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GATE - 2021

Questions with Detailed Solutions

MECHANICAL ENGINEERING

(Afternoon Session)

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GATE - 2021
MECHANICAL ENGINEERING
Questions Weightage

14/02/2021
Afternoon
Session

SUBJECT-WISE WEIGHTAGE

S. No.	NAME OF THE SUBJECT	No. of QUESTIONS
01	Engineering Mechanics	3
02	Fluid Mechanics & Turbomachinery	8
03	Heat Transfer	3
04	Theory of Machines	6
05	Thermal Engineering	5
06	Strength of materials	4
07	Machine Design	2
08	IM & OR	4
09	Production Technology	9
10	Material Science	2
11	Engineering Mathematics	9
12	Verbal Ability	3
13	Numerical Ability	7
Total No. of Questions		**65**

Section : General Aptitude

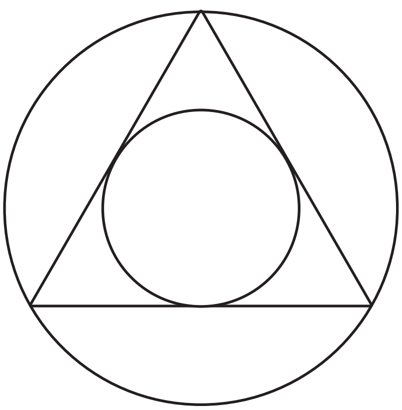
01. The world is going through the worst pandemic in the past hundred years. The air travel industry is facing a crisis, as the resulting quarantine requirement for travelers led to weak demand.
In relation to the first sentence above, what does the second do ?
(a) Second sentence entirely contradicts the first sentence.
(b) The two statements are unrelated.
(c) States an effect of the first sentence.
(d) Restates an idea from the first sentence.

Ans: (c)

Sol: Due to worst pandemic the air travel industry is facing a crisis is nothing but restating the idea from the first sentence.

02. Consider a sqare sheet of side 1 unit. The sheet is first folded along the main diagonal. This is followed by a fold along its line of symmetry. The resulting folded shape is again folded along its line of symmetry. The area of each face of the final folded shape, in square units, equal to
(a) $\frac{1}{16}$ (b) $\frac{1}{4}$
(c) $\frac{1}{8}$ (d) $\frac{1}{32}$

Ans: (c)

03.


The ratio of the area of the inscribed circle to the area of the circumscribed circle of an equilateral triangle is
(a) $\frac{1}{2}$ (b) $\frac{1}{6}$
(c) $\frac{1}{8}$ (d) $\frac{1}{4}$

Ans: (d)

04. The front door of Mr. X's house faces East. Mr. X leaves the house, walking 50 m straight from the back door that is situated directly opposite to the front door. He then turns to his right, walks for another 50 m and stops. The direcion of the point Mr. X is now located at with respect to the starting point is
(a) North-East (b) West
(c) North-West (d) South-East

Ans: (c)

05. Five persons P, Q, R, S and T are to be seated in a row, all facing the same direction, but not necessarily in the same order. P and T cannot be seated at either end of the row. P should not be seated adjacent to S. R is to be seated at the second position from the left end of the row. The number of distinct seating arrangements possible is:
(a) 3 (b) 2 (c) 4 (d) 5

Ans: (a)

06. A box contains 15 blue balls and 45 black balls. If 2 balls are selected randomly, without replacement, the probability of an outcome in which the first selected is a blue ball and the second selected is a black ball, is
(a) $\frac{1}{4}$ (b) $\frac{3}{4}$
(c) $\frac{45}{236}$ (d) $\frac{3}{16}$

Ans: (c)

07. Given below are two statements 1 and 2, and two conclusions I and II.

Statement 1: All entrepreneurs are wealthy.

Statement 2: All wealthy are risk seekers.

Conclusion I: All risk seekers are wealthy.

Conclusion II: Only some entrepreneurs are risk seekers.

Based on the above statements and conclusions, which one of the following options is CORRECT?

(a) Only conclusion II is correct

(b) Both conclusions I and II are correct

(c) Only conclusion I is correct

(d) Neither conclusion I nor II is correct

Ans: (d)

08. Consider the following sentences:

(i) The number of candidates who appear for the GATE examination is staggering.

(ii) A number of candidates from my class are appearing for the GATE examination

(iii) The number of candidates who appear for the GATE examination are staggering.

(iv) A number of candidates from my class is appearing for the GATE examination.

Which of the above sentences are grammatically CORRECT?

(a) (i) and (iii) (b) (i) and (ii)

(c) (ii) and (iii) (d) (ii) and (iv)

Ans: (b)

Sol: Subject verb agreement.

The number ..... is

A number ...... are

09. A digital watch X beeps every 30 seconds while watch Y beeps every 32 seconds. They beeped together at 10 AM. The immediate next time that they will beep together is

(a) 10.42 AM (b) 10.08 AM

(c) 10.00 PM (d) 11.00 AM

Ans: (b)

10. If $\oplus \div \odot = 2$; $\oplus \div \Delta = 3$; $\odot + \Delta = 5$; $\Delta \times \otimes = 10$; Then, the value of $(\otimes - \oplus)$, is

(a) 0 (b) 16

(c) 4 (d) 1

Ans: (d)

Section : MECHANICAL ENGINEERING

01. A vertical shaft Francis turbine rotates at 300 rpm. The available head at the inlet to the turbine is 200 m. The tip speed of the rotor is 40 m/s. Water leaves the runner of the turbine without whirl. Velocity at the exit of the draft tube is 3.5 m/s. The head losses in different components of the turbine are: (i) stator and guide vanes: 5.0 m. (ii) rotor: 10 m, and (iii) draft tube: 2 m. Flow rate through the turbine is 20 m^3/s. Take $g = 9.8\ m/s^2$. The hydraulic efficiency of the turbine is _______% (round off to one decimal place).

01. Ans: (91.5)

Sol: Given data:

$N = 300$ rpm, $\quad H_{inlet} = 20$ m,

Velocity at exit of draft tube = 3.5 m/s

$(h_L)_{stator} = 5$ m,

$(h_L)_{rotor} = 10$ m, $\quad (h_L)_{draft\ tube} = 2$ m

Net head = Head inlet – Velocity head at exit of draft tube.

$$= 200 - \frac{3.5^2}{2 \times 9.8}$$

$$= 199.315 \text{ m}$$

Theoritical head developed by turbine,

i.e. Euler's head (H_e) is given by

H_e = Net head – losses in turbine and draft tube

$$= 199.375 - (5 + 10 + 2)$$

$$= 182.375$$

The hydraulic efficiency (η_h) is given by,

$$\eta_h = \frac{H_e}{H} = \frac{182.375}{199.375} = 91.5\%$$

02. In forced convection heat transfer. Stanton number (St), Nusselt number (Nu). Reynolds number (Re) and Prandtl number (Pr) are related as

(a) $St = \frac{Nu\ \ Pr}{Re}$ (b) $St = \frac{Nu}{Re\ \ Pr}$

(c) $St = Nu\ \ Pr\ \ Re$ (d) $St = \frac{Nu\ \ Re}{Pr}$

02. Ans: (b)

Sol: Stanton number is ratio of rate of heat transfer due to convection to the rate of energy storage

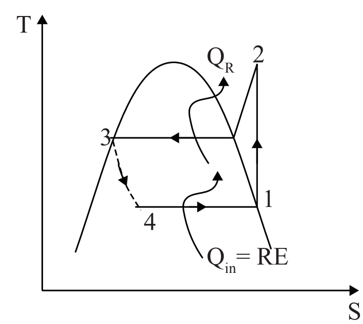
$$St = \frac{\dot{Q}_{conv}}{\dot{Q}_{storage}} = \frac{h}{\rho V c_p}$$

$$St = \frac{Nu}{Re \times Pr} = \frac{hL/k}{\frac{\rho VL}{\mu} \times \frac{\mu c_p}{k}} = \frac{h}{\rho V c_p}$$

03. Consider an ideal vapour compression refrigeration cycle working on R-134a refrigerant. The COP of the cycle is 10 and the refrigeration capacity is 150 kJ/kg. The heat rejected by the refrigerant in the condenser is _____ kJ/kg(round off to the nearest integer).

03. Ans: (165)

Sol: Given:



$(COP)_R = 10$

Refrigerating effect = 150 kJ/kg

$$(COP)_R = \frac{RE}{W_{in}}$$

$$10 = \frac{150}{W_{in}} \therefore W_{in} = 15 \text{ kJ/kg}$$

$$W_{in} = 15 = Q_R - Q_{in} = Q_R - 150$$

$$\therefore Q_R = 165 \text{ kJ/kg}$$

04. Ambient pressure, temperature, and relative humidity at a location are 101 kPa, 300 K, and 60%, respectively. The saturation pressure of water at 300 K is 3.6 kPa. The specific humidity of ambient air is _____g/kg of dry air.

(a) 21.9 (b) 21.4
(c) 13.6 (d) 35.1

04. Ans: (c)

Sol: $\phi = 0.6 = \frac{P_V}{P_{VS}}$

$$0.6 = \frac{P_V}{3.6}$$

$P_V = 2.16$ kPa

$$\omega = 0.622\frac{P_V}{P_t - P_V}$$

$$= 0.622\frac{2.16}{101 - 2.16}$$

= 0.0136 kg at vapour/kg of dry air
= 13.6 g of vapour/kg of dry air

05. Which of the following is responsible for eddy viscosity (or turbulent viscosity) in a turbulent boundary layer on a flat plate?

(a) Nikuradse stresses (b) Prandtl stresses
(c) Reynolds stresses (d) Boussinesq stresses

05. Ans: (c)

Sol: Reynolds stresses are responsible for eddy viscosity

$$\tau_{Reynolds} = \eta\frac{\partial \bar{u}}{\partial y}$$

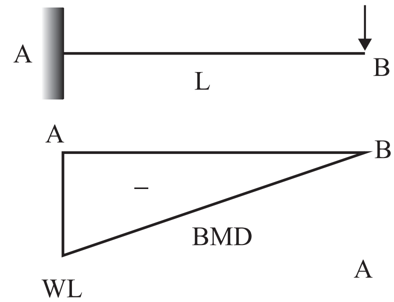
where η = Eddy viscosity

06. A cantilever beam with a uniform flexural rigidity ($EI = 200\times10^6$ N.m) is loaded with a concentrated force at its free end. The area of the bending moment diagram corresponding to the full length of the beam is 10000 N.m². The magnitude of the slope of the beam at its free end is _______ micro radian (round off to the nearest integer).

06. Ans: (50)

Sol: $EI = 200\times10^6$ N-m²

$[A]_{BMD} = 10000$ N-m²



Moment area method :

$$\theta_B - \theta_A = \frac{[[A]_{BMD}]_A^B}{EI}$$

$$\theta_B - 0 = \frac{1000}{200\times10^6} = 50\times10^{-6} \text{ radian}$$

$\theta_B = 50\ \mu$ radians

07. Value of $\int_4^{5.2} \ln\times dx$ using Simpson's one-third rule with interval size 0.3 is

(a) 1.83 (b) 1.06
(c) 1.51 (d) 1.60

07. Ans: (a)

Sol: Let $\int_a^b f(x)dx = \int_4^{5.2} \ln x dx$ and $h = 0.3$

Then $a = 4$, $b = 5.2$, $f(x) = l$nx

x	4	4.3	4.6	4.9	5.2
y=f(x)=*l*nx	1.3862	1.4586	1.5260	1.5892	1.6486
	y_0	y_1	y_2	y_3	y_4

The formula of Simpson's 1/3rd rule t the given data is given by

$$\int_a^b f(x)dx \simeq \int_a^b P(x)dx$$

$$= \frac{h}{3}\left[(y_0 + y_4) + 2(y_2) + 4(y_1 + y_3)\right]$$

$$\Rightarrow \int_4^{5.2} f(x)dx \simeq \int_4^{5.2} P(x)dx$$

$$= \frac{0.3}{3}\left[(1.3862+1.6486)+2(1.5260) + 4(1.4586+1.5892)\right]$$

$$\Rightarrow = \left(\frac{0.3}{3}\right)[(3.0348)+(3.052)+(12.1912)]$$

$$\Rightarrow \left(\frac{0.3}{3}\right)[18.278]$$

$$\therefore \int_4^{5.2} f(x)dx \simeq \int_4^{5.2} P(x) = 1.8278 = 1.83$$

08. A surface grinding operation has been performed on a Cast Iron plate having dimensions 300 mm (length) x 10 mm (width) x 50 mm (height). The grinding was performed using an alumina wheel having a wheel diameter of 150 mm and wheel width of 12 mm. The grinding velocity used is 40 m/s, table speed is 5 m/min, depth of cut per pass is 50 μm and the number of grinding passes is 20. The average tangential and average normal forces for each pass are found to be 40 N and 60 N respectively. The value of the specific grinding energy under the aforesaid grinding conditions is ______ J/mm^3 (round off to one decimal place).

08. Ans: (1.9)

Sol: Given, Surface Grinding,

Cast Iron plate dimension = 300 × 10 × 50 mm^3

Alumina wheel diameter (D) = 150 mm

Wheel width (b) = 12 mm

Wheel velocity (V_w) = 40 m/s = 4 × 1000 mm/s

Table speed (V_T) = 5 m/min = $\frac{5\times 1000}{60}$

depth of cut (d) = 50 μm

Number of passes = 20

Average Tangential force (F_t) = 40 N

Normal force (F_N) = 62 N

Specific grinding energy (u) = J/mm^3 ?

$$u = \frac{F_t \times V_w}{V_t \times W \times d}$$

$$= \frac{40\times 40}{\frac{5\times 1000}{60}\times 10\times 10^{-3}\times(50\times 20)}$$

$$= \frac{40\times 40}{833.33}$$

U = 1.92 J/mm^3

09. An object is moving with a Mach number of 0.6 in an ideal gas environment, which is at a temperature of 350 K. The gas constant is 320 J/kg.K and ratio of specific heats is 1.3. The speed of object is ______ m/s (round off to the nearest integer).

09. Ans: (229)

Sol: Given data: Ma = 0.6, T = 350 K

R = 320 J/kg.K, γ = 1.3

$$V = C.Ma$$
$$= \sqrt{\gamma RT}.Ma$$
$$= \sqrt{1.3\times 320\times 350}\times 0.6$$
$$= 228.95$$
$$= 229 \text{ m/s}$$

10. If the Laplace transform of a function f(t) is given by $\frac{s+3}{(s+1)(s+2)}$, then f(0) is

(a) 0 (b) 1 (c) $\frac{3}{2}$ (d) $\frac{1}{2}$

10. Ans: (b)

Sol: Let $L\{f(t)\} = \bar{f}(s) = \frac{s+3}{(s+1)(s+2)}$

Then $f(t) = L^{-1}\left\{\frac{s+3}{(s+1)(s+2)}\right\}$

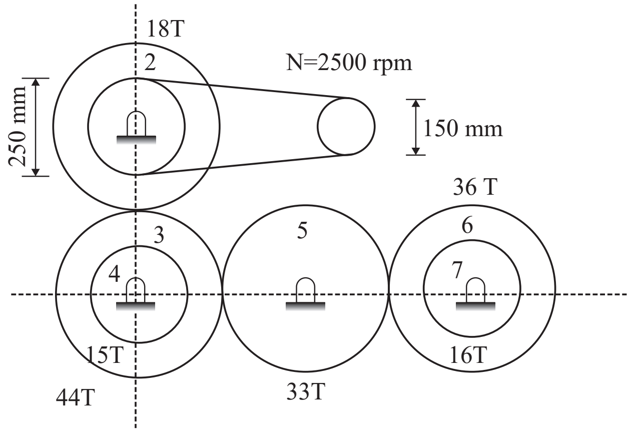
$$\Rightarrow f(t) = L^{-1}\left\{\frac{2}{s+1} - \frac{1}{s+2}\right\}$$

$$\Rightarrow f(t) = 2L^{-1}\left\{\frac{1}{s+1}\right\} - L^{-1}\left\{\frac{1}{s+2}\right\}$$

$\Rightarrow$ f(t) = 2 e^{-t} – e^{-2t}

$\therefore$ f(0) = 2 – 1 = 1

11. A power transmission mechanism consists of a belt drive and a gear train as shown in the figure.



Diameters of pulleys of belt drive and number of teeth (T) on the gears 2 to 7 are indicated in the figure. The speed and direction of rotation of gear 7, respectivley, are

(a) 255.68 rpm, anticlockwise
(b) 575.28 rpm, anticlockwise
(c) 575.28 rpm, clockwise
(d) 255.68 rpm, clockwise

11. Ans: (d)

Sol: Let, the CW direction of motion is taken as positive and counter clockwise as negative.

So, speed of pulley 2

$$\frac{N_2}{N_1} = \frac{D_1}{D_2}$$

$$\Rightarrow \frac{N_2}{2500} = \frac{150}{250}$$

$$\Rightarrow \quad N_2 = 1500 \text{ rpm (CCW)}$$

$$\frac{N_2}{N_7} = \frac{N_2}{N_3} \times \frac{N_3}{N_4} \times \frac{N_4}{N_5} \times \frac{N_5}{N_6} \times \frac{N_6}{N_7}$$

Here, $N_3 = N_4$, $N_6 = N_7$

$$\frac{N_2}{N_7} = \frac{Z_3}{Z_2} \times \frac{Z_5}{Z_4} \times \frac{Z_6}{Z_5}$$

$$\Rightarrow -\frac{1500}{N_7} = (-)\frac{44}{18} \times (-)\frac{33}{15} \times (-)\frac{36}{33}$$

$$\Rightarrow N_7 = 258.88 \text{ rpm (CW)}$$

12. A machine of mass 100 kg is subjected to an external harmonic force with a frequency of 40 rad/s. The designer decides to mount the machine on an isolator to reduce the force transmitted to the foundation. The isolator can be considered as a combination of stiffness (K) and damper (damping factor, ξ) in parallel. The designer has the following four isolators:

1. K = 640 kN/m, $\xi = 0.70$
2. K = 640 kN/m, $\xi = 0.07$
3. K = 22.5 kN/m, $\xi = 0.70$
4. K = 22.5 kN/m, $\xi = 0.07$

Arrange the isolators in the ascending order of the force transmitted to the foundation.

(a) 1-3-4-2 (b) 1-3-2-4
(c) 4-3-1-2 (d) 3-1-2-4

12. Ans: (c)

Sol: Given data, m = 100 kg, ω = 40 rad/s

(i) $\xi_1 = 0.7$

$$\omega_{n1} = \sqrt{\frac{k_1}{m}} = \sqrt{\frac{640 \times 10^3}{100}} = 80 \text{ rad/s}$$

$$r_1 = \frac{\omega}{\omega_{n1}} = \frac{40}{80} = 0.5$$

(ii) $\xi_2 = 0.07$

$$\omega_{n2} = \sqrt{\frac{k_2}{m}} = \sqrt{\frac{640 \times 10^3}{100}} = 80 \text{ rad/s}$$

$$r_2 = \frac{\omega}{\omega_{n2}} = \frac{40}{80} = 0.5$$

(iii) $\xi_2 = 0.7$

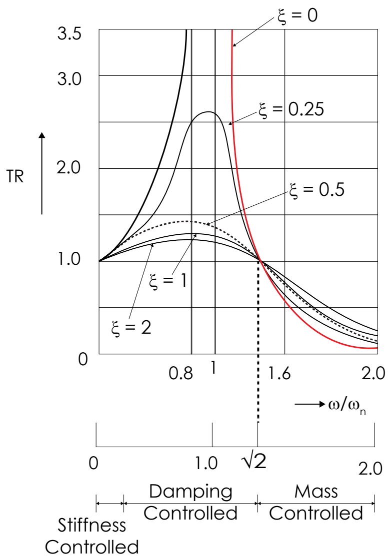
$$\omega_{n3} = \sqrt{\frac{k_3}{m}} = \sqrt{\frac{22.5 \times 10^3}{100}} = 15 \text{ rad/s}$$

$$r_3 = \frac{\omega}{\omega_{n3}} = \frac{40}{15} = 2.66$$

(iv) $\xi_2 = 0.07$

$$\omega_{n4} = \sqrt{\frac{k_4}{m}} = \sqrt{\frac{22.5 \times 10^3}{100}} = 15 \text{ rad/s}$$

$$r_4 = \frac{\omega}{\omega_{n4}} = \frac{40}{15} = 2.66$$



From this above graph,

(1) $0 < \frac{\omega}{\omega_n} < 1$; TR (Symbol) > 1

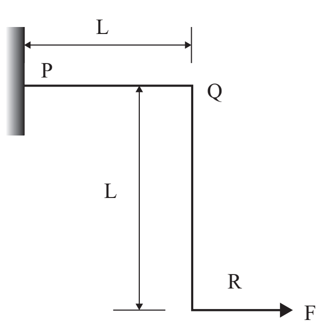
- TR increases when $\frac{\omega}{\omega_n}$ increases.
- TR decreases when ξ increases.

(2) when $\frac{\omega}{\omega_n} > \sqrt{2}$, TR $(\in) < 1$, i.e., the transmitted is always less than the exciting force.

- TR decreases when $\frac{\omega}{\omega_n}$ increases
- TR increases when ξ increases

$\Rightarrow \in_4 < \in_3 < \in_1 < \in_2$

13. A plane frame POR (fixed at P and free at R) is shown in the figure. Both members (PQ and OR) have length, L, and flexural rigidity, EI. Neglecting the effect of axial stress and transverse shear, the horizontal deflection at free end, R, is

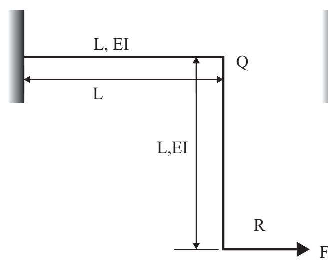


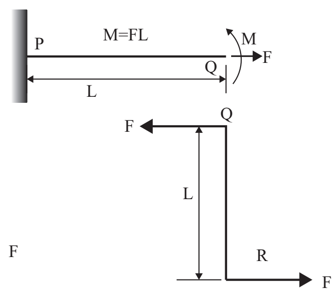
(a) $\frac{5FL^3}{3EI}$ (b) $\frac{2FL^3}{3EI}$

(c) $\frac{4FL^3}{3EI}$ (d) $\frac{FL^3}{3EI}$

13. Ans: (c)

Sol:





Strain Energy method :

$$U = U_{PQ} + U_{QR}$$

$$= \frac{M^2 L}{2EI} + \int_0^L \frac{(M_x)^2 dx}{2EI}$$

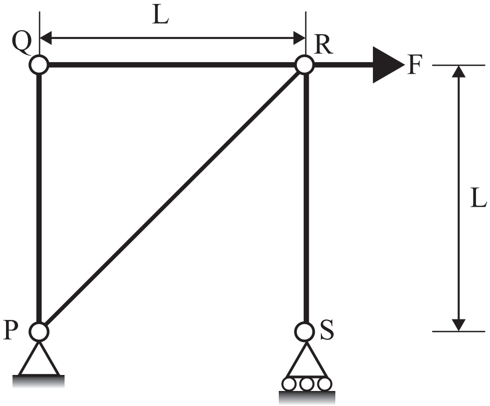
$$= \frac{(FL)^2 L}{2EI} + \int_0^L \frac{(F\,x)^2 dx}{2EI}$$

$$U = \frac{F^2 L^3}{2EI} + \frac{F^2}{2EI}\left[\frac{x^3}{3}\right]_0^L$$

$$= \frac{F^2 L^3}{2EI} + \frac{F^2 L^3}{6EI} = \frac{2F^2 L^3}{3EI}$$

$$(\delta_H)_R = \frac{\partial U}{\partial F} = \frac{4FL^3}{3EI}$$

14. A plane truss PQRS (PQ = RS, and ∠PQR = 90°) is shown in the figure.



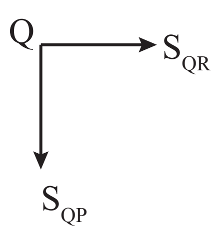
The forces in the members PR and RS, respectivley, are

(a) F (tensile) and $F\sqrt{2}$ (tensile)
(b) F (compressive) and $F\sqrt{2}$ (compressive)
(c) $F\sqrt{2}$ (tensile) and F (tensile)
(d) $F\sqrt{2}$ (tensile) and F (compressive)

14. Ans: (d)

Sol:

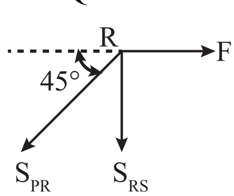
1. FBD of joint Q:



$\Sigma F_x = 0 \Rightarrow S_{QR} = 0$
$\Sigma F_Y = 0 \Rightarrow S_{QP} = 0$

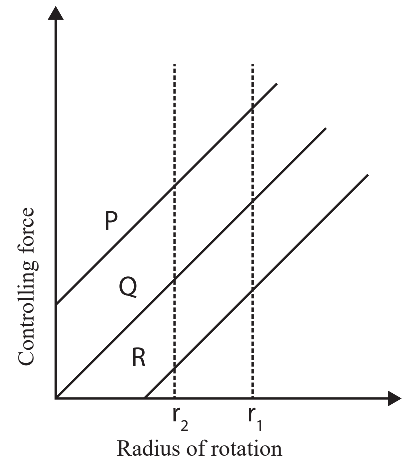
2. FBD of joint R:

i) PQ = QR $\therefore$ ∠QRP = 45°
ii) $S_{QP} = 0$



$\Sigma F_x = 0 \Rightarrow F = S_{PR} \times \cos 45$
$\therefore S_{PR} = \sqrt{2}.F$ {tensile}
$\Sigma F_y = 0 \Rightarrow S_{PR} \sin 45 + S_{RS} = 0$
$\therefore S_{RS} = -F = F$ {compressive}

15. The controlling force curves P, Q and R for a spring controlled governor are shown in the figure, where r_1 and r_2 are any two radii of rotation.

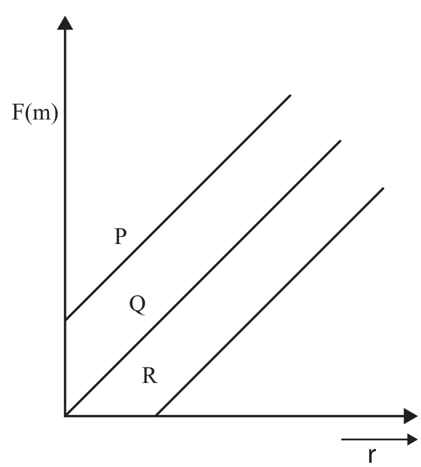


The characteristics shown by the curves are

(a) P - Unstable; Q - Stable; R - Isochronous
(b) P - Unstable; Q - Isochronous; R - Stable
(c) P - Stable; Q - Unstable; R - Isochronous
(d) P- Stable; Q - Isochronous; R - Unstable

15. Ans: (b)

Sol:

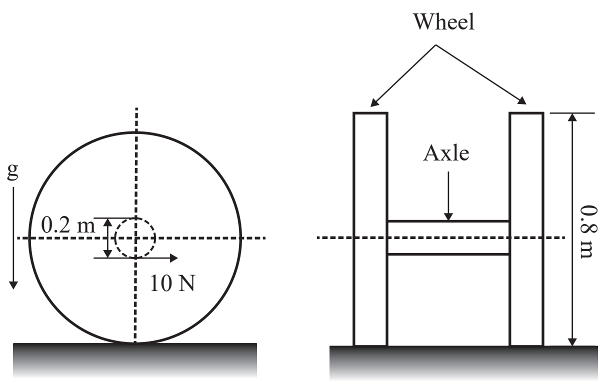


$F(r)|_P = ar + b$ $\rightarrow$ Unstable

$F(r)|_Q = ar$ $\rightarrow$ Isochronous

$F(r)|_R = ar - b$ $\rightarrow$ Stable

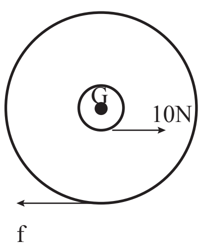
16. The wheels and axle system lying on a rough surface is shown in the figure.



Each wheel has diameter 0.8 m and mass 1 kg. Assume that the mass of the wheel is concentrated at rim and neglect the mass of the spokes. The diameter of axle is 0.2 m and its mass is 1.5 kg. Neglect the moment of inertia of the axle and assume g = 9.8 m/s^2. An effort of 10 N is applied on the axle in the horizontal direction shown at mid span of the axle. Assume that the wheels move on a horizontal surface without slip. The acceleration of the wheel axle system in horizontal direction is ______ m/s^2 (round off to one decimal place).

16. Ans: (5)

Sol:



$I_G = 2 \times (M \times r^2) = 2 \times 1 \times 0.4^2 = 0.32$ kg/m^2

$\Sigma F = m.a$

$\Rightarrow 10 - f = 3.5 \times a$ ...... (i)

$\Sigma T = I.\alpha$

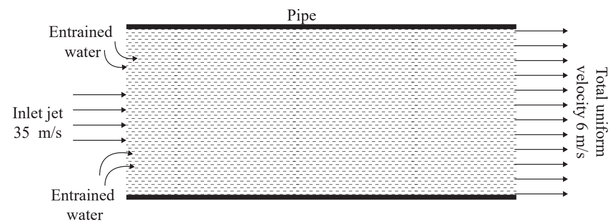
$\Rightarrow 10 \times 0.1 - f \times 0.4 = 0.32 \times \frac{a}{0.4}$ .... (ii)

[As there is no slip $\therefore$ a = rα]

Solving (i) and (ii),

$\therefore$ a = 5 m/s^2

17. A high velocity water jet of cross section area = 0.01 m^2 and velocity = 35 m/s enters a pipe filled with stagnant water. The diameter of the pipe is 0.32 m. This high velocity water jet entrains additional water from the pipe and the total water leaves the pipe with a velocity 6 m/s as shown in the figure.



The flow rate of entrained water is ______ litres/s (round off to two decimal places).

17. Ans: (132.55)

Sol: By Conservation of mass,

$Q_{jet} + Q_{entrained} = Q_{out}$

$\therefore Q_{entrained} = Q_{out} - Q_{jet}$

$= \frac{\pi}{4} \times 0.32 \times 6^2 - 0.01 \times 35$

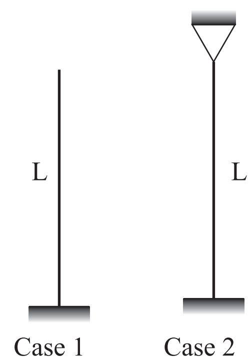
= 0.13255 m^3/s

= 132.55 lit/s

18. A column with one end fixed and one end free has a critical buckling load of 100 N. For the same column, if the free end is replaced with a pinned end then the critical buckling load will be _____ N (round off to the nearest integer).

18. Ans: (800)

Sol:



By using Euler formula,

$$P_e = \frac{\pi^2 EI_{min}}{L_e^2}$$

$(L_e)_1 = (L_e)_{fix\text{-}free} = 2\,L$

$(L_e)_2 = (L_e)_{fix\text{-}hinge} = \frac{L}{\sqrt{2}}$

$$P_e \propto \frac{1}{L_e^2}$$

$$\frac{(P_e)_{fix-hinge}}{(P_e)_{fix-free}} = \left[\frac{(L_e)_1}{(L_e)_1}\right]^2$$

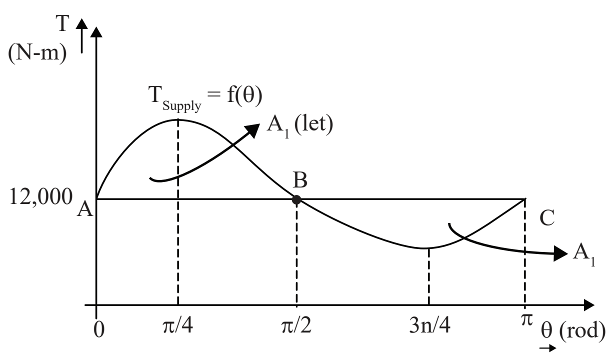
$$(P_e)_{fix-hinge} = \left(\frac{2L}{\frac{L}{\sqrt{2}}}\right)^2 \times 100$$

$(P_e)_{fix\text{-}hinge} = 8 \times 100 = 800$ N

19. The torque provided by an engine is given by $T(\theta) = 12000 + 2500\sin(2\theta)$ N.m, where θ is the angle turned by the crank from inner dead center. The mean speed of the engine is 200 rpm and it drives a machine that provides a constant resisting torque. If variation of the speed from the mean speed is not to exceed ±0.5%, the minimum mass moment of inertia of the flywheel should be _______ kg.m². (round off to the nearest integer).

19. Ans: (570)

Sol:



$T(\theta) = 12000 + 2500\sin 2\theta$ N-m

$N_m = 200$ rpm

$C_s = \pm 0.5$ %

$I = ?$

$C_s = 1\ \% = 0.01$

$T_{resisting}$ = constant (given)

Therefore, $T_{resisting} = T_{mean} = 12000$ N-m

Let,

Energy of flywheel at point A = E_A

Energy of flywheel at point B = E_B

$= E_A + A_1 = E_{max}$

Energy of flywheel at point C = E_C

$= E_A + A_1 - A_1$

$= E_A = E_{min}$

$(\Delta E)_{max} = E_{max} - E_{min}$

$= E_A - E_C$

$= A_1$

$$A_1 = \int_{\theta_A}^{\theta_B} (T_{supply} - T_{mean})\, d\theta$$

$$(\Delta E)_{max} = \int_0^{\pi/2} \{(12000 + 2500\sin 2\theta) - 12000\}\, d\theta$$

$$= \int_0^{\pi/2} 2500\sin 2\theta.\, d\theta$$

$$= 2500\int_0^{\pi/2} \sin 2\theta.\, d\theta$$

$$= 2500\left[\frac{-\cos 2\theta}{2}\right]_0^{\pi/2}$$

$$= 1250[-\cos\pi + \cos 0]$$

$= 1250\ [-(-1) + 1]$

$= 2500$ J

$(\Delta E)_{max} = I\,\omega_m^2\ C_s$

$$\Rightarrow 2500 = I \times \left(\frac{2\pi \times 200}{60}\right)^2 \times 0.01$$

$I = 569.93$ kg-m²

UPCOMING BATCHES @ HYDERABAD

GATE + PSUs – 2022 (REGULAR BATCHES)

Batch Type	Timings	Batch Date	Duration	Venue & Streams
Regular	Daily 4 to 6 Hours	**2nd & 17th April 2021**	5 to 6 Months	Abids (CS&IT) Dilsukhnagar (EC, EE, IN) Kothapet (CE, ME, PI)
		1st & 17th May 2021		
		1st & 17th June 2021		

GATE + PSUs - 2022 (FLEXIBLE BATCHES)

Batch Type	Timings	Batch Date	Duration	Venue & Streams
Flexible Batches	Daily 6 to 8 Hours	**5th, 20th July 2021**	3 to 4 Months	Abids (CS&IT) Dilsukhnagar (EC, EE, IN) Kothapet (CE, ME, PI)
		4th, 18th August 2021		

GATE + PSUs – 2022 (SPARK BATCHES)

Batch Type	Timings	Batch Date	Duration	Venue & Streams
Spark	Daily 5 to 8 Hours	**17th May 2021**	5 to 6 Months	Abids (CE, ME, CS) Kukatpally (EC, EE)
		1st & 17th June 2021		

ESE + GATE + PSUs – 2022 (REGULAR BATCHES)

Batch Type	Timings	Batch Date	Duration	Venue & Streams
Regular	Daily 6 to 8 Hours	**2nd & 17th April 2021**	9 to 10 Months	Kukatpally (EC, EE) Abids (CE, ME)
		1st & 17th May 2021		
		1st & 17th June 2021		

ESE + GATE + PSUs – 2022 (SPARK BATCHES)

Batch Type	Timings	Batch Date	Duration	Venue & Streams
Spark	Daily 6 to 8 Hours	**17th May 2021**	9 to 10 Months	Kukatpally (EC, EE) Abids (CE, ME)
		1st & 17th June 2021		

20. The size distribution of the powder particles used in Powder Metallurgy process can be determined by
(a) Laser penetration
(b) Laser absorption
(c) Laser scattering
(d) Laser reflection

20. Ans: (c)

Sol: Particle Size, Shape, and Distribution:

Particle size is generally controlled by screening, that is, by passing the metal powder through screens (sieves) of various mesh sizes. Several other methods also are available for particle-size analysis:

1. Sedimentation, which involves measuring the rate at which particles settle in a fluid.
2. Microscopic analysis, which may include the use of transmission and scanning- electron microscopy. 3. Light scattering from a laser that illuminates a sample, consisting of particles suspended in a liquid medium; the particles cause the light to be scattered, and a detector then digitizes the signals and computes the particle-size distribution.
4. Optical methods, such as particles blocking a beam of light, in which the particle is sensed by a photocell.
5. Suspending particles in a liquid and detecting particle size and distribution by electrical sensors.

21. The mean and variance, respectively, of a bionomial distribution for n independent trials with the probability of success as p, are
(a) np, np (1 - p)
(b) $\sqrt{np}$, $\sqrt{np(1-p)}$
(c) np, np
(d) $\sqrt{np}$, $np(1-2p)$

21. Ans: (a)

Sol: The Mean of a binomial distribution for n independent trials with the probability of success as p,

$\mu = np$

variance of of a binomial distribution for n independent trials with the probability of success as p,

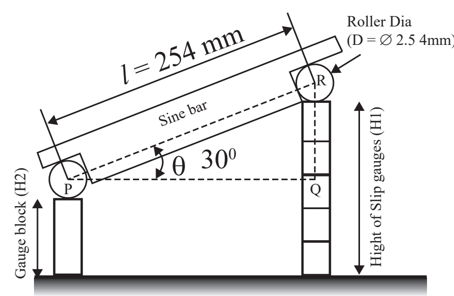
variance = npq = np(1 − p)

22. A 76.2 mm gauge block is used under one end of a 254 mm sine bar with roll diameter of 25.4 mm. The height of gauge blocks required at the other end of the sine bar to measure an angle of 30° is _____ mm (round off to two decimal places).

22. Ans: (203.2)

Sol: Given, $H_2 = 76.2$ mm

$\theta = 30°$



From Triangle PQR

$$\sin\theta = \frac{H_1 - H_2}{\ell}$$

$$\sin 30^\circ = \frac{H_1 - 76.2}{254}$$

The required height of gauge blocks at the other end of sine bar (H_1) = 203.2 mm

23. Consider the following differential equation,

$$(1+y)\frac{dy}{dx} = y$$

The solution of the equation that satisfies the condition $y(1) = 1$ is

(a) $y^2 e^y = e^x$

(b) $2y e^y = e^x + e$

(c) $y e^y = e^x$

(d) $(1 + y) e^y = 2e^x$

23. Ans: (c)

Sol: Given $(1+y)\frac{dy}{dx} = y$ .... (1)

with $y(1) = 1$ ....(2)

New, $\int \frac{1+y}{y} dy = \int dx + c$

$\Rightarrow ln\, y + y = x + c$ .... (3)

Using (2), (3) becomes

$ln\,(1) + 1 = 1 + c$

$\Rightarrow c = 0$ .... (4)

$\therefore$ The solution of (1) from (3) & (4) is

$\ln y + y = x$ (or) $\ln y = x - y$

(or) $y = e^{x-y} = e^x e^{-y}$

(or) $ye^y = e^x$

24. Ambient air flows over a heated slab having flat, top surface at $y = 0$. The local temperature (in Kelvin) profile within the thermal boundary layer is given by $T(y) = 300 + 200 \exp(-5y)$, where y is the distance measured from the slab surface in meters. If the thermal conductivity of air is 1.0 W/m.K and that of the slab is 100 W/m.K, then the magnitude of temperature gradient $|dT/dy|$ within the slab at $y = 0$ is _______ K/m (round off to the nearest integer).

24. Ans: (10)

Sol: Given data:

$k_{air} = k_a = 1$ W/mK

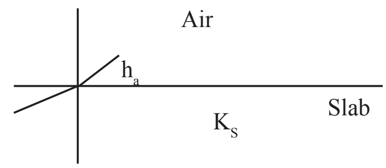
$k_{slab} = k_s = 100$ W/mK

For Air,

$T(y) = 300 + 200 \exp(-5y)$

$$\Rightarrow \frac{\partial T}{\partial y} = 0 + 200 \frac{\partial e^{-5y}}{\partial(-5y)} \times \frac{\partial(-5y)}{\partial y}$$

$$\Rightarrow \left.\frac{\partial T}{\partial y}\right|_{y=0} = -1000 \frac{K}{m}$$



$$-k_s \left.\left.\frac{\partial T}{\partial y}\right)_{y=0}\right|_{slab} = -k_a \left.\left.\frac{\partial T}{\partial y}\right)_{y=0}\right|_{air}$$

$$\Rightarrow -100 \times \left.\frac{\partial T}{\partial y}\right|_{y=0} = -1 \times (-1000)$$

So, magnitude of temperature gradient within the slab at $y = 0$, is

$$\left|\frac{\partial T}{\partial y}\right|_{y=0,\, slab} = 10 \text{ K/m}$$

25. Consider an $n \times n$ matrix A and a non-zero $n \times 1$ vector p. Their product $Ap = \alpha^2 p$, where $\alpha \in \Re$ and $\alpha \notin \{-1, 0, 1\}$. Based on the given information, the eigen value of A^2 is :

(a) α (b) $\sqrt{\alpha}$

(c) α^2 (d) α^4

25. Ans: (d)

Sol: If x is an eigen vector of an $n \times n$ matrix A corresponding to an eigen value λ then $AX = \lambda X$

Replace X by P

i.e $AP = \lambda P$

$\Rightarrow AP = \alpha^2 P$

α^2 is an eigen value of $A_{n\times n}$ matrix

If λ is an eigen value of a matrix $A^2_{n\times n}$ will be λ^2

$\therefore$ The eigen value of a requried matrix $A^2_{n\times n}$ is $(\alpha^2)^2 = \alpha^4$

College Goers Batch for GATE & ESE - 2022 / 2023 @ Hyderabad

Batch Type	Timings	Batch Date	Duration	Venue
Morning, Evening Batches	**6am to 8am** & **6pm to 8:30pm**	20th March 2021	8 to 10 Months	Abids, Dilsukhnagar, Kukatpally.

GATE + PSUs – 2022 & ESE + GATE + PSUs – 2022 @ DELHI

Batch Type	Timings	Batch Date	Duration	Venue
Regular Batches	Daily 5 to 6 Hours	5th March 2021	6 to 7 Months	ACE campus Saket
		7th April 2021		
		15th May 2021		
		5th June 2021		

GATE + PSUs – 2022 & ESE + GATE + PSUs – 2022 @ PUNE

Batch Type	Timings	Batch Date	Duration	Venue
Regular / Weekend Batches	Daily 5 to 6 Hours	20th March 2021	6 to 7 Months	Pune Classroom

GATE + PSUs – 2022 & 2023 @ VIZAG

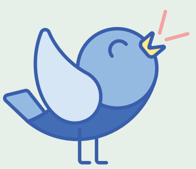
Batch Type	Timings	Batch Date	Duration	Venue
Weekend Batch	Saturday **2 pm to 8 pm** Sunday **9am to 6pm**	3rd April 2021	6 to 7 Months	Vizag Classroom

GATE + PSUs – 2022 & 2023 @ VIJAYAWADA

Batch Type	Timings	Batch Date	Duration	Venue
Weekend Batch	Saturday **2 pm to 8 pm** Sunday **9am to 6pm**	3rd April 2021	6 to 7 Months	Vijayawada Classroom

GATE + PSUs – 2022 @ TIRUPATI

Batch Type	Timings	Batch Date	Duration	Venue
Weekend Batch	Saturday **2 pm to 8 pm** Sunday **9am to 6pm**	20th March 2021	6 to 7 Months	Tirupati Classroom



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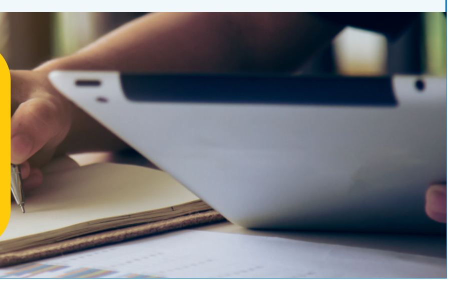
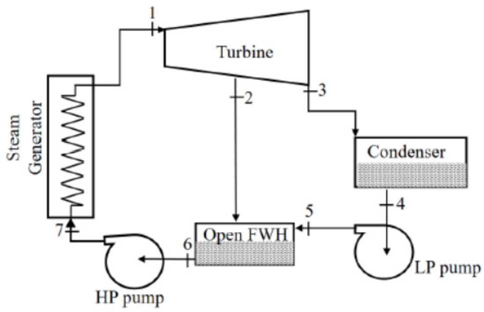


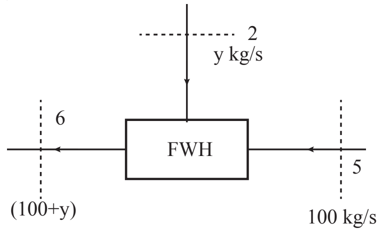
26. Consider the open feed water heater (FWH) shown in the figure given below :



Specific enthalpy of steam at location 2 is 2624 kJ/kg, specific enthalpy of water at location 5 is 226.7 kJ/kg and specific enthalpy of saturated water at location 6 is 708.6 kJ/kg. If the mass flow rate of water entering the open feed water heater (at location 5) is 100 kg/s then the mass flow rate of steam at location 2 will be _______ kg/s (round off to one decimal place).

26. Ans: (25.2)

Sol: Energy balance in open FWH



$\Rightarrow 100\ h_5 + yh_2 = (100+y)h_6$

$100 \times 226.7 + y \times 2624 = (100 + y)708.6$

$22670 + 2624y = 70860 + 708.6\ y$

$1915.4\ y = 48190$

$y = 25.16$ kg/s

27. The machining process that involves ablation is

(a) Abrasive Jet Machining

(b) Chemical Machining

(c) Electrochemical Machining

(d) Laser Beam Machining

27. Ans: (d)

Sol: Laser beam machining (LBM) is a nonconventional machining process, which broadly refers to the process of material removal, accomplished through the interactions between the laser and target materials. The processes can include laser drilling, cutting, grooving, writing, scribing, ablation, welding, cladding, milling, and so on. LBM is a thermal process, and unlike conventional mechanical processes, LBM removes material without mechanical engagement. In general, the workpiece is heated to melting or boiling point and removed by melt ejection, vaporization, or ablation.

28. The demand and forecast of an item for five months are given in the table.

Month	Demand	Forecast
April	225	200
May	220	240
June	285	300
July	290	270
August	250	230

The Mean Absolute Percent Error (MAPE) in the forecast is _______ % (round off to two decimal places).

28. Ans: (8.07)

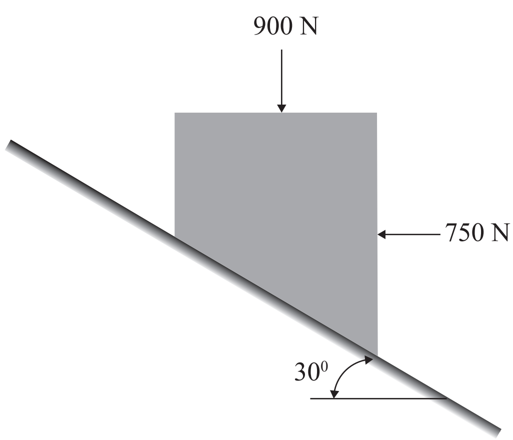
Sol:

month	demand	forecast	|D-F|	$\left\lvert\frac{D-F}{D}\right\rvert$
Apr	225	200	25	$\frac{25}{225} = 0.11$
May	220	240	20	$\frac{20}{220} = 0.09$
June	285	300	15	$\frac{15}{285} = 0.052$
July	290	270	20	$\frac{20}{290} = 0.068$
Aug	250	230	20	$\frac{20}{250} = 0.08$
				$\sum\left\lvert\frac{D-F}{D}\right\rvert = 0.4$

Mean Absolute Percent Error (MAPE) ,

$$\text{MAPE} = \frac{100}{N} \times \sum\left\lvert\frac{D-F}{D}\right\rvert = \frac{100}{5} \times 0.4 = 8\%$$

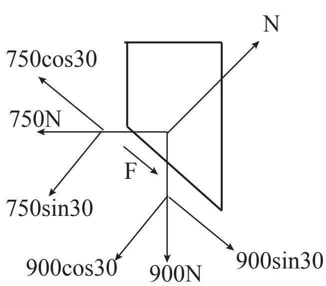
29. A block of negligible mass rests on a surface that is inclined at 30 to the horizontal plane as shown in the figure. When a vertical force of 900 N and a horizontal force of 750 N are applied, the block is just about to slide.



The coefficient of static friction between the block and surface is _______ (round off to two decimal places).

29. Ans: (0.17)

Sol: FBD of block



From FBD,

750 cos 30 > 900 sin 30

∴ Block will try to slide upward

∴ Frictional force on block will be downward

∴ N = 750 sin 30 + 900 cos 30 = 1154.4 (Newton)

& 750 cos 30 – 900 sin 30 = f = μ × N

= μ × 1154.4

∴ μ = 0.1728

30. Consider adiabatic flow of air through a duct. At a given point in the duct, velocity of air is 300 m/s, temperature is 330 K and pressure is 180 kPa. Assume that the air behaves as a perfect gas with constant C_p =1.005 kJ/kg.K. The stagnation temperature at this point is ________ K (round off to two decimal places).

30. Ans: (374.78)

Sol: Given data:

T = 330 K, V = 300 m/s

c_p = 1.005 kJ/kg.K

Let T_o be the stagnation temperature required.

Then,

$$T_0 = T + \frac{V^2}{2c_p} = 330 + \frac{300^2}{2\times 1005} = 374.78\text{ K}$$

31. Let the superscript T respresent the transpose operation. Consider the function

$$f(x) = \frac{1}{2}x^TQx - r^Tx,$$

where x and r are n× 1 vectors and Q is a symmetric n× n matrix. The stationary point of f(x) is

(a) $Q^{-1}r$ (b) $\frac{r}{r^Tr}$

(c) r (d) Q^Tr

31. Ans: (a)

Sol: Given that

$$x \text{ is } n\times 1 \text{ vector} = \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ x_n \end{bmatrix},$$

$$x^T \text{ is } 1\times n \text{ matrix } \begin{bmatrix} x_1 & x_2 & . & . & x_n \end{bmatrix}$$

$$r \text{ is } n\times 1 \text{ vector } \begin{bmatrix} r_1 \\ r_2 \\ . \\ . \\ r_n \end{bmatrix}$$

$$r^T \text{ is } 1\times n \text{ matrix } \begin{bmatrix} r_1 & r_2 & . & . & r_n \end{bmatrix}$$

Q is a symmetric n × n matrix

Let us consider 2 × 2 matrix = $\begin{bmatrix} a & c \\ c & b \end{bmatrix}$

$$f(x) = \frac{1}{2}x^T Qx - r^T x$$

$$F(x) = \frac{1}{2}[x_1\ x_2]\begin{bmatrix} a & c \\ c & b \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} - [r_1\ r_2]\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\left[\frac{1}{2}[ax_1 + cx_2\ \ x_1c + x_2b]\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right] - [r_1\ r_2]\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$f(x_1, x_2) = \frac{1}{2}ax_1^2 + bx_2^2 + cx_1x_2 - r_1x_1 - r_2x_2$$

for stationary point of f(x) is

$$\frac{\partial f(x_1, x_2)}{\partial x_1} = 0 \qquad \frac{\partial f(x_1, x_2)}{\partial x_2} = 0$$

$ax_1 + cx_2 - r_1 = 0$ and $cx_2 + cx_1 - r_2 = 0$

In matrix form we can write it as

$$\begin{bmatrix} a & c \\ c & b \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} r_1 \\ r_2 \end{bmatrix}$$

$Qx = r$

By multiplying both side by Q^{-1}

$x = Q^{-1}r$

32. A cast product of a particular material has dimensions 75 mm x 125 mm x 20 mm. The total solidification time for the cast product is found to be 2.0 minutes as calculated using Chorinov's rule having the index, n = 2. If under the identical casting conditions, the cast product shape is changed to a cylinder having diameter = 50 mm and height = 50 mm, the total solidification time will be _______ minutes (round off to two decimal places).

32. Ans: (2.82)

Sol: Given,

Case 1: Casting 1 product volume

$(V_1) = 75 \times 125 \times 20\ \text{mm}^3$

Solidification time $(\tau_1) = 2.0$ min

Index, n = 2

Case 2: Casting 2 product volume $(V_2) = \frac{\pi}{4}D^2 \times h$

$$(V_2) = \frac{\pi}{4} \times 50^2 \times 50$$

$(\tau_2) = ?$

We know, $\frac{\tau_1}{\tau_2} = \left(\frac{M_1}{M_2}\right)^2$

$$M_1 = \frac{V_1}{A_1} = \frac{75 \times 125 \times 20}{2[(75 \times 125) + (125 \times 20) + (200 \times 75)]}$$

$= 7.0093$

$$M_2 = \frac{V_2}{A_2} = \frac{D}{6} = \frac{50}{6} = 8.333$$

$$\frac{\tau_1}{\tau_2} = \left(\frac{M_1}{M_2}\right)^2 \Rightarrow \frac{2.0}{\tau_2} = \left(\frac{7.0093}{8.33}\right)^2$$

$\tau_2 = 2.377$ min

Solidification time cylinder, $\tau_2 \cong 2.38$ min

33. The allowance provided in between a hole and a shaft is calculated from the difference between

(a) lower limit of the shaft and the upper limit of the hole

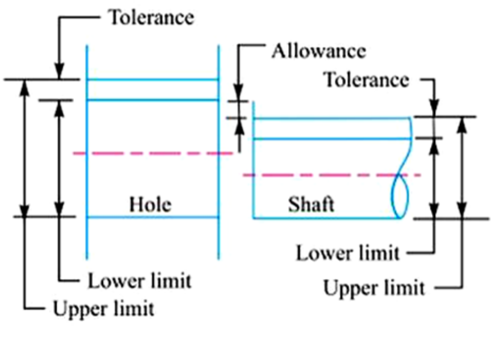
(b) upper limit of the shaft and the upper limit of the hole

(c) lower limit of the shaft and the lower limit of the hole

(d) upper limit of the shaft and the lower limit of the hole

33. Ans: (d)

Sol: **Allowance:** It is the difference between the basic dimensions of the mating parts. When the shaft size is less than the hole size, then the allowance is positive and when the shaft size is greater than the hole size, then the allowance is negative.



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34. For a two-dimensional, incompressible flow having velocity components u and v in the x and y directions, respectively, the expression

$$\frac{\partial(u^2)}{\partial x}+\frac{\partial(uv)}{\partial y}$$

can be simplified to

(a) $u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}$

(b) $2u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}$

(c) $u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}$

(d) $2u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}$

34. Ans: (a)

Sol: The given relation can be expanded as:

Given data: 2-D incompressible flow u and v are functions of x and y

$$\frac{\partial}{\partial x}(u^2)+\frac{\partial}{\partial y}(uv)$$

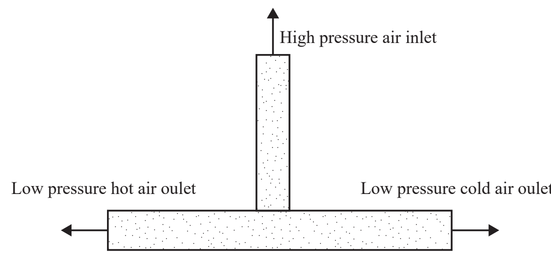
$$=2u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}+v\frac{\partial u}{\partial y}$$

$$=u\left(2\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}\right)+v\frac{\partial u}{\partial y}$$

$$=u\left(\frac{\partial u}{\partial x}+\underbrace{\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}}_{0}\right)+v\frac{\partial u}{\partial y}$$

$$=u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y} \qquad \left\{\begin{array}{l}\because \frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \\ \text{for incompressible flow}\end{array}\right\}$$

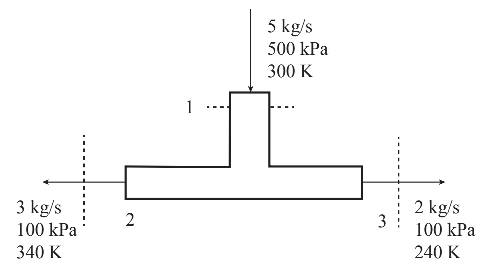
35. An adiabatic vortex tube, shown in the figure given below is supplied with 5 kg/s of air (inlet 1) at 500 kPa and 300 K. Two separate streams of air are leaving the device from outlets 2 and 3. Hot air leaves the device at a rate of 3 kg/s from outlet 2 at 100 kPa and 340 K, while 2 kg/s of cold air stream is leaving the device from outlet 3 at 100 kPa and 240 K.



Consider constant specific heat of air is 1005 J/kg.K and gas constant is 287 J/kg.K. There is no work transfer across the boundary of this device. The rate of entropy generation is _____ kW/K (round off to one decimal place)

35. Ans: (2.2)

Sol:



Given data:

$c_p = 1.005$ kJ/kg.K

$R = 0.287$ kJ/kg.K

$$(\delta s)_{gen} = (ds)_{net} = (ds)_{1\text{-}2} + (ds)_{2\text{-}3}$$

$$= 3\{s_2 - s_1\} + 2\{s_3 - s_1\}$$

for ideal gas (air)

$$= 3\left\{c_p \ell n\frac{T_2}{T_1} - R\ell n\frac{P_2}{P_1}\right\} + 2\left\{c_p \ell n\frac{T_3}{T_1} - R\ell n\frac{P_3}{P_1}\right\}$$

$$= 3\left\{1.005\ell n\frac{340}{300} - 0.287\ell n\frac{100}{500}\right\} + 2\left\{1.005\ell n\frac{240}{300} - 0.287\ell n\frac{100}{500}\right\}$$

$$=3\{0.125789+0.4619\}+2\{-0.22426+0.4619\}$$

$$= 2.238347$$

$$(\delta s)_{gen} = 2.238 \text{ kW/K}$$

36. Find the positive real root of $x^3 - x - 3 = 0$ using Newton-Raphson method. If the starting guess (x_o) is 2, the numerical value of the root after two iterations (x_2) is _______ (round off to two decimal places).

36. Ans: (1.62)

Sol: Let $f(x) = x^3 - x - 3$ and $x_0 = 2$

First iteration:

Here, $f(2) = 2^3 - 2 - 3 = 3$

and $f'(2) = 3(4) - 1 = 11$

Now, $x_1 = x_0 - \dfrac{f(x_0)}{f'(x_0)} = 2 - \left(\dfrac{3}{11}\right)$

$\therefore\ x_1 = 1.73$

Second iteration:

Here, $f(x_1) = f(1.73)$

$= 1.73^3 - 1.73 - 3 = 0.45$

and $f'(x_1) = f'(1.73) = 3(1.73) - 1 = 4.19$

Now, $x_2 = x_1 - \dfrac{f(x_1)}{f'(x_1)} = 1.73 - \left(\dfrac{0.45}{4.19}\right)$

$\Rightarrow x_2 = 1.73 - 0.11$

$\therefore\ x_2 = 1.62$

37. A two dimensional flow has velocities in x and y directions given by $u = 2xyt$ and $v = -y^2 t$, where t denotes time. The equation for streamline passing through $x = 1$, $y = 1$ is

(a) $xy^2 = 1$ (b) $x^2y^2 = 1$

(c) $x/y^2 = 1$ (d) $x^2y = 1$

37. Ans: (a)

Sol: Given data: $u = 2\,xyt$, $v = y^2t$

For streamline, $\dfrac{dx}{u} = \dfrac{dy}{v}$

$$\frac{dx}{2xyt} = \frac{dy}{-y^2t}$$

$$\frac{1}{2}\frac{dx}{x} = -\frac{dy}{y}$$

Integrating the above equation:

$$\frac{1}{2}\int\frac{dx}{x} + \int\frac{dy}{y} = \text{constant}$$

$$\frac{1}{2}\ell nx + \ell ny = \text{constant}$$

$$\ell n\sqrt{x} + \ell ny = \text{constant}$$

or $\ell n\left(\sqrt{x}\,y\right) = \text{constant}$

or $xy^2 = c$

at $x = 1$, $y = 1$

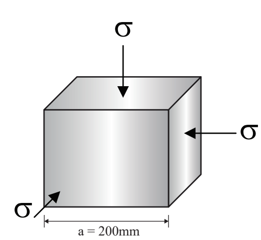
$\therefore\ c = 1 \times 1^2 = 1$

$\therefore\ xy^2 = 1$

38. A steel cubic block of side 200 mm is subjected to hydrostatic pressure of 250 N/mm². The elastic modulus is 2×10^5 N/mm² and Poisson's ratio is 0.3 for steel. The side of the block is reduced by ____ mm (round off to two decimal places).

38. Ans: (0.10)

Sol: $\sigma_x = \sigma_y = \sigma_z = \sigma$



$\sigma = 250$ N/mm², $E = 2\times 10^5$ N/mm², $\mu = 0.3$

$$\varepsilon_x = \frac{\Delta a}{a} = \frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E} - \mu\frac{\sigma_z}{E}$$

$$\frac{\Delta a}{a} = -\frac{\sigma}{E} + \mu\frac{\sigma}{E} + \mu\frac{\sigma}{E}$$

$$\frac{\Delta a}{a} = -\frac{\sigma}{E}(1-2\mu)$$

$$\frac{\Delta a}{a} = -\frac{\sigma}{E}(1-2\mu)a$$

$$= -\frac{250}{2\times 10^5}(1 - 2\times 0.3)\times 200 = -0.10$$

$\Delta a = 0.10$ (decreases)

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39. The von Mises stress at a point in a body subjected to forces is proportional to the square root of the
(a) dilatational strain energy per unit volume
(b) total strain energy per unit volume
(c) distortional strain energy per unit volume
(d) plastic strain energy per unit volume

39. Ans: (c)

Sol: The distortion energy per unit volume is,

$$U_d = \frac{(1+\mu)}{\sigma \times E}\{(\sigma_1-\sigma_2)^2+(\sigma_1-\sigma_3)^2+(\sigma_2-\sigma_3)^2\}$$

and, von-mises stress is,

$$\sigma_{vm} = \sqrt{\frac{1}{2}\{(\sigma_1-\sigma_2)^2+(\sigma_1-\sigma_3)^2+(\sigma_2-\sigma_3)^2\}}$$

$$U_d = \frac{(1+\mu)}{3\times E}\times \sigma_{vm}^2$$

$$U_d \propto (\sigma_{vm})^2$$

40. The thickness, width and length of a metal slab are 50 mm, 250 mm and 3600 mm, respectively. A rolling operation on this slab reduces the thickness by 10% and increases the width by 3%. The length of the rolled slab is ______ mm (round off to one decimal place).

40. Ans: (3883.49)

Sol: Given, $H_0 = 50$ mm,

$W_0 = 250$ mm,

$L_0 = 3600$ mm

$V_0 = V_1 =$ volume remains same

$\therefore H_0\times W_0\times L_0 = H_1\times W_1\times L_1$

$50 \times 250 \times 3600 = 0.9 \times H_0 \times 1.03 \times W_0 \times L_1$

$50 \times 250 \times 3600 = 0.9 \times 50 \times 1.03 \times 250 \times L_1$

$\therefore L_1 = 3883.49$ mm

41. A shell and tube heat exchanger is used as a steam condenser. Coolant water enters the tube at 300 K at a rate of 100 kg/s. The overall heat transfer coefficient is 1500 W/m^{2}K, and total heat transfer area is 400 m^2. Steam condenses at a saturation temperature of 350 K. Assume that the specific heat of coolant water is 4000 J/kg.K. The temperature of the coolant water coming out of the condenser is _____ K (round off to the nearest integer).

41. Ans: (339)

Sol: Given data:

Water (cold fluid)

$T_{c1} = 300$ K

$\dot{m}_c = 100$ kg/s

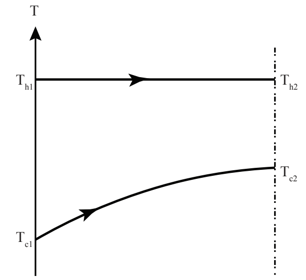
$c_{pc} = 4000$ J/kg.K'

Steam (Hot fluid)

$T_{h1} = T_{h2} = T_h = 350$ K

$C_h = C_{max} = \infty$ (condenser)

$C_c = C_{min} = \dot{m}_c c_{pc} = 100 \times 4000 = 4 \times 10^5$ W/K



$$NTU = \frac{UA}{C_{min}} = \frac{1500\times 400}{4\times 10^5} = 1.5$$

$\varepsilon = 1 - e^{-NTU}$

$= 1 - e^{-1.5} = 0.776$

$$\varepsilon = \frac{\dot{m}_c c_{pc}(T_{c2}-T_{c1})}{C_{min}(T_{h1}-T_{c1})} \quad (\text{as } C_{min} = \dot{m}_c c_{pc})$$

$$\Rightarrow 0.776 = \frac{T_{c2}-300}{350-300}$$

$T_{c2} = 338.8$ K

$T_{c2} = 339$ K

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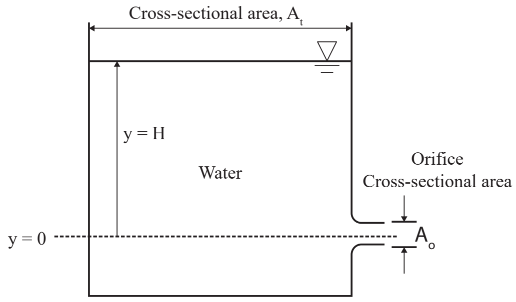
42. Water flows out from a large tank of cross-sectional area A_t = 1 m^2 through a small rounded orifice of cross-sectional area A_o = 1 cm^2, located at y = 0. Initially the water level (H), measured from y = 0, is 1 m. The acceleration due to gravity is 9.8 m/s.



Neglecting any losses, the time taken by water in the tank to reach a level of y = H/4 is _____ seconds (round off to one decimal place).

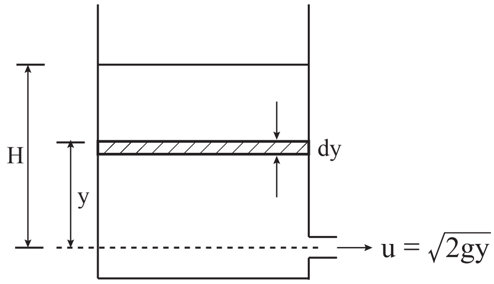
42. Ans: (2258.8)

Sol: Given data:

$A_{tank} = A_t = 1\text{m}^2$

$A_{orifice} = A_o = 1\text{ cm}^2$

H = 1m; g = 9.8 m/s^2



Let 'y' be depth of water at time 't' above the orifice.

$$dt = \frac{d\forall}{Q} = \frac{A_t(-dy)}{A_0 u}$$

$$= -\frac{1dy}{10^4\sqrt{2gy}}$$

$$dt = \frac{-10^4 dy}{\sqrt{2gy}}$$

Negative sign in above equation indicates as time increases y decreases

$$\int_0^T dt = \int_H^{H/4} \frac{-10^4 dy}{\sqrt{2gy}}$$

$$= \frac{-10^4}{\sqrt{2g}} \cdot \int_H^{H/4} \frac{dy}{\sqrt{y}}$$

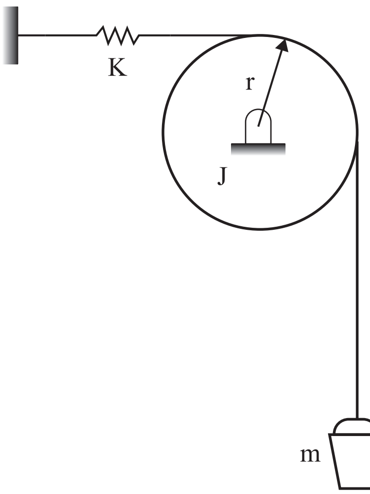
$$= \frac{-10^4}{\sqrt{2g}}\left[2\sqrt{y}\right]_H^{H/4}$$

$$= -\sqrt{\frac{2}{g}} \times 10^4 \left[\sqrt{\frac{H}{4}} - \sqrt{H}\right]$$

$$= -\sqrt{\frac{2}{9.8}} \times 10^4 \left[\sqrt{\frac{1}{4}} - \sqrt{1}\right]$$

= 2258.8 sec

43. Consider the system shown in the figure. A rope goes over a pulley. A mass, m, is hanging from the rope. A spring of stiffness, k, is attached at one end of the rope. Assume rope is inextensible, massless and there is no slip between pulley and rope.



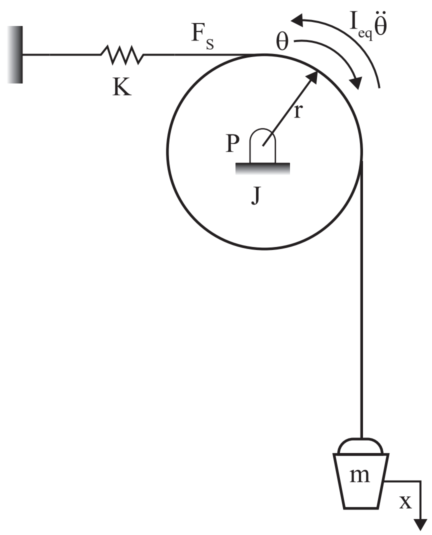
The pulley radius is r and its mass moment of inertia is J. Assume that the mass is vibrating harmonically about its static equilibrium position. The natural frequency of the system is

(a) $\sqrt{\frac{k\,r^2}{J}}$ (b) $\sqrt{\frac{k\,r^2}{J - mr^2}}$

(c) $\sqrt{\frac{k\,r^2}{J + mr^2}}$ (d) $\sqrt{\frac{k}{m}}$

43. Ans: (c)

Sol:



$I_{eq} = I_{pulley} + I_{mass}$

$= J + mr^2$

$x = r\,\theta = x_s$

D-Alembert's principle

Taking moment about pivoted point 'P' (let CCW couples are +ve)

$\because\ I_{eq}\ddot{\theta} + F_s.r = 0$

$\Rightarrow I_{eq}\ddot{\theta} + k\ x_s\ r = 0$

$\Rightarrow I_{eq}\ddot{\theta} + k\ (r\theta)\ r = 0$

$\Rightarrow I_{eq}\ddot{\theta} + k\ (r^2)\ \theta = 0$ equation of motion

$I_{eq}\ddot{\theta} + k_{eq}\theta = 0 \Rightarrow$ governing equation

$I_{eq} = J + mr^2$

$k_{eq} = kr^2$

$$\omega_n = \sqrt{\frac{k_{eq}}{I_{eq}}} = \sqrt{\frac{kr^2}{J + mr^2}}$$

44. The value of $\int_0^{\pi/2}\int_0^{\cos\theta} r\sin\theta\, dr\, d\theta$ is

(a) π (b) $\frac{1}{6}$ (c) 0 (d) $\frac{4}{3}$

44. Ans: (b)

Sol: Let $$I = \int_0^{\pi/2}\left(\int_{r=0}^{\cos\theta} r\sin\theta dr\right)d\theta$$

Then $$I = \int_0^{\pi 2} \sin\theta\left(\frac{r^2}{2}\right)_0^{\cos\theta} d\theta$$

$$\Rightarrow I = \int_0^{\pi/2} \sin\theta.\frac{\left(\cos^2\theta - 0\right)}{2}d\theta$$

$$\Rightarrow I = \left(\frac{1}{-2}\right)\int_0^{\pi/2}\left(\cos\theta\right)^2\left(-\sin\theta\right)d\theta$$

$$\Rightarrow I = \left(\frac{1}{-2}\right)\left[\frac{\left(\cos\theta\right)^3}{3}\right]_0^{\pi/2}$$

$$\Rightarrow I = [0-1]\left(-\frac{1}{6}\right)$$

$$\therefore\ I = -\frac{1}{6}$$

45. A spot welding operation performed on two pieces of steel yielded a nugget with a diameter of 5 mm and a thickness of 1 mm. The welding time was 0.1 s. The melting energy for the steel is 20 J/mm^3. Assuming the heat conversion efficiency as 10%, the power required for performing the spot welding operation is _____ kW (round off to two decimal places).

45. Ans: (39.26)

Sol: Given, Resistance spot welding

Nugget Diameter $\left(D_N\right) = 5$mm

Nugget thickness $\left(h_N\right) = 1$mm

Weld time $\left(\tau\right) = 0.15$

Melting energy $\left(U_m\right) = 20$ J/mm^3

Heat conversion efficiency $\eta_c = 10\% = 0.1$

Required power for spot welding (P) = ?

$$P = I^2R = ?$$

Heat generated $(HG) = I^2R\tau$

Heat required to melt material $(HR) = V \times U$

$= \frac{\pi}{4} \times 5^2 \times 1 \times 20$

$\eta_c = \frac{(HR)}{(HG)} = \frac{HR}{P \times \tau}$

$P = \frac{HR}{\eta \times \tau} = \frac{\frac{\pi}{4} \times 5^2 \times 1 \times 20}{1.0 \times 0.1} = 39269.90 \text{ J/S}$

$P \simeq 39.27 \text{ kW}$

46. A factory produces m (i = 1,2, ..., m) products, each of which requires processing on n (j = 1,2, ..., n) workstations. Let a_{ij} be the amount of processing time that one unit of the i^{th} product requires on the j^{th} workstation. Let the revenue from selling one unit of the i^{th} product be r_i and h_i be the holding cost per unit per time period for the i^{th} product. The planning horizon consists of T (t = 1,2,.., T) time periods. The minimum demand that must be satisfied in time period t is d_{it}, and the capacity of the j^{th} workstation in time period t is c_{jt}. Consider the aggregate planning formulation below, with decision variables S_{it} (amount of product i sold in time period t), X_{it} (amount of product i manufactured in time period t) and I_{it} (amount of product i held in inventory at the end of time period t).

$$\max \sum_{t=1}^{T}\sum_{i=1}^{m}(r_i S_{it} - h_i I_{it})$$

subject to

$S_{it} \geq d_{it} \ \forall i, t$

< capacity constraint >

< inventory balance constraint >

$X_{it}, S_{it}, I_{it} \geq 0 \ ; I_{io} = 0$

The capacity constraints and inventory balance constraints for this formulation respectively are

(a) $\sum_{i}^{m} a_{ij}X_{it} \leq c_{jt} \ \forall\ j,t$ and $I_{it} = I_{i,t-1} + X_{it} - S_{it} \ \forall\ i,t$

(b) $\sum_{i}^{m} a_{ij}X_{it} \leq d_{it} \ \forall\ i,t$ and $I_{it} = I_{i,t-1} + X_{it} - S_{it} \ \forall\ i,t$

(c) $\sum_{i}^{m} a_{ij}X_{it} \leq d_{it} \ \forall\ i,t$ and $I_{it} = I_{i,t-1} + S_{it} - X_{it} \ \forall\ i,t$

(d) $\sum_{i}^{m} a_{ij}X_{it} \leq c_{jt} \ \forall\ i,t$ and $I_{it} = I_{i,t-1} + X_{it} - d_{it} \ \forall\ i,t$

46. Ans: (a)

Sol: J $\rightarrow$ Work station, n $\rightarrow$ Number of work stations

i $\rightarrow$ product, m $\rightarrow$ number of products

Capacity constraint

Time required to produce i^{th} product on j^{th} work station = a_{ij}

Number of units produced in time period 't' = X_{it}

Total number of units produced in time period 't' using j^{th} work station = $\sum_{i}^{m} a_{ij}X_{it}$

j^{th} work station capacity in time period 't' = C_{jt}

$$\sum_{i}^{m} a_{ij}X_{it} \leq C_{jt} \ \forall\ j,t$$

Inventory constaint:

Inventory held at the end of t^{th} period

= Previous inventory + production in 't^{th}' period

+ Total number of units sold out

$I_{i,t} = I_{i,t-1} + X_{i,t} - S_{i,t} \ \forall$ i, t

47. In a CNC machine tool, the function of an interpolator is to generate

(a) signal for the lubrication pump during machining

(b) error signal for tool radius compensation during machining

(c) reference signal prescribing the shape of the part to be machined

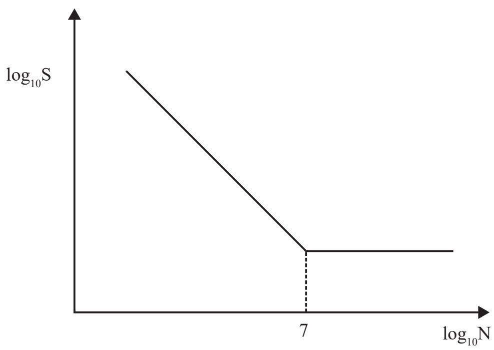
(d) NC code from the part drawing during post processing

47. Ans: (c)

Sol: In contouring systems the machining path is usually constructed from a combination of linear and circular segments. It is only necessary to specify the coordinates of the initial and final points of each segment, and the feedrate. The operation of producing the required shape based on this information is termed interpolation, and the corresponding electronic unit is the interpolator. The interpolator coordinates the motion along the machine axes, which are separately driven, to generate the required machining path.

The two most common types of interpolators found in practice are those providing linear and circular facilities. Parabolic interpolators are also available in a few NC systems which are used in the aircraft industry.

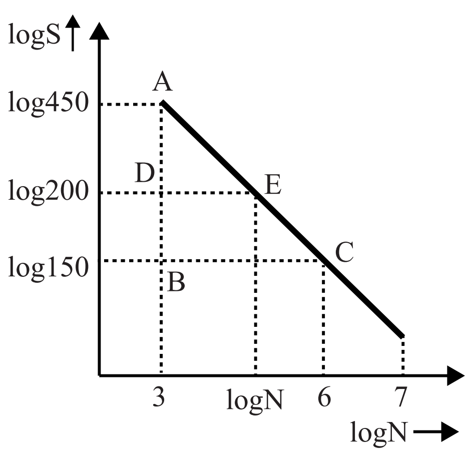
48. The figure shows the relationship between fatigue strength (S′) and fatigue life (N) of a material. The fatigue strength of the material for a life of 1000 cycles is 450 MPa. while its fatigue strength for a life of 10^6 cycles is 150 MPa.



The life of a cylindrical shaft made of this material subjected to an alternating stress of 200 MPa will then be _____ cycles (round off to the nearest integer)

48. Ans: (163840.58)

Sol:



Comparing similar triangles,

ΔABC and ΔADE

$$\frac{AB}{BC} = \frac{AD}{ED}$$

$$\frac{\log 450 - \log 150}{6-3} = \frac{\log 450 - \log 200}{\log N - 3}$$

$\therefore$ N = 163840.58 cycles

49. Daily production capacity of a bearing manufacturing company is 30000 bearings. The daily demand of the bearing is 15000. The holding cost per year of keeping a bearing in the inventory is Rs. 20. The setup cost for the production of a batch is Rs. 1800. Assuming 300 working days in a year. the economic batch quantity in number of bearings is ______ (in integer).

49. Ans: (40250)

Sol: Production (p) = 30,000

Demand (d) = 15000

Inventory cost, C_h = Rs. 20

Setup cost, C_o = Rs. 1800

1 year = 300 days

$D = d \times 300 = 15000 \times 300 = 45 \times 10^5$

Economic batch quantity (EBQ) =

$$EBQ = \sqrt{\frac{2DC_o}{C_h} \times \left(\frac{p}{p-d}\right)}$$

$$= \sqrt{\frac{2 \times 45 \times 10^5 \times 1800}{20 \times 0.5}} = 40250 \text{ units}$$

50. In a pure orthogonal turning by a zero rake angle single point carbide cutting tool, the shear force has been computed to be 400 N. If the cutting velocity, V_c = 100 m/min, depth of cut, t = 2.0 mm, feed, S_o = 0.1 mm/revolution and chip velocity, V_f = 20 m/min, then the shear strength, τ_s of the material will be ______ MPa (round off to two decimal places).

50. Ans: (392.23)

Sol: Given, $\alpha_0 = 0°$

$F_s = 400$ N

$V_c = 100$ m/min

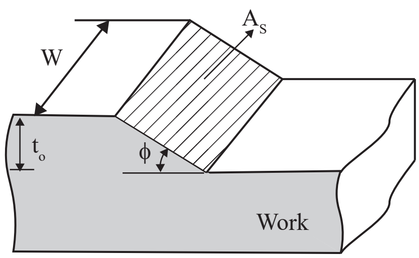
$d = 2.0$ mm

feed (f) = 0.1 mm/rev

$V_f = 20$ m/min

$\tau_s = ?$

$$\tau_s = \frac{F_s}{A_s}$$



As $\alpha_0 = 0°$,

$d = 2$ mm = Width of cut = W

$f = t_0 = 0.1$ mm

Length of shear plane $(L_s) = ?$

$$\therefore \sin\phi = \frac{t_0}{L_s}$$

$$L_s = \frac{t_0}{\sin\phi}$$

$$A_s = L_s \times W$$

$$A_s = \frac{t_0 \times W}{\sin\phi}$$

$$\tau_s = \frac{F_s}{A_s}$$

$$\tau_s = 400\text{N} \times \frac{\sin\phi}{t_0 \times W} = 400 \times \frac{\sin 11.30°}{0.1 \times 2}$$

shear stress

$$\therefore r = \frac{V_f}{V_c} = \frac{20}{100} = 0.2$$

$$\tan\phi = \frac{r\cos\alpha_0}{1 - r\sin\alpha_0} = \frac{0.2 \times \cos 0°}{1 - 0.2\sin 0°}$$

$$\phi = 11.30°$$

$$\tau_s = 392.23 \text{ N/mm}^2$$

51. The Cast Iron which possesses all the carbon in the combined form as cementite is known as

(a) Spheroidal Cast Iron

(b) Malleable Cast Iron

(c) White Cast Iron

(d) Grey Cast Iron

51. Ans: (c)

Sol: On the basis of nature of carbon present in cast iron, it may be divided into white cast iron and gray cast iron.

In the gray cast iron, carbon is present in free form as graphite. Under very slow rate of cooling during solidification, carbon atoms get sufficient time to separate out in pure form as graphite. In addition, certain elements promote decomposition of cementite. Silicon and nickel are two commonly used graphitizing elements.

In white cast iron, carbon is present in the form of combined form as cementite. In normal conditions, carbon has a tendency to combine with iron to form cementite.

52. A PERT network has 9 activities on its critical path. The standard deviation of each activity on the critical path is 3. The standard deviation of the critical path is

(a) 3 (b) 81 (c) 27 (d) 9

52. Ans: (d)

Sol:

$$\sigma_{cp} = \sqrt{3^2+3^2+3^2+3^2+3^2+3^2+3^2+3^2+3^2}$$

$$= \sqrt{9 \times 3^2}$$

$$= \sqrt{9 \times 9}$$

$$= 9$$

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ESE - 2019 TOP RANKERS

ELECTRICAL ENGINEERING

- AIR 1 — KARTIKEYA SINGH
- AIR 2 — SHAMBHAVI T
- AIR 3 — ABHISHEK ANAND
- AIR 4 — ANKIT TAYAL
- AIR 5 — KUMAR MAYANK
- AIR 6 — RITESH LALWANI
- AIR 7 — KARTIKEY SINGH
- AIR 9 — DEEPITA ROY
- AIR 10 — ANKITA SHARMA

ELECTRONICS & TELECOMMUNICATION ENGINEERING

- AIR 1 — RAJAT SONI
- AIR 2 — ANKUSH MANGLA
- AIR 3 — ROHIT KUMAR
- AIR 4 — AMIR KHAN
- AIR 7 — RAHUL JAIN
- AIR 8 — KULDEEP KUMAR
- AIR 9 — SHUBHAM KARNANI
- AIR 10 — GAURAV SRIVASTAVA

MECHANICAL ENGINEERING

- AIR 1 — HARSHAL BHOSALE
- AIR 2 — SAHIL GOYAL
- AIR 3 — KUMAR CHANDAN
- AIR 4 — SAURAV
- AIR 6 — PUSHPAK
- AIR 7 — MANISH RAJPUT
- AIR 8 — HEMANT KUMAR SINGH
- AIR 9 — DWEEP SABAPARA
- AIR 10 — SUMIT BHAMBOO

CIVIL ENGINEERING

- AIR 1 — ABUZAR GAFFARI
- AIR 3 — AMARJEET
- AIR 4 — AMAN GULIA
- AIR 5 — AYUSH CHANDRA
- AIR 6 — KABIL BHARGAVA
- AIR 8 — YOGESH KUMAR
- AIR 9 — ANKIT KUMAR

and many more...

Total Selections in Top 10 — 33

EE : 9	E&T : 8	ME : 9	CE : 7

53. A rigid tank of volume 50 m^3 contains a pure substance as a saturated liquid vapour mixture at 400 kPa. Of the total mass of the mixture, 20% mass is liquid and 80% mass is vapour. Properties at 400 kPa are: Saturation temperature, T_{sat} = 143.61°C; Specific volume of saturated liquid, v_f = 0.001084 m^3/kg; Specific volume of saturated vapour, v_g = 0.46242 m^3/kg. The total mass of liquid vapour mixture in the tank is _______kg (round off to the nearest integer).

53. Ans: (135)

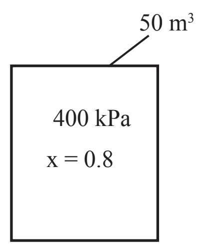
Sol: Given data:

400 kPa

T_{sat} = 143.61°C

v_f = 0.001084 m^3/kg,

v_g = 0.46242 m^3/kg



we know

$V = m\{v_f + x(v_g - v_f)\}$

$50 = m\{0.001084 + 0.8\{0.46242 - 0.001084\}$

m = 135.08 kg

54. Value of $(1+i)^8$, where $i = \sqrt{-1}$, is equal to

(a) 16 (b) 16i

(c) 4i (d) 4

54. Ans: (a)

Sol:

$$(1+i)^8 \quad \Rightarrow 1+i = \frac{\sqrt{2}}{\sqrt{2}}(1+i)$$

$$= \sqrt{2}\left(\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}\right)$$

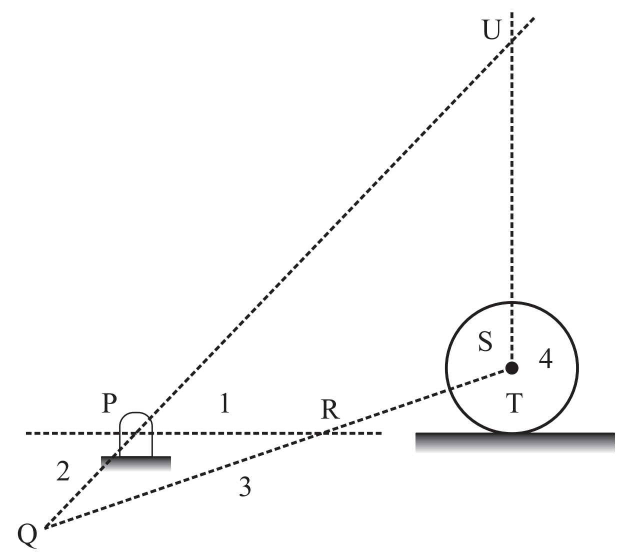
$$= \sqrt{2}\left(\cos\frac{\pi}{4} + i\ \sin\frac{\pi}{4}\right)$$

$$= \left[\sqrt{2}\left(\cos\frac{\pi}{4} + i\ \sin\frac{\pi}{4}\right)\right]^8$$

$$= 2^{8/2}\left[\cos\frac{8\pi}{4} + i\sin\frac{8\pi}{4}\right]$$

$$= 16\,[1 + i\,(0)] = 16$$

55. Consider the mechanism shown in the figure. There is rolling contact without slip between the disc and ground.



Select the correct statement about instantaneous centers in the mechanism.

(a) All points P. Q. R. S. T and U are instantaneous centers of mechanism

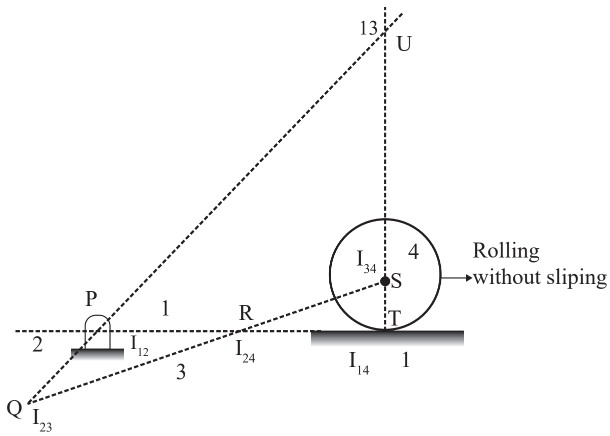
(b) Only points P. Q. R. S, and U are instantaneous centers of mechanism

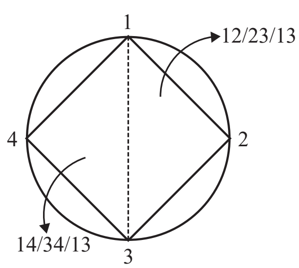
(c) Only points P, Q. S and T are instantaneous centers of mechanism

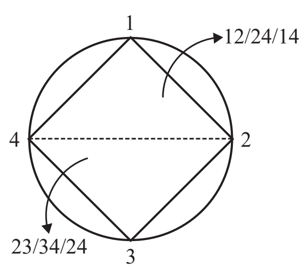
(d) Only points P, Q, and S are instantaneous centers of mechanism

55. Ans: (a)

Sol:







n = 4

No. of instantaneous centers = $\dfrac{4(4-1)}{2} = 6$

All points P, Q, R, S, T and U are I-centers of mechanism.

Hearty Congratulations to our

GATE - 2020 TOP RANKERS

EC

KALPIT AGRAWAL	AIR – 1
PAVAN KUMAR REDDY A	AIR – 1
D SURENDRA KUMAR	AIR – 3
K MUKHESH	AIR – 4
GHANENDRA SINGH	AIR – 6
KV PAVAN KUMAR REDDY	AIR – 7
VELURU APARANJINI	AIR – 9
JYOTSNA PRIYA RAGU	AIR – 10
NISHANT DHULL	AIR – 10

EE

ABHASH RAI	AIR – 1
RUPAM RAJ	AIR – 2
ALIN ANTO	AIR – 4
AYUSH RAJ	AIR – 4
NEERAJ KUSHWAHA	AIR – 6
JATIN TIWARI	AIR – 8
HIMANSHU KUMAR	AIR – 9
NIKHIL KUMAR	AIR – 9
YUVRAJ SINGH RATHORE	AIR – 9

CE

AJAY SINGHAL	AIR – 1
SUMIT DEWDA	AIR – 1
ASHISH CHOUDHARY	AIR – 3
ADITYA SHARMA	AIR – 4
TARUN GUPTA	AIR – 8
SANAT DUTTA	AIR – 9
SATISH RAI	AIR – 10

ME

VIKASH KUMAR	AIR – 1
SHREYASH AGARWAL	AIR – 3
MAYANK GUPTA	AIR – 5
AKSHAY KUTE	AIR – 6
V. V. ATCHUTA SRAVAN KUMAR	AIR – 6
AVINASH VERMA	AIR – 9
VIVEK KUMAR KASHYAP	AIR – 9
NIKHIL GAIKWAD	AIR – 4 (XE)
APURVA KRISHNA YADAV	AIR – 7 (XE)
SHASHI BHUSHAN	AIR – 7 (XE)
SANKET BHATT	AIR – 10 (XE)

CS

HITESH POPLY	AIR – 1
HIMANSHU JAIN	AIR – 3
AVINASH KRISHNA	AIR – 5
ARAVIND G	AIR – 6
PHANI MADHUSUDHAN	AIR – 7
ASHISH KUMAR	AIR – 8
KARAN GUPTA	AIR – 9

IN

KRISHNA SINGH RAJPUT	AIR – 1
SHAKTI PATHAK	AIR – 3
SIDDHARTHA SINHA ROY	AIR – 5
AKASH CHOTIA	AIR – 6
SUSHANTHIKA J	AIR – 7
RIYA ARON	AIR – 10

PI

SURYANSH GARG	AIR – 1
MOHIT JEENA	AIR – 2
PRAVEEN KUMAR	AIR – 2
ROHIT AGARWAL	AIR – 4
ANKIT YADAV	AIR – 6
GOWTHAM GUDIMELLA	AIR – 6
SUBHANSHU RANJAN TIWARI	AIR – 8
GANESH ADIGAUR	AIR – 9
DEEPESH SHARMA	AIR – 10

and many more...

Total Selections in Top 10 — 58

EE : 9	EC : 9	ME:7	CE : 7	CS : 7	IN : 6	PI : 9	XE : 4