	10	$\boxed{0}$	6	$\cancel{0}$
$\boxed{0}$	6	2	4	8
6	4	6	$\boxed{0}$	10

Optimal Assignment

$J_1 - M_2 = 30$

$J_2 - M_5 = 38$

$J_3 - M_3 = 28$

$J_4 - M_1 = 28$

$J_5 - M_4 = 22$

Minimum time = 30+38+28+28+22= 146

End of Solution

54. The variable x takes a value between 0 and 10 with uniform probability distribution. The variable y takes a value between 0 and 20 with uniform probability distribution. The probability of the sum of variables (x + y) being greater than 20 is

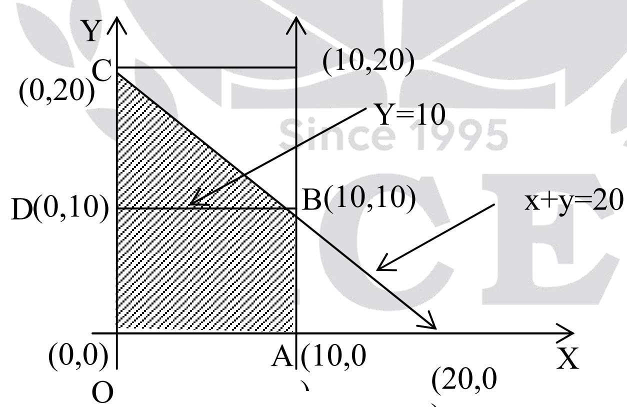
(A) 0.50 (B) 0

(C) 0.33 (D) 0.25

54. Ans: (D)

Sol: X is uniformly distributed in (0, 10)

Y is uniformly distributed in (0, 20)



$P(x + y > 20) = 1 - p(x + y \leq 20)$

$$= 1 - \left\{\frac{\text{Area of OABD}}{\text{Area of OAEC}} + \frac{\text{Area of BCD}}{\text{Area of OAEC}}\right\}$$

$$= 1 - \left\{ \left(\frac{10 \times 10}{10 \times 20} \right) + \frac{\left(\frac{1}{2} \right)(10)(10)}{(10)(20)} \right\}$$

$$= 1 - \left\{ \left(\frac{1}{2} \right) + \frac{1}{4} \right\}$$

$$= 1 - \frac{3}{4}$$

$$= \frac{1}{4}$$

$= 0.25$

End of Solution

55. Taylor's tool life equation is given $VT^n = C$, where V is in m/min and T is in min. In a turning operation, two tools X and Y are used. For tool X, n = 0.3 and C = 60 and for tool Y, n = 0.6 and C = 90. Both the tools will have the same tool life for the cutting speed (in m/min, round off to one decimal place) of _________.

55. Ans: 40

Sol: $V_x T_x^{0.3} = 60$ -------- (1)

$V_Y T_Y^{0.6} = 90$ -------- (2)

Diving (2) by (1)

$T_0^{0.3} = 1.5$

$\Rightarrow T_0 = (1.5)^{1/0.3} = 3.85$

$\Rightarrow V_0 \times (3.85)^{0.3} = 60 \Rightarrow V_0 = 40$ m/min