ME GATE-10

MCQ 1.1
GATE ME 2010 ONE MARK

The parabolic arc $y = \sqrt{x}$, $1 \le x \le 2$ is revolved around the x-axis. The volume of the solid of revolution is

(A) $\pi/4$
(B) $\pi/2$
(C) $3\pi/4$
(D) $3\pi/2$

SOL 1.1

Option (D) is correct.

We know that the volume of a solid generated by revolution about x-axis bounded by the function $f(x)$ & limits between a to b is given by the equation.

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

Given $\quad y = \sqrt{x}$ & $a = 1$, $b = 2$

Therefore, $\quad V = \int_1^2 \pi(\sqrt{x})^2 dx = \pi\int_1^2 x dx$

On integrating above equation, we get

$$= \pi\left[\frac{x^2}{2}\right]_1^2$$

Substitute the limits, we get

$$V = \pi\left[\frac{4}{2} - \frac{1}{2}\right] = \frac{3\pi}{2}$$

MCQ 1.2
GATE ME 2010 ONE MARK

The Blasius equation, $\frac{d^3 f}{d\eta^3} + \frac{f}{2}\frac{d^2 f}{d\eta^2} = 0$, is a

(A) second order nonlinear ordinary differential equation
(B) third order nonlinear ordinary differential equation
(C) third order linear ordinary differential equation
(D) mixed order nonlinear ordinary differential equation

SOL 1.2

Option (B) is correct.

Given: $\frac{d^3 f}{d\eta^3} + \frac{f}{2}\frac{d^2 f}{d\eta^2} = 0$

Order → It is determined by the order of the highest derivation present in it.

So, It is third order equation but it is a nonlinear equation because in linear equation, the product of f with $d^2f/d\eta^2$ is not allow.
Therefore, it is a third order non-linear ordinary differential equation.

MCQ 1.3 The value of the integral $\int_{-\infty}^{\infty} \frac{dx}{1+x^2}$ is

GATE ME 2010
ONE MARK

(A) $-\pi$ (B) $-\pi/2$

(C) $\pi/2$ (D) π

SOL 1.3 Option (D) is correct.

Let
$$I = \int_{-\infty}^{\infty} \frac{dx}{1+x^2}$$
$$I = [\tan^{-1}x]_{-\infty}^{\infty}$$
$$I = [\tan^{-1}(+\infty) - \tan^{-1}(-\infty)]$$
$$I = \frac{\pi}{2} - \left(-\frac{\pi}{2}\right) = \pi \qquad \tan^{-1}(-\theta) = -\tan^{-1}(\theta)$$

MCQ 1.4 The modulus of the complex number $\left(\frac{3+4i}{1-2i}\right)$ is

GATE ME 2010
ONE MARK

(A) 5 (B) $\sqrt{5}$

(C) $1/\sqrt{5}$ (D) $1/5$

SOL 1.4 Option (B) is correct.

Let,
$$z = \frac{3+4i}{1-2i}$$

Divide & multiply z by the conjugate of $(1-2i)$ to convert it in the form of $a+bi$.

So,
$$z = \frac{3+4i}{1-2i} \times \frac{1+2i}{1+2i} = \frac{(3+4i)(1+2i)}{(1)^2-(2i)^2}$$
$$= \frac{3+10i+8i^2}{1-4i^2} = \frac{3+10i-8}{1-(-4)}$$
$$= \frac{-5+10i}{5} = -1+2i$$
$$|z| = \sqrt{(-1)^2+(2)^2} = \sqrt{5} \qquad |a+ib| = \sqrt{a^2+b^2}$$

MCQ 1.5 The function $y = |2-3x|$

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ONE MARK

(A) is continuous $\forall x \in R$ and differentiable $\forall x \in R$

(B) is continuous $\forall x \in R$ and differentiable $\forall x \in R$ except at $x = 3/2$

(C) is continuous $\forall x \in R$ and differentiable $\forall x \in R$ except at $x = 2/3$

(D) is continuous $\forall x \in R$ except $x = 3$ and differentiable $\forall x \in R$

SOL 1.5 Option (C) is correct.

$$y = f(x) = \begin{cases} 2-3x & \text{if } x < \frac{2}{3} \\ 0 & \text{if } x = \frac{2}{3} \\ -(2-3x) & \text{if } x > \frac{2}{3} \end{cases}$$

Checking the continuity of the function.

at $x = \frac{2}{3}$, $$Lf(x) = \lim_{h \to 0} f\left(\frac{2}{3} - h\right)$$

$$= \lim_{h \to 0} 2 - 3\left(\frac{2}{3} - h\right)$$

$$= \lim_{h \to 0} 2 - 2 + 3h$$

$$= 0$$

and $$Rf(x) = \lim_{h \to 0} f\left(\frac{2}{3} + h\right)$$

$$= \lim_{h \to 0} 3\left(\frac{2}{3} + h\right) - 2$$

$$= \lim_{h \to 0} 2 + 3h - 2 = 0$$

Since $$L\lim_{h \to 0} f(x) = R\lim_{h \to 0} f(x)$$

So, function is continuous $\forall\ x \in R$

Now checking the differentiability :

$$Lf'(x) = \lim_{h \to 0} \frac{f\left(\frac{2}{3} - h\right) - f\left(\frac{2}{3}\right)}{-h}$$

$$= \lim_{h \to 0} \frac{2 - 3\left(\frac{2}{3} - h\right) - 0}{-h}$$

$$= \lim_{h \to 0} \frac{2 - 2 + 3h}{-h} = \lim_{h \to 0} \frac{3h}{-h} = -3$$

And $$Rf'(x) = \lim_{h \to 0} \frac{f\left(\frac{2}{3} + h\right) - f\left(\frac{2}{3}\right)}{h}$$

$$= \lim_{h \to 0} \frac{3\left(\frac{2}{3} + h\right) - 2 - 0}{h} = \lim_{h \to 0} \frac{2 + 3h - 2}{h}$$

$$= 3$$

Since $Lf'\left(\frac{2}{3}\right) \neq Rf'\left(\frac{2}{3}\right)$, $f(x)$ is not differentiable at $x = \frac{2}{3}$.

MCQ 1.6 Mobility of a statically indeterminate structure is

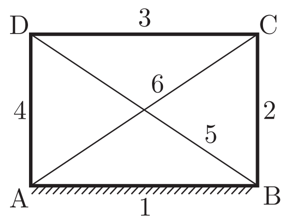
GATE ME 2010
ONE MARK

(A) ≤ -1 (B) 0

(C) 1 (D) ≥ 2

SOL 1.6 Option (A) is correct.

Given figure shows the six bar mechanism.



We know movability or degree of freedom is $n = 3(l - 1) - 2j - h$

The mechanism shown in figure has six links and eight binary joints (because there are four ternary joints A, B, C & D, i.e. $l = 6, \quad j = 8 \quad h = 0$

So, $$n = 3(6 - 1) - 2 \times 8 = -1$$

Therefore, when $n = -1$ or less, then there are redundant constraints in the chain, and it forms a statically indeterminate structure.

So, From the Given options (A) satisfy the statically indeterminate structure $n \leq -1$

MCQ 1.7 GATE ME 2010 ONE MARK

There are two points P and Q on a planar rigid body. The relative velocity between the two points

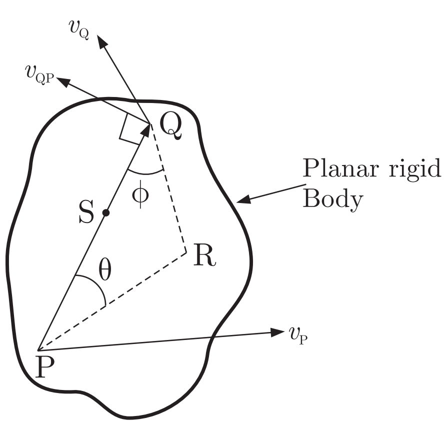
(A) should always be along PQ

(B) can be oriented along any direction

(C) should always be perpendicular to PQ

(D) should be along QP when the body undergoes pure translation

SOL 1.7 Option (C) is correct.



Velocity of any point on a link with respect to another point (relative velocity) on the same link is always perpendicular to the line joining these points on the configuration (or space) diagram.

$$v_{QP} = \text{Relative velocity between P \& Q}$$
$$v_{QP} = v_P - v_Q \text{ always perpendicular to PQ.}$$

MCQ 1.8 GATE ME 2010 ONE MARK

The state of plane-stress at a point is given by $\sigma_x = -200\,\text{MPa}$, $\sigma_y = 100\,\text{MPa}$ $\tau_{xy} = 100\,\text{MPa}$. The maximum shear stress (in MPa) is

(A) 111.8 (B) 150.1

(C) 180.3 (D) 223.6

SOL 1.8

Option (C) is correct.

Given : $\sigma_x = -200\,\text{MPa}$, $\sigma_y = 100\,\text{MPa}$, $\tau_{xy} = 100\,\text{MPa}$

We know that maximum shear stress is given by,

$$\tau_{\max} = \frac{1}{2}\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}$$

Substitute the values, we get

$$\tau_{\max} = \frac{1}{2}\sqrt{(-200-100)^2 + 4\times(100)^2}$$

$$= \frac{1}{2}\sqrt{90000 + 40000} = 180.27 \simeq 180.3\,\text{MPa}$$

MCQ 1.9 GATE ME 2010 ONE MARK

Which of the following statements is INCORRECT ?

(A) Grashof's rule states that for a planar crank-rocker four bar mechanism, the sum of the shortest and longest link lengths cannot be less than the sum of the remaining two link lengths

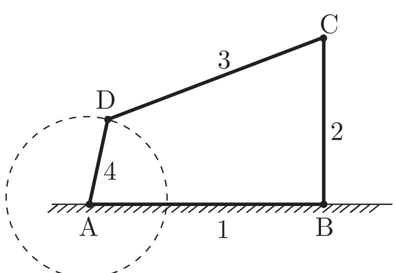
(B) Inversions of a mechanism are created by fixing different links one at a time

(C) Geneva mechanism is an intermittent motion device

(D) Gruebler's criterion assumes mobility of a planar mechanism to be one

SOL 1.9

Option (A) is correct.



According to Grashof's law "For a four bar mechanism, the sum of the shortest and longest link lengths should not be greater than the sum of remaining two link lengths if there is to be continuous relative motion between the two links.

$$l_4 + l_2 \ngtr l_1 + l_3$$

MCQ 1.10 GATE ME 2010 ONE MARK

The natural frequency of a spring-mass system on earth is ω_n. The natural frequency of this system on the moon $(g_{\text{moon}} = g_{\text{earth}}/6)$ is

(A) ω_n (B) $0.408\omega_n$

(C) $0.204\omega_n$ (D) $0.167\omega_n$

SOL 1.10

Option (A) is correct.

We know natural frequency of a spring mass system is,

$$\omega_n = \sqrt{\frac{k}{m}} \qquad \text{...(i)}$$

This equation (i) does not depend on the g and weight $(W = mg)$
So, the natural frequency of a spring mass system is unchanged on the moon.
Hence, it will remain ω_n, i.e. $\omega_{moon} = \omega_n$

MCQ 1.11 GATE ME 2010 ONE MARK

Tooth interference in an external involute spur gear pair can be reduced by

(A) decreasing center distance between gear pair

(B) decreasing module

(C) decreasing pressure angle

(D) increasing number of gear teeth

SOL 1.11 Option (D) is correct.

When gear teeth are produced by a generating process, interference is automatically eliminated because the cutting tool removes the interfering portion of the flank. This effect is called undercutting. By undercutting the undercut tooth can be considerably weakened.

So, interference can be reduced by using more teeth on the gear. However, if the gears are to transmit a given amount of power, more teeth can be used only by increasing the pitch diameter.

MCQ 1.12 GATE ME 2010 ONE MARK

For the stability of a floating body, under the influence of gravity alone, which of the following is TRUE ?

(A) Metacenter should be below centre of gravity.

(B) Metacenter should be above centre of gravity.

(C) Metacenter and centre of gravity must lie on the same horizontal line.

(D) Metacenter and centre of gravity must lie on the same vertical line.

SOL 1.12 Option (B) is correct.

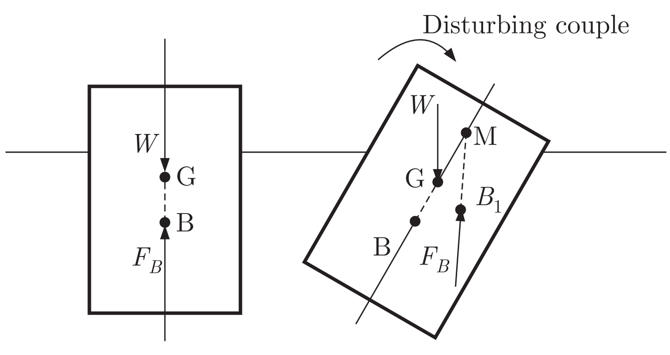


Fig. (I) Fig. (II)

As shown in figure above. If point B' is sufficiently far from B, these two forces

(Gravity force and Buoyant force) create a restoring moment and return the body to the original position.
A measure of stability for floating bodies is the metacentric height GM, which is the distance between the centre of gravity G and the metacenter M (the intersection point of the lines of action of the buoyant force through the body before and after rotation.)
A floating body is stable if point M is above the point G, and thus GM is positive, and unstable if point M is below point G, and thus GM is negative.
Stable equilibrium occurs when M is above G.

MCQ 1.13 The maximum velocity of a one-dimensional incompressible fully developed viscous flow, between two fixed parallel plates, is $6\,\text{ms}^{-1}$. The mean velocity (in ms^{-1}) of the flow is

GATE ME 2010 ONE MARK

(A) 2 (B) 3
(C) 4 (D) 5

SOL 1.13 Option (C) is correct.
In case of two parallel plates, when flow is fully developed, the ratio of $V_{\max}$ & V_{avg} is a constant.

$$\frac{V_{\max}}{V_{avg}} = \frac{3}{2} \qquad V_{\max} = 6\ \text{m/sec}$$

$$V_{avg} = \frac{2}{3} \times V_{\max} = \frac{2}{3} \times 6 = 4\ \text{m/sec}$$

MCQ 1.14 A phenomenon is modeled using n dimensional variables with k primary dimensions. The number of non-dimensional variables is

GATE ME 2010 ONE MARK

(A) k (B) n
(C) $n-k$ (D) $n+k$

SOL 1.14 Option (C) is correct.
From Buckingham's π-theorem
It states "If there are n variable (Independent & dependent variables) in a physical phenomenon & if these variables contain m fundamental dimensions (M, L, T), then variables are arranged into $(n-m)$ dimensionless terms.
Here n = dimensional variables
k = Primary dimensions (M, L, T)
So, non dimensional variables, $\Rightarrow n-k$

MCQ 1.15 A turbo-charged four-stroke direct injection diesel engine has a displacement volume of $0.0259\,\text{m}^3$ (25.9 litres). The engine has an output of $950\,\text{kW}$ at $2200\,\text{rpm}$. The mean effective pressure (in MPa) is closest to

GATE ME 2010 ONE MARK

(A) 2 (B) 1
(C) 0.2 (D) 0.1

SOL 1.15 Option (A) is correct.

Given : $\nu = 0.0259\,\text{m}^3$, Work output $= 950\,\text{kW}$, $N = 2200$ rpm
Mean effective pressure

$$mep = \frac{\text{Net work for one cycle}}{\text{displacement volume}} \times 60$$

Number of power cycle

$$n = \frac{N}{2} = \frac{2200}{2} = 1100 \qquad \text{(for 4 stroke)}$$

Hence, net work for one cycle

$$= \frac{950 \times 10^3}{1100} = 863.64\,\text{W}$$

So,

$$mep = \frac{60 \times 863.64}{0.0259}$$

$$= 2 \times 10^6\,\text{Pa} = 2\,\text{MPa}$$

MCQ 1.16 GATE ME 2010 ONE MARK

One kilogram of water at room temperature is brought into contact with a high temperature thermal reservoir. The entropy change of the universe is
(A) equal to entropy change of the reservoir
(B) equal to entropy change of water
(C) equal to zero
(D) always positive

SOL 1.16

Option (D) is correct.
We know that,
Entropy of universe is always increases.

$$\Delta s_{universe} > 0$$

$$(\Delta s)_{system} + (\Delta s)_{surrounding} > 0$$

MCQ 1.17 GATE ME 2010 ONE MARK

A hydraulic turbine develops $1000\,\text{kW}$ power for a head of $40\,\text{m}$. If the head is reduced to $20\,\text{m}$, the power developed (in kW) is
(A) 177 (B) 354
(C) 500 (D) 707

SOL 1.17

Option (B) is correct.
Given : $P_1 = 10^3\,\text{kW}$, $H_1 = 40\,\text{m}$, $H_2 = 40 - 20 = 20\,\text{m}$
If a turbine is working under different heads, the behavior of turbine can be easily known from the values of unit quantities i.e. from the unit power.
So

$$P_u = \frac{P}{H^{3/2}}$$

$$\frac{P_1}{H_1^{3/2}} = \frac{P_2}{H_2^{3/2}}$$

$$P_2 = \left(\frac{H_2}{H_1}\right)^{3/2} \times P_1 = \left(\frac{20}{40}\right)^{3/2} \times 1000 = 353.6 \approx 354\,\text{kW}$$

MCQ 1.18 GATE ME 2010 ONE MARK

The material property which depends only on the basic crystal structure is

(A) fatigue strength (B) work hardening

(C) fracture strength (D) elastic constant

SOL 1.18 Option (C) is correct.

Fracture strength be a material property which depends on the basic crystal structure. Fracture strength depends on the strength of the material.

MCQ 1.19 In a gating system, the ratio 1 : 2 : 4 represents

GATE ME 2010 ONE MARK

(A)	sprue base area	: runner area	: ingate area
(B)	pouring basin area	: ingate area	: runner area
(C)	sprue base area	: ingate area	: casting area
(D)	runner area	: ingate area	: casting area

SOL 1.19 Option (A) is correct.

Gate Ratio : It is defined as the ratio of sprue base area, followed by the total runner area and the total ingate area. The sprue base area is taken is unity.

So, $1:2:4 = \text{Sprue base area} : \text{Runner area} : \text{Total ingate area}$

MCQ 1.20 A shaft has a dimension, $\phi 35^{-0.009}_{-0.025}$. The respective values of fundamental deviation and tolerance are

GATE ME 2010 ONE MARK

(A) $-0.025, \pm 0.008$ (B) $-0.025, 0.016$

(C) $-0.009, \pm 0.008$ (D) $-0.009, 0.016$

SOL 1.20 Option (D) is correct.

$$\begin{aligned}\text{We know that, shaft tolerance} &= \text{Upper limit of shaft} - \text{Lower limit of shaft}\\ &= (35 - 0.009) - (35 - 0.025)\\ &= 34.991 - 34.975 = 0.016\end{aligned}$$

Fundamental deviation for basic shaft is lower deviation.

$$= -0.009$$

MCQ 1.21 In a CNC program block, N002 GO2 G91 X40 Z40......,GO2 and G91 refer to

GATE ME 2010 ONE MARK

(A) circular interpolation in counterclockwise direction and incremental dimension

(B) circular interpolation in counterclockwise direction and absolute dimension

(C) circular interpolation in clockwise direction and incremental dimension

(D) circular interpolation in clockwise direction and absolute dimension

SOL 1.21 Option (C) is correct.

GO2 represent circular interpolation in clockwise direction.

G91 represent incremental dimension.

MCQ 1.22 The demand and forecast for February are 12000 and 10275, respectively. Using single exponential smoothening method (smoothening coefficient = 0.25), forecast for the month of March is

GATE ME 2010 ONE MARK

(A) 431 (B) 9587

(C) 10706 (D) 11000

SOL 1.22 Option (C) is correct.

Given,

$$\begin{aligned} \text{Forecast for February } F_{t-1} &= 10275 \\ \text{Demand for February } D_{t-1} &= 12000 \\ \text{Smoothing coefficient } \alpha &= 0.25 \end{aligned}$$

Which is The forecast for the next period is given by,

$$\begin{aligned} F_t &= \alpha(D_{t-1}) + (1-\alpha) \times F_{t-1} \\ &= 0.25 \times (12000) + (1-0.25) \times (10275) \\ &= 10706.25 \simeq 10706 \end{aligned}$$

Hence, forecast for the month of march is 10706.

MCQ 1.23 Little's law is a relationship between

GATE ME 2010 ONE MARK

(A) stock level and lead time in an inventory system

(B) waiting time and length of the queue in a queuing system

(C) number of machines and job due dates in a scheduling problem

(D) uncertainty in the activity time and project completion time

SOL 1.23 Option (B) is correct.

Little's law is a relationship between average waiting time and average length of the queue in a queuing system.

The little law establish a relation between Queue length (L_q), Queue waiting time (W_q) and the Mean arrival rate λ.

So, $$L_q = \lambda W_q$$

MCQ 1.24 Vehicle manufacturing assembly line is an example of

GATE ME 2010 ONE MARK

(A) product layout (B) process layout

(C) manual layout (D) fixed layout

SOL 1.24 Option (A) is correct.

Vehicle manufacturing assembly line is an example of product layout.

A product-oriented layout is appropriate for producing one standardized product, usually in large volume. Each unit of output requires the same sequence of operations from beginning to end.

MCQ 1.25 Simplex method of solving linear programming problem uses

GATE ME 2010 ONE MARK

(A) all the points in the feasible region

(B) only the corner points of the feasible region

(C) intermediate points within the infeasible region

(D) only the interior points in the feasible region

SOL 1.25 Option (D) is correct.

Simplex method provides an algorithm which consists in moving from one point of

the region of feasible solutions to another in such a manner that the value of the objective function at the succeeding point is less (or more, as the case may be) than at the preceding point. This procedure of jumping from one point to another is then repeated. Since the number of points is finite, the method leads to an optimal point in a finite number of steps.
Therefore simplex method only uses the interior points in the feasible region.

MCQ 1.26 Torque exerted on a flywheel over a cycle is listed in the table. Flywheel energy (in J per unit cycle) using Simpson's rule is

GATE ME 2010 TWO MARK

Angle (Degree)	0	60°	120°	180°	240°	300°	360°
Torque (N-m)	0	1066	-323	0	323	-355	0

(A) 542 (B) 993

(C) 1444 (D) 1986

SOL 1.26 Option (B) is correct.

Given :
$$h = 60^\circ - 0 = 60^\circ$$
$$h = 60 \times \frac{\pi}{180} = \frac{\pi}{3} = 1.047 \text{ radians}$$

From the table, we have

$y_0 = 0$ $\quad y_1 = 1066$ $\quad y_2 = -323$

$y_3 = 0,\ y_4 = 323,\ y_5 = -355,\ y_6 = 0$

From the Simpson's 1/3rd rule the flywheel Energy is,
$$E = \frac{h}{3}[(y_0 + y_6) + 4(y_1 + y_3 + y_5) + 2(y_2 + y_4)]$$

Substitute the values, we get
$$E = \frac{1.047}{3}[(0+0) + 4(1066 + 0 - 355) + 2(-323 + 323)]$$
$$= \frac{1.047}{3}[4 \times 711 + 2(0)] = 993 \text{ Nm rad (Joules/cycle)}$$

MCQ 1.27 One of the eigen vectors of the matrix $A = \begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$ is

GATE ME 2010 TWO MARK

(A) $\begin{bmatrix} 2 \\ -1 \end{bmatrix}$ (B) $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$

(C) $\begin{bmatrix} 4 \\ 1 \end{bmatrix}$ (D) $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

SOL 1.27 Option (A) is correct.

Let, $$A = \begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$$

And λ_1 & λ_2 are the eigen values of the matrix A.
The characteristic equation is written as

$$|A-\lambda I| = 0$$

$$\left|\begin{bmatrix}2 & 2\\1 & 3\end{bmatrix} - \lambda\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}\right| = 0$$

$$\begin{vmatrix}2-\lambda & 2\\1 & 3-\lambda\end{vmatrix} = 0 \qquad \text{...(i)}$$

$$(2-\lambda)(3-\lambda)-2 = 0$$

$$\lambda^2-5\lambda+4 = 0$$

$$\lambda^2-4\lambda-\lambda+4 = 0$$

$$(\lambda-4)(\lambda-1) = 0$$

$$\lambda = 1 \;\&\; 4$$

Putting $\lambda = 1$ in equation (i),

$$\begin{bmatrix}2-1 & 2\\1 & 3-1\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} = \begin{bmatrix}0\\0\end{bmatrix} \qquad \text{where } \begin{bmatrix}x_1\\x_2\end{bmatrix} \text{ is eigen vector}$$

$$\begin{bmatrix}1 & 2\\1 & 2\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} = \begin{bmatrix}0\\0\end{bmatrix}$$

$$x_1+2x_2 = 0 \text{ or } x_1+2x_2 = 0$$

Let $x_2 = K$

Then $x_1+2K = 0 \Rightarrow x_1 = -2K$

So, the eigen vector is

$$\begin{bmatrix}-2K\\K\end{bmatrix} \text{ or } \begin{bmatrix}-2\\1\end{bmatrix}$$

Since option A $\begin{bmatrix}2\\-1\end{bmatrix}$ is in the same ratio of x_1 and x_2. Therefore option (A) is an eigen vector.

MCQ 1.28 GATE ME 2010 TWO MARK

Velocity vector of a flow field is given as $\boldsymbol{V} = 2xy\boldsymbol{i} - x^2z\boldsymbol{j}$. The vorticity vector at $(1,1,1)$ is

(A) $4\boldsymbol{i}-\boldsymbol{j}$ (B) $4\boldsymbol{i}-\boldsymbol{k}$

(C) $\boldsymbol{i}-4\boldsymbol{j}$ (D) $\boldsymbol{i}-4\boldsymbol{k}$

SOL 1.28 Option (D) is correct.

Given : $\boldsymbol{V} = 2xy\boldsymbol{i} - x^2z\boldsymbol{j}$ $\qquad P(1,1,1)$

The vorticity vector is defined as,

$$\text{Vorticity Vector} = \begin{vmatrix}\boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k}\\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ u & v & w\end{vmatrix}$$

Substitute, $u = 2xy \quad \& \quad v = -x^2z, \quad w = 0$

So,

$$= \begin{vmatrix}\boldsymbol{i} & \boldsymbol{j} & \boldsymbol{k}\\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ 2xy & -x^2z & 0\end{vmatrix}$$

$$= \boldsymbol{i}\left[-\frac{\partial}{\partial z}(-x^2 z)\right] - \boldsymbol{j}\left[-\frac{\partial}{\partial z}(2xy)\right] + \boldsymbol{k}\left[\frac{\partial}{\partial x}(-x^2 z) - \frac{\partial}{\partial y}(2xy)\right]$$

$$= x^2\boldsymbol{i} - 0 + \boldsymbol{k}[-2xz - 2x]$$

Vorticity vector at $P(1,1,1)$,

$$= \boldsymbol{i} + \boldsymbol{k}[-2-2] = \boldsymbol{i} - 4\boldsymbol{k}$$

MCQ 1.29 The Laplace transform of a function $f(t)$ is $\frac{1}{s^2(s+1)}$. The function $f(t)$ is

GATE ME 2010
TWO MARK

(A) $t - 1 + e^{-t}$ (B) $t + 1 + e^{-t}$

(C) $-1 + e^{-t}$ (D) $2t + e^{t}$

SOL 1.29 Option (A) is correct.

$f(t)$ is the inverse Laplace

So, $$f(t) = \mathcal{L}^{-1}\left[\frac{1}{s^2(s+1)}\right]$$

Solving this by partial fraction, we get

$$\frac{1}{s^2(s+1)} = \frac{A}{s} + \frac{B}{s^2} + \frac{C}{s+1}$$

$$= \frac{As(1+s) + B(s+1) + Cs^2}{s^2(s+1)}$$

$$\frac{1}{s^2(s+1)} = \frac{s^2(A+C) + s(A+B) + B}{s^2(s+1)}$$

Compare the coefficients of s^2, s and constant terms and we get

$$A + C = 0$$
$$A + B = 0$$
$$B = 1$$

On solving above equation, we get

$A = -1$, $B = 1$ and $C = 1$

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

$$= -1 + t + e^{-t} \qquad \mathcal{L}^{-1}\left[\frac{1}{s+a}\right] = e^{-at}$$

$$= t - 1 + e^{-t}$$

MCQ 1.30 A box contains 2 washers, 3 nuts and 4 bolts. Items are drawn from the box at random one at a time without replacement. The probability of drawing 2 washers first followed by 3 nuts and subsequently the 4 bolts is

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(A) 2/315 (B) 1/630

(C) 1/1260 (D) 1/2520

SOL 1.30 Option (C) is correct.

The box contains :

Number of washers $= 2$

Number of nuts $= 3$

Number of bolts $= 4$

Total objects $= 2 + 3 + 4 = 9$

Firstly two washers are drawn from the box which contain 9 items. So the probability of drawing 2 washers is,

$$P_1 = \frac{{}^2C_2}{{}^9C_2} == \frac{1}{\frac{9!}{7!2!}} = \frac{7!2!}{9 \times 8 \times 7!} = \frac{2}{9 \times 8} = \frac{1}{36} \qquad {}^nC_n = 1$$

After this box contains only 7 objects & then 3 nuts drawn from it. So the probability of drawing 3 nuts from the remaining objects is,

$$P_2 = \frac{{}^3C_3}{{}^7C_3} = \frac{1}{\frac{7!}{4!3!}} = \frac{4!3!}{7 \times 6 \times 5 \times 4!} = \frac{1}{35}$$

After this box contain only 4 objects, probability of drawing 4 bolts from the box,

$$P_3 = \frac{{}^4C_4}{{}^4C_4} = \frac{1}{1} = 1$$

Therefore the required probability is,

$$P = P_1 P_2 P_3 = \frac{1}{36} \times \frac{1}{35} \times 1 = \frac{1}{1260}$$

MCQ 1.31 GATE ME 2010 TWO MARK

A band brake having band-width of 80 mm, drum diameter of 250 mm, coefficient of friction of 0.25 and angle of wrap of 270 degrees is required to exert a friction torque of 1000 Nm. The maximum tension (in kN) developed in the band is

(A) 1.88 (B) 3.56

(C) 6.12 (D) 11.56

SOL 1.31 Option (D) is correct.

Given : $b = 80$ mm, $d = 250$ mm, $\mu = 0.25$, $\theta = 270°$, $T_B = 1000$ N-m

Let, $T_1 \rightarrow$ Tension in the tight side of the band (Maximum Tension)

$T_2 \rightarrow$ Tension in the slack side of the band (Minimum Tension)

Braking torque on the drum,

$$T_B = (T_1 - T_2)\, r$$

$$T_1 - T_2 = \frac{T_B}{r} = \frac{1000}{0.125} = 8000 \text{ N} \qquad \text{...(i)}$$

We know that limiting ratio of the tension is given by,

$$\frac{T_1}{T_2} = e^{\mu\theta} = e^{\left(0.25 \times \frac{\pi}{180} \times 270\right)} = 3.246$$

$$T_2 = \frac{T_1}{3.246}$$

Substitute T_2 in equation (i), we get

$$T_1 - \frac{T_1}{3.246} = 8000 \qquad \Rightarrow \quad 3.246\,T_1 - T_1 = 25968$$

$$2.246\,T_1 = 25968 \qquad \Rightarrow \quad T_1 = \frac{25968}{2.246} = 11.56\,\text{kN}$$

MCQ 1.32 A bracket (shown in figure) is rigidly mounted on wall using four rivets. Each rivet is 6 mm in diameter and has an effective length of 12 mm.

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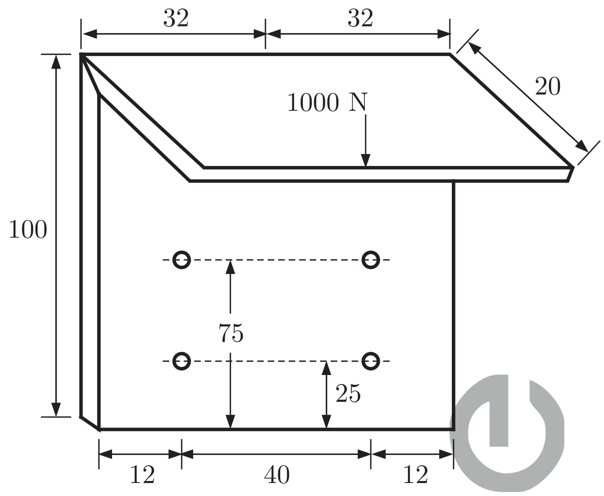

Direct shear stress (in MPa) in the most heavily loaded rivet is

(A) 4.4 (B) 8.8

(C) 17.6 (D) 35.2

SOL 1.32 Option (B) is correct.

Given : $d = 6\,\text{mm},\ l = 12\,\text{mm},\ P = 1000\,\text{N}$

Each rivets have same diameter, So equal Load is carried by each rivet.

Primary or direct force on each rivet,

$$F = \frac{P}{4} = \frac{1000}{4} = 250\,\text{N}$$

Shear area of each rivet is,

$$A = \frac{\pi}{4}(6 \times 10^{-3})^2 = 28.26 \times 10^{-6}\,\text{mm}^2$$

Direct shear stress on each rivet,

$$\tau = \frac{F}{A} = \frac{250}{28.26 \times 10^{-6}} = 8.84 \times 10^6 \simeq 8.8\,\text{MPa}$$

MCQ 1.33 A mass m attached to a spring is subjected to a harmonic force as shown in figure The amplitude of the forced motion is observed to be 50 mm. The value of m (in kg) is

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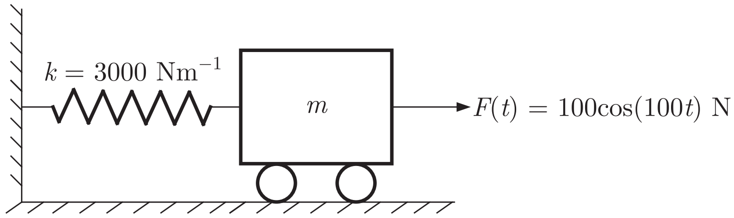
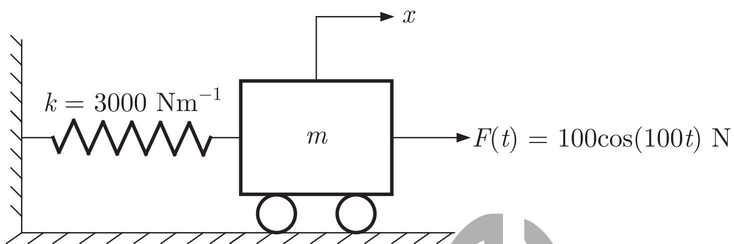
TWO MARK



(A) 0.1 (B) 1.0

(C) 0.3 (D) 0.5

SOL 1.33 Option (A) is correct.



Given $k = 3000\,\text{N/m}$, $c = 0$, $A = 50\,\text{mm}$, $F(t) = 100\cos(100t)\,\text{N}$

$$\omega t = 100t$$
$$\omega = 100$$

It is a forced vibratory system.

From the Newton's law,

$$m\ddot{x} + kx = F \qquad ...(i)$$

And its general solution will be,

$$x = A\cos\omega t$$
$$\frac{dx}{dt} = \dot{x} = -A\omega\sin\omega t \qquad \text{where } \omega = \sqrt{\frac{k}{m}}$$
$$\frac{d^2x}{dt^2} = \ddot{x} = -A\omega^2\cos\omega t$$

Substitute these values in equation (i), we get

$$-mA\omega^2\cos\omega t + kA\cos\omega t = 100\cos(\omega t)$$
$$-mA\omega^2 + kA = 100$$

Now substitute $k = 3000\,\text{N/m}$, $A = 0.05\,\text{m}$, in above equation, we get

$$-m \times 0.05 \times (100)^2 + 3000 \times 0.05 = 100$$
$$-5m + 1.5 = 1$$
$$m = 0.1\,\text{kg}$$

Alternate Method:

We know that, in forced vibration amplitude is given by :

$$A = \frac{F_O}{\sqrt{(k - m\omega)^2 + (c\omega)^2}} \qquad ...(i)$$

Here, $F(t) = 100\cos(100t)$, $F_O = 100$ N, $A = 50$ mm $= 50 \times 10^{-3}$ m

$\omega = 100$ rad/sec, $k = 3000\,\text{Nm}^{-1}$, $c = 0$

So, from equation (i), we get

$$A = \frac{F_O}{k - m\omega^2}$$

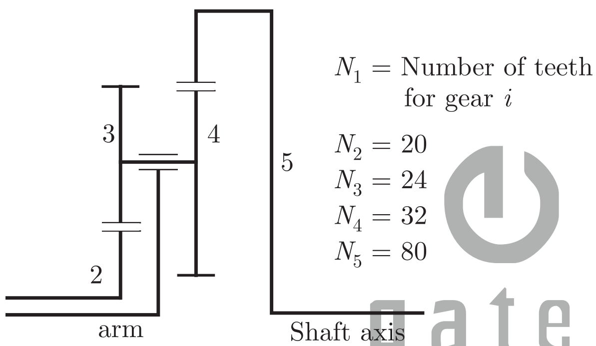
$$k - m\omega^2 = \frac{F_O}{A}$$

$$3000 - m \times (100)^2 = \frac{100}{50 \times 10^{-3}}$$

$$10000m = 1000 \quad \Rightarrow m = 0.1 \text{ kg}$$

MCQ 1.34 GATE ME 2010 TWO MARK

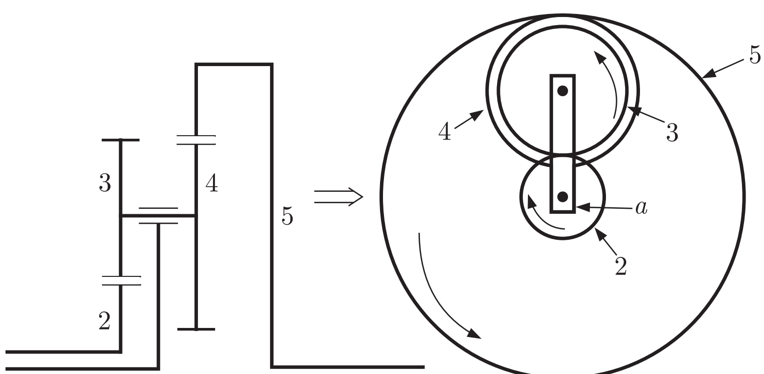
For the epicyclic gear arrangement shown in the figure $\omega_2 = 100$ rad/s clockwise (CW) and $\omega_{arm} = 80$ rad/s counter clockwise (CCW). The angular velocity ω_5 (in rad/s) is



(A) 0 (B) 70 CW

(B) 140 CCW (D) 140 CW

SOL 1.34 Option (C) is correct.



Given N_i = No. of teeth for gear i,

$N_2 = 20$, $N_3 = 24$, $N_4 = 32$, $N_5 = 80$, $\omega_2 = 100$ rad/sec (CW)

$\omega_{arm} = 80$ rad/sec (CCW) $= -80$ rad/sec

The table of the motion given below :

Take CCW $= -$ve and CW $= +$ve

S. No.	Condition of Motion	Revolution of elements			
		Arm	Gear 2 ω_2	Compound Gear 3 - 4, $\omega_3 = \omega_4$	Gear 5 ω_5
1.	Arm 'a' is fixed & Gear 2 rotates through +1 revolution (CW)	0	+1	$-\dfrac{N_2}{N_3}$	$-\dfrac{N_2}{N_3} \times \dfrac{N_4}{N_5}$
2.	Gear 2 rotates through $+x$ revolution (CW)	0	$+x$	$-x\dfrac{N_2}{N_3}$	$-x\dfrac{N_2}{N_3} \times \dfrac{N_4}{N_5}$
3.	Add $+y$ revolutions to all elements	$+y$	$+y$	$+y$	$+y$
4.	Total motion.	$+y$	$x+y$	$y - x\dfrac{N_2}{N_3}$	$y - x\dfrac{N_2}{N_3} \times \dfrac{N_4}{N_5}$

Note. Speed ratio $= \dfrac{\text{Speed of driver}}{\text{Speed of driven}} = \dfrac{\text{No.of teeth on driven}}{\text{No. of teeth on driver}}$

i.e. $\dfrac{\omega_1}{\omega_2} = \dfrac{N_2}{N_1}$

Gear 3 & 4 mounted on same shaft, So $\omega_3 = \omega_4$

And $\omega_{arm} = y$ From the table

$y = -80$ rad/sec (CCW)

$x + y = \omega_2 = 100$ From the table

$x = 100 - (-80) = 180$ rad/sec (CW)

And $\omega_5 = y - x \times \dfrac{N_2}{N_3} \times \dfrac{N_4}{N_5}$ From the table

$$= -80 - 180 \times \frac{20}{24} \times \frac{32}{80} = -140 \text{ rad/sec}$$

Negative sign shows the counter clockwise direction.

MCQ 1.35 GATE ME 2010 TWO MARK

A lightly loaded full journal bearing has journal diameter of 50 mm, bush bore of 50.05 mm and bush length of 20 mm. If rotational speed of journal is 1200 rpm and average viscosity of liquid lubricant is 0.03 Pa s, the power loss (in W) will be

(A) 37 (B) 74

(C) 118 (D) 237

SOL 1.35 Option (A) is correct.

Given : $d = 50\text{ mm}$, $D = 50.05\text{ mm}$, $l = 20\text{ mm}$, $N = 1200\text{ rpm}$, $\mu = 0.03\text{ Pa s}$

Tangential velocity of shaft,

$$u = \frac{\pi dN}{60} = \frac{3.14 \times 50 \times 10^{-3} \times 1200}{60} = 3.14 \text{ m/sec}$$

And Radial clearance, $y = \dfrac{D-d}{2} = \dfrac{50.05 - 50}{2} = 0.025\text{ mm}$

Shear stress from the Newton's law of viscosity,

$$\tau = \mu \times \frac{u}{y}$$

$$= 0.03 \times \frac{3.14}{0.025 \times 10^{-3}} = 3768 \text{ N/m}^2$$

Shear force on the shaft, $F = \tau \times A = 3768 \times (\pi \times d \times l)$

$$= 3768 \times 3.14 \times 50 \times 10^{-3} \times 20 \times 10^{-3} = 11.83 \text{ N}$$

Torque, $T = F \times \frac{d}{2} = 11.83 \times \frac{50}{2} \times 10^{-3} = 0.2957 \text{ N-m}$

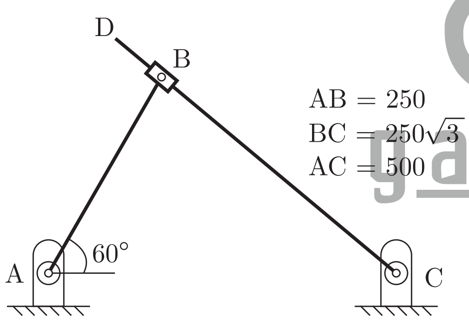
We know that power loss,

$$P = \frac{2\pi NT}{60}$$

$$= \frac{2 \times 3.14 \times 1200 \times 0.2957}{60} = 37.13 \text{ W} \simeq 37 \text{ W}$$

MCQ 1.36 GATE ME 2010 TWO MARK

For the configuration shown, the angular velocity of link AB is 10 rad/s counterclockwise. The magnitude of the relative sliding velocity (in ms^{-1}) of slider B with respect to rigid link CD is



(A) 0 (B) 0.86

(C) 1.25 (D) 2.50

SOL 1.36 Option (D) is correct.

Let, v_B is the velocity of slider B relative to link CD

The crank length AB = 250 mm and velocity of slider B with respect to rigid link CD is simply velocity of B (because C is a fixed point).

Hence, $v_B = (AB) \times \omega_{AB} = 250 \times 10^{-3} \times 10 = 2.5 \text{ m/sec}$

Alternate method

From the given figure, direction of velocity of CD is perpendicular to link AB & direction of velocity of AB is parallel to link CD.

So, direction of relative velocity of slider B with respect to C is in line with link BC.

Hence $v_C = 0$

Or $v_{BC} = v_B - v_C$

$$= AB \times \omega_{AB} - 0 = 0.025 \times 10 = 2.5 \text{ m/sec}$$

MCQ 1.37 GATE ME 2010 TWO MARK

A smooth pipe of diameter 200 mm carries water. The pressure in the pipe at section S_1 (elevation : 10 m) is 50 kPa. At section S_2 (elevation : 12 m) the pressure is 20 kPa and velocity is $2\,\text{ms}^{-1}$. Density of water is $1000\,\text{kgm}^{-3}$ and acceleration due to gravity is $9.8\,\text{ms}^{-2}$. Which of the following is TRUE

(A) flow is from S_1 to S_2 and head loss is 0.53 m

(B) flow is from S_2 to S_1 and head loss is 0.53 m

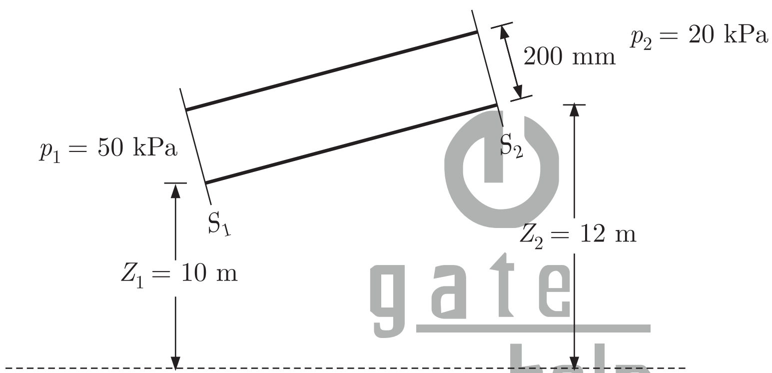
(C) flow is from S_1 to S_2 and head loss is 1.06 m

(D) flow is from S_2 to S_1 and head loss is 1.06 m

SOL 1.37 Option (C) is correct.

Given : $p_1 = 50\,\text{kPa},\ Z_1 = 10\,\text{m},\ V_2 = 2\,\text{m/sec}$

$p_2 = 20\,\text{kPa},\ Z_2 = 12\,\text{m},\ \rho = 1000\,\text{kg/m}^3,\ g = 9.8\,\text{m/sec}^2$



Applying continuity equation at section S_1 & S_2,

$$A_1 V_1 = A_2 V_2$$

$$V_1 = V_2 \qquad D_1 = D_2 \text{ so } A_1 = A_2 \ldots \text{(i)}$$

Applying Bernoulli's equation at section S_1 & S_2 with head loss h_L,

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$\frac{p_1}{\rho g} + z_1 = \frac{p_2}{\rho g} + z_2 + h_L \qquad \text{From equation (i)}$$

$$h_L = \left(\frac{p_1 - p_2}{\rho g}\right) + (z_1 - z_2)$$

$$= \frac{(50-20)\times 10^3}{(1000\times 9.8)} + (10-12) = 3.058 - 2 = 1.06\,\text{m}$$

Head at section (S_1) is given by,

$$H_1 = \frac{p_1}{\rho g} + Z_1 = \frac{50\times 10^3}{10^3\times 9.8} + 10 = 15.09\,\text{m}$$

Head at section S_2,

$$H_2 = \frac{p_2}{\rho g} + Z_2 = \frac{20\times 10^3}{10^3\times 9.8} + 12 = 14.04\,\text{m}$$

From H_1 & H_2 we get $H_1 > H_2$. So, flow is from S_1 to S_2

MCQ 1.38 Match the following

GATE ME 2010 TWO MARK

P.	Compressible flow	**U.**	Reynolds number
Q.	Free surface flow	**V.**	Nusselt number
R.	Boundary layer flow	**W.**	Weber number
S.	Pipe flow	**X.**	Froude number
T.	Heat convection	**Y.**	Mach number
		Z.	Skin friction coefficient

(A) P-U; Q-X; R-V; S-Z; T-W (B) P-W; Q-X; R-Z; S-U; T-V

(C) P-Y; Q-W; R-Z; S-U; T-X (D) P-Y; Q-W; R-Z; S-U; T-V

SOL 1.38 Option (D) is correct.

Here type of flow is related to the dimensionless numbers (Non-dimensional numbers).

So

P.	Compressible flow	**Y.**	Mach number
Q.	Free surface flow	**W.**	Weber number
R.	Boundary layer	**Z.**	Skin friction coefficient
S.	Pipe flow	**U.**	Reynolds number
T.	Heat convection	**V.**	Nusselt number

So, correct pairs are P-Y, Q-W, R-Z, S-U, T-V

MCQ 1.39 A mono-atomic ideal gas $(\gamma = 1.67, \text{molecular weight} = 40)$ is compressed adiabatically from $0.1\,\text{MPa}$, $300\,\text{K}$ to $0.2\,\text{MPa}$. The universal gas constant is $8.314\,\text{kJ}\,\text{kg}^{-1}\text{mol}^{-1}\text{K}^{-1}$. The work of compression of the gas (in kJkg^{-1}) is

GATE ME 2010 TWO MARK

(A) 29.7 (B) 19.9

(C) 13.3 (D) 0

SOL 1.39 Option (A) is correct.

Given : $\gamma = 1.67$, $M = 40$, $p_1 = 0.1\,\text{MPa} = 10^6 \times 0.1 = 10^5\,\text{Pa}$

$T_1 = 300\,\text{K}$, $p_2 = 0.2\,\text{MPa} = 2 \times 10^5\,\text{Pa}$, $R_u = 8.314\,\text{kJ/kgmol K}$

$$\text{Gas constant} = \frac{\text{Universal Gas constant}}{\text{Molecular Weight}}$$

$$R = \frac{R_u}{M} = \frac{8.314}{40} = 0.20785\,\text{kJ/kg K}$$

For adiabatic process,

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$\frac{T_2}{300} = \left(\frac{0.2}{0.1}\right)^{\frac{1.67-1}{1.67}} = (2)^{0.4012}$$

$$T_2 = 300 \times (2)^{0.4012} = 300 \times 1.32 = 396\,\text{K}$$

Work done in adiabatic process is given by,

$$W = \frac{p_1\nu_1 - p_2\nu_2}{\gamma - 1} = \frac{R(T_1 - T_2)}{\gamma - 1}$$

$$= \frac{0.20785[300 - 396]}{1.67 - 1} = \frac{0.20785(-96)}{0.67} = -29.7 \text{ kJ/kg}$$

(Negative sign shows the compression work)

MCQ 1.40 Consider the following two processes ;

GATE ME 2010 TWO MARK

(a) A heat source at 1200 K loses 2500 kJ of heat to a sink at 800 K

(b) A heat source at 800 K loses 2000 kJ of heat to a sink at 500 K

Which of the following statements is true ?

(A) Process I is more irreversible than Process II

(B) Process II is more irreversible than Process I

(C) Irreversibility associated in both the processes are equal

(D) Both the processes are reversible

SOL 1.40 Option (B) is correct.

We know from the clausius Inequality,

If $\oint \frac{dQ}{T} = 0$, the cycle is reversible

$\oint \frac{dQ}{T} < 0$, the cycle is irreversible and possible

For case (a),

$$\oint_a \frac{dQ}{T} = \frac{2500}{1200} - \frac{2500}{800}$$

$$= \frac{25}{12} - \frac{25}{8} = -1.041 \text{ kJ/kg}$$

For case (b),

$$\oint_b \frac{dQ}{T} = \frac{2000}{800} - \frac{2000}{500} = \frac{20}{8} - \frac{20}{5} = -1.5 \text{ kJ/kg}$$

$$\oint_a \frac{dQ}{T} > \oint_b \frac{dQ}{T}$$

So, process (b) is more irreversible than process (a)

MCQ 1.41 A fin has 5 mm diameter and 100 mm length. The thermal conductivity of fin material is $400 \text{ Wm}^{-1}\text{K}^{-1}$. One end of the fin is maintained at 130° C and its remaining surface is exposed to ambient air at 30° C. If the convective heat transfer coefficient is $40 \text{ Wm}^{-2}\text{K}^{-1}$, the heat loss (in W) from the fin is

GATE ME 2010 TWO MARK

(A) 0.08 (B) 5.0

(C) 7.0 (D) 7.8

SOL 1.41 Option (B) is correct.

Given, $d = 5 \text{ mm} = 0.005 \text{ m}$, $l = 100 \text{ mm} = 0.1 \text{ m}$, $k = 400 \text{ W/m K}$

$T_0 = 130^\circ \text{C}$, $T_a = 30^\circ \text{C}$, $h = 40 \text{ W/m}^2 \text{K}$

Heat loss by the fin is given by,

$$Q_{fin} = mkA_c(T_0 - T_a)\tanh(ml) \quad \text{...(i)}$$

$$\frac{\text{Perimeter}}{\text{Cross sectional Area}} = \frac{p}{A_c} = \frac{\pi d}{\frac{\pi}{4}d^2} = \frac{4}{d} = \frac{4}{0.005}$$

$$\frac{p}{A_c} = 800 \quad \text{...(ii)}$$

And $$m = \sqrt{\frac{h}{k}\left(\frac{p}{A_c}\right)} = \sqrt{\frac{40}{400} \times 800} = \sqrt{80}$$

From equation(i),

$$Q_{fin} = \sqrt{80} \times 400 \times \frac{\pi}{4} \times (0.005)^2(130 - 30) \times \tanh(\sqrt{80} \times 0.1)$$

$$= 8.944 \times 400 \times 1.96 \times 10^{-5} \times 100 \times \tanh(0.8944)$$

$$= 7.012 \times 0.7135 \simeq 5 \text{ W}$$

MCQ 1.42 GATE ME 2010 TWO MARK

A moist air sample has dry bulb temperature of 30° C and specific humidity of 11.5 g water vapour per kg dry air. Assume molecular weight of air as 28.93. If the saturation vapour pressure of water at 30° C is 4.24 kPa and the total pressure is 90 kPa, then the relative humidity (in %) of air sample is

(A) 50.5 (B) 38.5

(C) 56.5 (D) 68.5

SOL 1.42

Option (B) is correct.

Given : $t_{DBT} = 30^\circ$ C, $W = 11.5$ g water vapour/kg dry air

$p_s = 4.24$ kPa, $p = 90$ kPa

Specific humidity, $$W = 0.622\left(\frac{p_v}{p - p_v}\right)$$

Substitute the values, we get

$$11.5 \times 10^{-3} = 0.622\left(\frac{p_v}{90 - p_v}\right)$$

$$18.489 \times 10^{-3} = \frac{p_v}{90 - p_v}$$

$$(90 \times 18.489 - 18.489p_v) \times 10^{-3} = p_v$$

$$1.664 - 0.01849p_v = p_v$$

$$1.664 = 1.01849p_v$$

$$p_v = 1.634 \text{ kPa}$$

Relative humidity

$$\phi = \frac{p_v}{p_s} = \frac{1.634}{4.24}$$

$$\phi = 0.3853 = 38.53\% \simeq 38.5\%$$

MCQ 1.43 GATE ME 2010 TWO MARK

Two pipes of inner diameter 100 mm and outer diameter 110 mm each are joined by flash-butt welding using 30 V power supply. At the interference, 1 mm of material melts from each pipe which has a resistance of 42.4 Ω. If the unit melt energy is

$64.4\,\text{MJm}^{-3}$, then time required for welding (in s) is

(A) 1 (B) 5

(C) 10 (D) 20

SOL 1.43 Option (C) is correct.

Given : $d_i = 100\text{ mm}$, $d_o = 110\text{ mm}$, $V = 30\text{ Volt}$, $R = 42.4\,\Omega$, $E_u = 64.4\text{ MJ/m}^3$

Each pipe melts 1 mm of material. So, thickness of material melt, $t = 2 \times 1 = 2\text{ mm}$

Melting energy in whole volume is given by

$$Q = \text{Area} \times \text{thickness} \times E_u = \frac{\pi}{4}(d_o^2 - d_i^2) \times t \times E_u$$

$$Q = \frac{\pi}{4}[(110)^2 - (100)^2] \times 10^{-6} \times 2 \times 10^{-3} \times 64.4 \times 10^6$$

$$= 212.32\text{ J} \qquad ...(i)$$

And the amount of heat generated at the contacting area of the element to be weld is,

$$Q = I^2 Rt = \frac{V^2}{R}t \qquad I = \frac{V}{R}$$

$$t = \frac{Q \times R}{V^2}$$

Substitute the values, we get

$$t = \frac{212.32 \times 42.4}{(30)^2} = 10\text{ sec}$$

MCQ 1.44 GATE ME 2010 TWO MARK

For tool A, Taylor's tool life exponent (n) is 0.45 and constant (K) is 90. Similarly for tool B, $n = 0.3$ and $K = 60$. The cutting speed (in m/min) above which tool A will have a higher tool life than tool B is

(A) 26.7 (B) 42.5

(C) 80.7 (D) 142.9

SOL 1.44 Option (A) is correct.

Given :

For Tool A, $n = 0.45$, $K = 90$

For Tool B, $n = 0.3$, $K = 60$

Now, From the Taylor's tool life equation ($VT^n = K$)

For Tool A, $V_A T_A^{0.45} = 90$ ...(i)

For Tool B, $V_B T_B^{0.3} = 60$ ...(ii)

On Dividing equation (i) by equation (ii), we get

$$\left(\frac{V_A}{V_B}\right) \times \frac{T_A^{0.45}}{T_B^{0.3}} = \frac{90}{60} \qquad ...(iii)$$

Let V is the speed above which tool A will have a higher life than B. But at V, $T_A = T_B$

Then $V_A = V_B = V(\text{let})$

$T_A = T_B = T(\text{let})$

So, from equation(iii) $\frac{T^{0.45}}{T^{0.3}} = \frac{3}{2}$

$$T^{0.45-0.3} = \frac{3}{2}$$

$$T = \left(\frac{3}{2}\right)^{\frac{1}{0.15}} = 14.92 \text{ min}.$$

From equation (i),

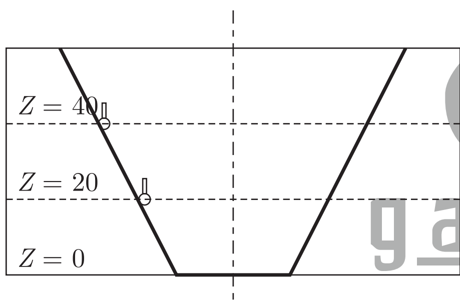
$$V \times T^{0.45} = 90$$

$$V \times (14.92)^{0.45} = 90$$

$$V = 26.67 \text{ m/min} \simeq 26.7 \text{ m/min}$$

MCQ 1.45 GATE ME 2010 TWO MARK

A taper hole is inspected using a CMM, with a probe of 2 mm diameter. At a height, $Z = 10$ mm from the bottom, 5 points are touched and a diameter of circle (not compensated for probe size) is obtained as 20 mm. Similarly, a 40 mm diameter is obtained at a height $Z = 40$ mm. The smaller diameter (in mm) of hole at $Z = 0$ is

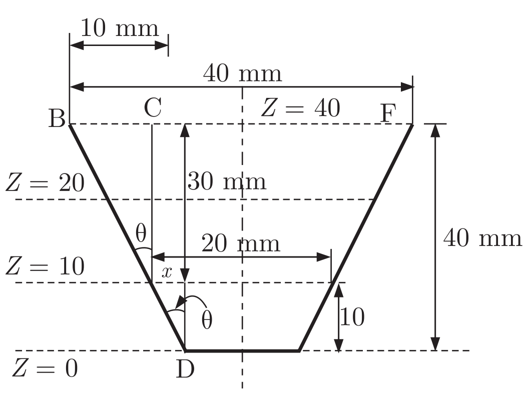


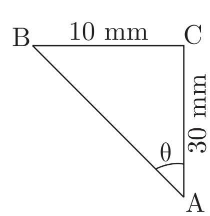
(A) 13.334 (B) 15.334

(C) 15.442 (D) 15.542

SOL 1.45 Option (A) is correct

Draw a perpendicular from the point A on the line BF, which intersect at point C.





Let Angle $\angle BAC = \theta$

And $AE = x$

Now, take the right angle triangle ΔABC,

$$\tan\theta = \frac{BC}{AC} = \frac{10}{30} = \frac{1}{3} \qquad \text{...(i)}$$

From the same triangle ΔADE,

$$\tan\theta = \frac{x}{DE} = \frac{x}{10}$$

Put the value of $\tan\theta$, from the equation (i),

So, $$\frac{1}{3} = \frac{x}{10}$$

$$x = \frac{10}{3}\text{ mm} = 3.333\text{ mm}$$

Now, diameter at $Z = 0$ is,

$$d = 20 - 2x = 20 - 2 \times 3.333$$
$$= 13.334\text{ mm}$$

MCQ 1.46 GATE ME 2010 TWO MARK

Annual demand for window frames is 10000. Each frame cost Rs. 200 and ordering cost is Rs. 300 per order. Inventory holding cost is Rs. 40 per frame per year. The supplier is willing of offer 2% discount if the order quantity is 1000 or more, and 4% if order quantity is 2000 or more. If the total cost is to be minimized, the retailer should

(A) order 200 frames every time (B) accept 2% discount

(C) accept 4% discount (D) order Economic Order Quantity

SOL 1.46 Option (C) is correct.

Given : $D = 10000$

Ordering cost C_o = Rs. 300 per order

Holding cost C_h = Rs. 40 per frame per year

Unit cost, C_u = Rs. 200

$$EOQ = \sqrt{\frac{2C_oD}{C_h}} = \sqrt{\frac{2 \times 300 \times 10000}{40}}$$

$$\simeq 387\text{ units}$$

Total cost = Purchase cost + holding cost + ordering cost

For $EOQ = 387$ units

$$\text{Total cost} = D \times C_u + \frac{Q}{2} \times C_h + \frac{D}{Q} \times C_o$$

Where $Q = EOQ = 387$ units

$$\text{Total cost} = 10000 \times 200 + \frac{387}{2} \times 40 + \frac{10000}{387} \times 300$$

$$= 2000000 + 7740 + 7752$$
$$= \text{Rs. } 2015492$$

Now supplier offers 2% discount if the order quantity is 1000 or more.

For $Q = 1000$ units

$$\text{Total cost} = 10000 \times (200 \times 0.98) + \frac{1000}{2} \times 40 + \frac{10000}{1000} \times 300$$

$$= 1960000 + 20000 + 3000$$
$$= \text{Rs. } 1983000$$

Supplier also offers 4% discount if order quantity is 2000 or more.

For $\quad Q = 2000$ units

$$\text{Total cost} = 10000 \times (200 \times 0.96) + \frac{2000}{2} \times 40 + \frac{10000}{2000} \times 300$$

$$= 1920000 + 40000 + 1500$$

$$= \text{Rs.}\, 1961500$$

It is clearly see that the total cost is to be minimized, the retailer should accept 4% discount.

MCQ 1.47

GATE ME 2010
TWO MARK

The project activities, precedence relationships and durations are described in the table. The critical path of the project is

Activity	Precedence	Duration (in days)
P	-	3
Q	-	4
R	P	5
S	Q	5
T	R, S	7
U	R, S	5
V	T	2
W	U	10

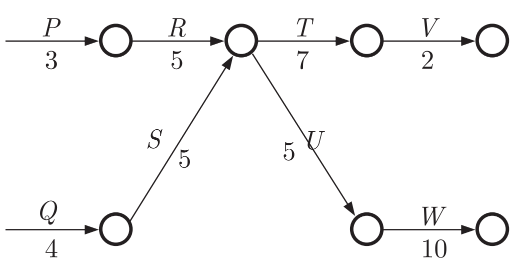
(A) P-R-T-V (B) Q-S-T-V

(C) P-R-U-W (D) Q-S-U-W

SOL 1.47

Option (D) is correct.

We have to draw a arrow diagram from the given data.



Here Four possible ways to complete the work.

	Path	Total duration (days)
(i)	$P - R - T - V$	$T = 3 + 5 + 7 + 2 = 17$
(ii)	$Q - S - T - V$	$T = 4 + 5 + 7 + 2 = 18$
(iii)	$Q - S - U - W$	$T = 4 + 5 + 5 + 10 = 24$

(iv)	$P-R-U-W$	$T=3+5+5+10=23$

The critical path is the chain of activities with the longest time durations.

So, Critical path $= Q-S-U-W$

Common Data for Q. (48-49)

In a steam power plant operating on the Rankine cycle, steam enters the turbine at $4\,\text{MPa}$, 350°C and exists at a pressure of $15\,\text{kPa}$. Then it enters the condenser and exits as saturated water. Next, a pump feeds back the water to the boiler. The adiabatic efficiency of the turbine is 90%. The thermodynamic states of water and steam are given in table.

State	$h(\text{kJkg}^{-1})$		$s(\text{kJkg}^{-1}\text{K}^{-1})$		$\nu(\text{m}^3\text{kg}^{-1})$	
Steam : 4 MPa, 350°C	3092.5		6.5821		0.06645	
Water : 15 kPa	h_f	h_g	s_f	s_g	ν_f	ν_g
	225.94	2599.1	0.7549	8.0085	0.001014	10.02

h is specific enthalpy, s is specific entropy and ν the specific volume; subscripts f and g denote saturated liquid state and saturated vapor state.

MCQ 1.48 GATE ME 2010 TWO MARK

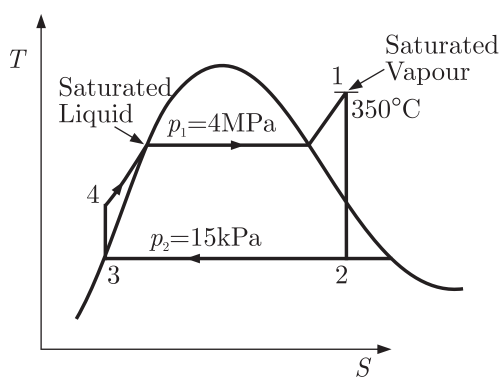
The net work output (kJkg^{-1}) of the cycle is

(A) 498 (B) 775

(C) 860 (D) 957

SOL 1.48 Option (C) is correct.

Given T-s curve is for the steam plant



Given : $p_1 = 4\,\text{MPa} = 4\times10^6\,\text{Pa}$, $T_1 = 350^{\circ}\text{C} = (273+350)\,\text{K} = 623\,\text{K}$

$p_2 = 15\,\text{kPa} = 15\times10^3\,\text{Pa}$, $\eta_{adiabatic} = 90\% = 0.9$

Now from the steam table,

Given data : $h_1 = 3092.5\,\text{kJ/kg}$, $h_3 = h_f = 225.94\,\text{kJ/kg}$, $h_g = 2599.1\,\text{kJ/kg}$

$$s_1 = s_2 = s_f + x(s_g - s_f) \quad \text{...(i)}$$

Where, x = dryness fraction

From the table, we have

$$s_f = 0.7549 \text{ kJ/kg K}$$
$$s_g = 8.0085 \text{ kJ/kg K}$$
$$s_1 = s_2 = 6.5821$$

From equation (i),

$$x = \frac{s_2 - s_f}{s_g - s_f} = \frac{6.5821 - 0.7549}{8.0085 - 0.7549} = 0.8033$$

And,

$$h_2 = h_f + x(h_g - h_f)$$
$$= 225.94 + 0.8033(2599.1 - 225.94)$$
$$= 225.94 + 1906.36 = 2132.3 \text{ kJ/kg}$$

Theoretical turbine work from the cycle is given by,

$$W_T = h_1 - h_2$$
$$= 3092.5 - 2132.3 = 960.2 \text{ kJ/kg}$$

Actual work by the turbine,

$$= \text{Theoretical work} \times \eta_{adiabatic}$$
$$= 0.9 \times 960.2 = 864.18 \text{ kJ/kg}$$

Pump work, $W_p = \nu_f(p_1 - p_2)$

$$= 0.001014(4000 - 15) = 4.04 \text{ kJ/kg}$$
$$W_{net} = W_T - W_p = 864.18 - 4.04 = 860.14 \text{ kJ/kg} \approx 860$$

MCQ 1.49 Heat supplied (kJkg^{-1}) to the cycle is

GATE ME 2010 TWO MARK

(A) 2372 (B) 2576

(C) 2863 (D) 3092

SOL 1.49 Option (C) is correct.

Heat supplied $= h_1 - h_4$ From T-s diagram

From the pump work equation,

$$W_p = h_4 - h_3$$
$$h_4 = W_p + h_3 = 4.04 + 225.94 = 229.98 \text{ kJ/kg}$$

And Heat supplied,

$$Q = h_1 - h_4$$
$$= 3092.50 - 229.98 = 2862.53 \simeq 2863 \text{ kJ/kg}$$

Common Data for Q. (50-51) :

Four jobs are to be processed on a machine as per data listed in the table.

Job	Processing time (in days)	Due date
1	4	6
2	7	9
3	2	19

4	8	17

MCQ 1.50 GATE ME 2010 TWO MARK

If the Earliest Due Date (EDD) rule is used to sequence the jobs, the number of jobs delayed is

(A) 1 (B) 2

(C) 3 (D) 4

SOL 1.50 Option (C) is correct.

In the Earliest due date (EDD) rule, the jobs will be in sequence according to their earliest due dates.

Table shown below :

Job	Processing time (in days)	Due date	Operation start	Operation end
1	4	6	0	$0+4=4$
2	7	9	4	$4+7=11$
4	8	17	11	$11+8=19$
3	2	19	19	$19+2=21$

We see easily from the table that, job 2, 4, & 3 are delayed.

Number of jobs delayed is 3.

MCQ 1.51 GATE ME 2010 TWO MARK

Using the Shortest Processing Time (SPT) rule, total tardiness is

(A) 0 (B) 2

(C) 6 (D) 8

SOL 1.51 Option (D) is correct.

By using the shortest processing time (SPT) rule & make the table

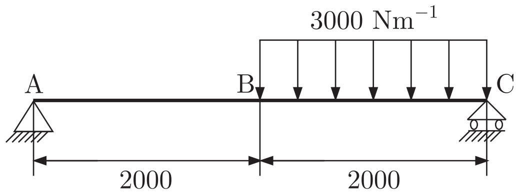
Job	Processing time (in days)	Flow time		Due date	Tradiness
		Start	End		
3	2	0	2	19	0
1	4	2	$2+4=6$	6	0
2	7	6	$6+7=13$	9	4
4	8	13	$13+8=21$	17	4

So, from the table

$$\text{Total Tradiness} = 4+4 = 8$$

Statement for Linked Answer Q. (52-53) :

A massless beam has a loading pattern as shown in the figure. The beam is of rectangular cross-section with a width of 30 mm and height of 100 mm

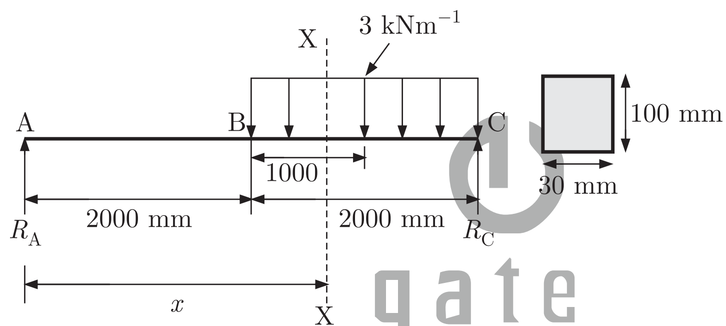


MCQ 1.52 The maximum bending moment occurs at

GATE ME 2010 TWO MARK

(A) Location B
(B) 2675 mm to the right of A
(C) 2500 mm to the right of A
(D) 3225 mm to the right of A

SOL 1.52 Option (C) is correct.



First of all we have to make the FBD of the given system.
Let R_A & R_C are the reactions acting at point A & C respectively.
In the equilibrium condition of forces,

$$R_A + R_C = 6000\text{ N} \qquad \text{...(i)}$$

Taking moment about point A,

$$R_C \times 4 = 6000 \times 3$$

$$R_C = \frac{18000}{4} = 4500\text{ N} = 4.5\text{ kN}$$

And from equation (i),

$$R_A = 6000 - 4500 = 1500\text{ N} = 1.5\text{ kN}$$

Taking a section $X - X$ at a distance x from A and taking the moment about this section

$$M_{XX} = R_A \times x - 3(x-2) \times \frac{(x-2)}{2} \qquad F = 3(x-2) \text{ \& } d = \frac{x-2}{2}$$

$$M_{XX} = 1.5x - 1.5(x-2)^2 \qquad \text{...(ii)}$$

For maximum Bending moment,

$$\frac{d}{dx}(M_{XX}) = 0$$

$$1.5 - 2 \times 1.5(x-2) = 0$$

$$1.5 - 3x + 6 = 0$$

$$-3x = -7.5$$
$$x = 2.5\text{ m} = 2500\text{ mm}$$

So the maximum bending moment occurs at 2500 mm to the right of A.

MCQ 1.53 The maximum magnitude of bending stress (in MPa) is given by

GATE ME 2010 TWO MARK

(A) 60.0 (B) 67.5

(C) 200.0 (D) 225.0

SOL 1.53 Option (B) is correct.

From the equation (ii) of the previous part, we have

Maximum bending moment at $x = 2.5$ m is,

$$(BM)_{2.5\text{ m}} = 1.5\times 2.5 - 1.5(2.5-2)^2 = 3.375\text{ kN-m}$$

From the bending equation,

$$\sigma_b = \frac{M}{I}\times y = \frac{M}{\frac{bh^3}{12}}\times\frac{h}{2}$$

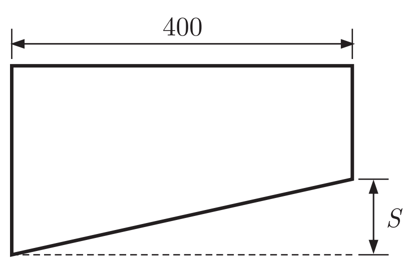
$$\sigma_b = \frac{6M}{bh^2}$$

Substitute the values, we get

$$\sigma_b = \frac{6\times 3375}{0.030\times(0.1)^2} = 67.5\times 10^6\text{ N/m}^2 = 67.5\text{ MPa}$$

Statement for Linked Answer Questions 54 and 55

In shear cutting operation, a sheet of 5 mm thickness is cut along a length of 200 mm. The cutting blade is 400 mm long (see fig.) and zero-shear ($S = 0$) is provided on the edge. The ultimate shear strength of the sheet is 100 MPa and penetration to thickness ratio is 0.2. Neglect friction.



MCQ 1.54 Assuming force vs displacement curve to be rectangular, the work done (in J) is

GATE ME 2010 TWO MARK

(A) 100 (B) 200

(C) 250 (D) 300

SOL 1.54 Option (B) is correct.

Given : $t = 5\text{ mm}$, $L = 200\text{ mm}$, $\tau_s = 100\text{ MPa}$

Penetration to thickness ratio $\frac{p}{t} = 0.2 = k$

Force vs displacement curve to be rectangle, So, Shear area, $A = (200 + 200) \times 5 = 2000\,\text{mm}^2$

Work done, $W = \tau \times A \times k \times t$

Substitute the values, we get

$$W = 100 \times 10^6 \times 2000 \times 10^{-6} \times 0.2 \times 5 \times 10^{-3}$$
$$= 100 \times 2 \times 0.2 \times 5 = 200\ \text{Joule}$$

MCQ 1.55 GATE ME 2010 TWO MARK

A shear of 20 mm ($S = 0$ mm) is now provided on the blade. Assuming force vs displacement curve to be trapezoidal, the maximum force (in kN) exerted is

(A) 5 (B) 10

(C) 20 (D) 40

SOL 1.55 Option (B) is correct.

Given : Shear $S = 20$ mm

Now force vs displacement curve to be trapezoidal.

So, maximum force is given by,

$$F_{\max} = \frac{W}{(kt + \text{Shear})} = \frac{200}{(0.2 \times 5 + 20) \times 10^{-3}}$$
$$= \frac{200}{21} \times 10^{-3} = 9.52 \times 10^3 \simeq 10\ \text{kN}$$

MCQ 1.56 GATE ME 2010 ONE MARK

25 persons are in a room 15 of them play hockey, 17 of them play football and 10 of them play hockey and football. Then the number of persons playing neither hockey nor football is

(A) 2 (B) 17

(C) 13 (D) 3

SOL 1.56 Option (D) is correct.

Number of people who play hockey

$n(A) = 15$

Number of people who play football

$$n(B) = 17$$

Persons who play both hockey and football $n(A \cap B) = 10$

Persons who play either hockey or football or both :

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$
$$= 15 + 17 - 10 = 22$$

Thus people who play neither hockey nor football $= 25 - 22 = 3$

MCQ 1.57 GATE ME 2010 ONE MARK

Choose the most appropriate word from the options given below to complete the following sentence :

If we manage to .... our natural resources, we would leave a better planet for our children.

(A) unhold (B) restrain

(C) cherish (D) conserve

SOL 1.57 Option (D) is correct.

Here conserve is most appropriate word.

MCQ 1.58 GATE ME 2010 ONE MARK

The question below consist of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.

Unemployed : Worker

(A) Fallow : Land (B) Unaware : Sleeper

(C) Wit : Jester (D) Renovated : House

SOL 1.58 Option (B) is correct.

A worker may by unemployed. Like in same relation a sleeper may be unaware.

MCQ 1.59 GATE ME 2010 ONE MARK

Which of the following options is the closest in meaning to the word below ?

Circuitous

(A) Cyclic (B) Indirect

(C) Confusing (D) Crooked

SOL 1.59 Option (B) is correct.

Circuitous means round about or not direct. Indirect is closest in meaning to this circuitous

(A) Cyclic : Recurring in nature

(B) Indirect : Not direct

(C) Confusing : lacking clarity of meaning

(D) Crooked : set at an angle; not straight

MCQ 1.60 GATE ME 2010 ONE MARK

Choose the most appropriate word from the options given below to complete the following sentence :

His rather casual remarks on politics..................his lack of seriousness about the subject.

(A) masked (B) belied

(C) betrayed (D) suppressed

SOL 1.60 Option (C) is correct.

Betrayed means reveal unintentionally that is most appropriate.

MCQ 1.61 GATE ME 2010 TWO MARK

Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters.) All were born on 1^{st} January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts :

1. Hari's age + Gita's age > Irfan's age + Saira's age.
2. The age difference between Gita and Saira is 1 year. However, Gita is not the oldest and Saira is not the youngest.
3. There are no twins.

In what order were they born (oldest first) ?

(A) HSIG (B) SGHI

(C) IGSH (D) IHSG

SOL 1.61 Option (B) is correct.

Let H, G, S and I be ages of Hari, Gita, Saira and Irfan respectively.

Now from statement (1) we have $H+G>I+S$

Form statement (2) we get that $G-S=1$ or $S-G=1$

As G can't be oldest and S can't be youngest thus either GS or SG possible.

From statement (3) we get that there are no twins

(A) HSIG : There is I between S and G which is not possible

(B) SGHI : SG order is also here and $S>G>H>I$ and $G+H>S+I$ which is possible.

(C) IGSH : This gives $I>G$ and $S>H$ and adding these both inequalities we have $I+S>H+G$ which is not possible.

(D) IHSG : This gives $I>H$ and $S>G$ and adding these both inequalities we have $I+S>H+G$ which is not possible.

MCQ 1.62 GATE ME 2010 TWO MARK

5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall ?

(A) 20 days (B) 18 days

(C) 16 days (D) 15 days

SOL 1.62 Option (D) is correct.

Let W be the total work.

Per day work of 5 skilled workers $=\dfrac{W}{20}$

Per day work of one skill worker $=\dfrac{W}{5\times 20}=\dfrac{W}{100}$

Similarly per day work of 1 semi-skilled workers $=\dfrac{W}{8\times 25}=\dfrac{W}{200}$

Similarly per day work of one semi-skill worker $=\dfrac{W}{10\times 30}=\dfrac{W}{300}$

Thus total per day work of 2 skilled, 6 semi-skilled and 5 unskilled workers is

$$=\frac{2W}{100}+\frac{6W}{200}+\frac{5W}{300}=\frac{12W+18W+10W}{600}=\frac{W}{15}$$

Therefore time to complete the work is 15 days.

MCQ 1.63 GATE ME 2010 TWO MARK

Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare ; and regretfully, their exist people in military establishments who think that chemical agents are useful fools for their cause.

Which of the following statements best sums up the meaning of the above passage ?

(A) Modern warfare has resulted in civil strife.

(B) Chemical agents are useful in modern warfare.

(C) Use of chemical agents in ware fare would be undesirable.

(D) People in military establishments like to use chemical agents in war.

SOL 1.63 Option (D) is correct.

MCQ 1.64 Given digits 2, 2, 3, 3, 3, 4, 4, 4, 4 how much distinct 4 digit numbers greater than 3000 can be formed ?

GATE ME 2010
TWO MARK

(A) 50 (B) 51

(C) 52 (D) 54

SOL 1.64 Option (B) is correct.

As the number must be greater than 3000, it must be start with 3 or 4. Thus we have two case:

Case (1) If left most digit is 3 an other three digits are any of 2, 2, 3, 3, 4, 4, 4, 4.

(1) Using 2, 2, 3 we have 3223, 3232, 3322 i.e. $\frac{3!}{2!} = 3$ no.

(2) Using 2,2,4 we have 3224, 3242, 3422 i.e. $\frac{3!}{2!} = 3$ no.

(3) Using 2,3,3 we have 3233,3323,3332 i.e. $\frac{3!}{2!} = 3$ no.

(4) Using 2,3,4 we have $3! = 6$ no.

(5) Using 2,4,4 we have 3244, 3424, 3442 i.e. $\frac{3!}{2!} = 3$ no.

(6) Using 3,3,4 we have 3334, 3343, 3433 i.e. $\frac{3!}{2!} = 3$ no.

(7) Using 3,4,4 we have 3344,3434,3443 i.e. $\frac{3!}{2!} = 3$ no.

(8) Using 4,4,4 we have 3444 i.e. $\frac{3!}{3!} = 1$ no.

Total 4 digit numbers in this case is

$1 + 3 + 3 + 3 + 6 + 3 + 3 + 3 + 1 = 25$

Case 2 : If left most is 4 and other three digits are any of 2, 2, 3, 3, 3, 4, 4, 4.

(1) Using 2,2,3 we have 4223, 4232, 4322 i.e. . $\frac{3!}{2!} = 3$ no

(2) Using 2,2,4 we have 4224, 4242, 4422 i.e. . $\frac{3!}{2!} = 3$ no

(3) Using 2,3,3 we have 4233, 4323, 4332 i.e. . $\frac{3!}{2!} = 3$ no

(4) Using 2,3,4 we have i.e. . $3! = 6$ no

(5) Using 2,4,4 we have 4244, 4424, 4442 i.e. . $\frac{3!}{2!} = 3$ no

(6) Using 3,3,3 we have 4333 i.e $\frac{3!}{3!} = 1$. no.

(7) Using 3,3,4 we have 4334, 4343, 4433 i.e. . $\frac{3!}{2!} = 3$ no

(8) Using 3,4,4 we have 4344, 4434, 4443 i.e. . $\frac{3!}{2!} = 3$ no

(9) Using 4,4,4 we have 4444 i.e. $\frac{3!}{3!} = 1$. no

Total 4 digit numbers in 2nd case $= 3 + 3 + 3 + 6 + 3 + 3 + 1 + 3 + 1 = 26$
Thus total 4 digit numbers using case (1) and case (2) is $= 25 + 26 = 51$

MCQ 1.65 If $137 + 276 = 435$ how much is $731 + 672$?

GATE ME 2010 TWO MARK

(A) 534 (B) 1403

(C) 1623 (D) 1531

SOL 1.65 Option (C) is correct.

Since $7 + 6 = 13$ but unit digit is 5 so base may be 8 as 5 is the remainder when 13 is divided by 8. Let us check.

$$\begin{array}{r} 137_8 \\ \underline{276_8} \\ 435 \end{array} \quad \text{Thus here base is 8. Now} \quad \begin{array}{r} 731_8 \\ \underline{672_8} \\ 1623 \end{array}$$

Answer Sheet									
1.	(D)	14.	(C)	27.	(A)	40.	(B)	53.	(B)
2.	(B)	15.	(A)	28.	(D)	41.	(B)	54.	(B)
3.	(D)	16.	(D)	29.	(A)	42.	(B)	55.	(B)
4.	(B)	17.	(B)	30.	(C)	43.	(C)	56.	(D)
5.	(C)	18.	(C)	31.	(D)	44.	(A)	57.	(D)
6.	(A)	19.	(A)	32.	(B)	45.	(A)	58.	(B)
7.	(C)	20.	(D)	33.	(A)	46.	(C)	59.	(B)
8.	(C)	21.	(C)	34.	(C)	47.	(D)	60.	(C)
9.	(A)	22.	(C)	35.	(A)	48.	(C)	61.	(B)
10.	(A)	23.	(B)	36.	(D)	49.	(C)	62.	(D)
11.	(D)	24.	(A)	37.	(C)	50.	(C)	63.	(D)
12.	(B)	25.	(D)	38.	(D)	51.	(D)	64.	(B)
13.	(C)	26.	(B)	39.	(A)	52.	(C)	65.	(C)

GATE Multiple Choice Questions
For Mechanical Engineering

By NODIA and Company

Available in Three Volumes

Features:

- The book is categorized into chapter and the chapter are sub-divided into units
- Unit organization for each chapter is very constructive and covers the complete syllabus
- Each unit contains an average of 40 questions
- The questions match to the level of GATE examination
- Solutions are well-explained, tricky and consume less time. Solutions are presented in such a way that it enhances you fundamentals and problem solving skills
- There are a variety of problems on each topic
- Engineering Mathematics is also included in the book

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2.6 Design of beams and shafts
2.7 Deflection of beams and shafts
2.8 Column
2.9 Energy methods

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3.2 Design of joints
3.3 Design of shaft and shaft components
3.4 Design of spur gears
3.5 Design of bearings
3.6 Design of clutch and brakes

UNIT 4. Theory of Machine

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4.2 Velocity and acceleration
4.3 Dynamic analysis of slider-crank and cams
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4.6 vibration

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6.6 Free convection
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UNIT 8. Engineering Materials

8.1 Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials

UNIT 9. Metal Casting:

Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

UNIT 10. Forming:

Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

UNIT 11. Joining:

Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

UNIT 12. Machining and Machine Tool Operations:

Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

UNIT 13. Metrology and Inspection:

Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

UNIT 14. Computer Integrated Manufacturing:

Basic concepts of CAD/CAM and their integration tools.

UNIT 15. Production Planning and Control:

Forecasting models, aggregate production planning, scheduling, materials requirement planning

UNIT 16. Inventory Control:

Deterministic and probabilistic models; safety stock inventory control systems.

UNIT 17. Operations Research:

Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

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18.2 Differential Calculus

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18.6 Probability & Statistics

18.7 Numerical Methods