# Super Talent Batches

MADE EASY

India's Best Institute for IES, GATE & PSUs

*announcing*

## Mechanical Engineering

# Super Talent Batches

at **Delhi Centre**

1st Batch : Commencing from **Mid May**
Morning Batch

2nd Batch : Commencing from **Mid June**
Evening Batch

**Eligibility**
**(Any of the following)**

- Top 2000 Rank in GATE
- Appeared in IES or 3 PSUs Interview
- B.Tech from IIT
- B.Tech from NIT with 65% marks
- B.Tech from Private Engineering college with 70% marks

**Benefits**

- Better Teaching Environment
- Extra teaching hours
- In-depth coverage of subjects

**Q.1** The process utilizing mainly thermal energy for removing material is

(a) USM (b) ECM

(c) AJM (d) LBM

**Ans. (d)**

| **Method** | | **Mechanics of Removal** |
|---|---|---|
| USM | — | Brittle fracture |
| ECM | — | Electrolysis |
| AJM | — | Mechanical action |
| LBM | — | Melting, vaporization i.e., thermal |

End of Solution

**Q.2** Hot tearing in metal casting is due to

(a) high fluidity

(b) high melting point temperature

(c) wide range of solidification temperature

(d) low coefficient of thermal expansion

**Ans. (c)**

Due to residual stress, for wide range of solidification temperature hot tears develop in the casting.

End of Solution

**Q.3** A minimal spanning tree in network model involves

(a) all the nodes with cycle/loop allowed

(b) all the nodes with cycle/loop not allowed

(c) shortest path between start and end nodes

(d) All the nodes with directed

**Ans. (b)**

End of Solution

**Q.4** In which of the following options will the expression $P < M$ is true

(a) $M < R < P < S$ (b) $M > S < P < S$

(c) $Q < M < F < P$ (d) $P = A < R < M$

**Ans. (d)**

End of Solution

**Q.5** The value of one US dollar is ₹ 65 compared to last 60 year. The Indian rupee has

(a) depressed (b) depreciated

(c) appreciated (d) stabilized

**Ans. (b)**

Indian rupee has depreciated.

End of Solution

**Q.6** Advice is

(a) verb (b) noun
(c) adjective (d) both verb and noun

**Ans. (b)**

Advice is noun — mean suggestion.
Advice is verb — mean to give advice.

End of Solution

**Q.7** Next term of the sequence 7G, 11K, 13M, is

(a) 15Q (b) 17Q
(c) 15P (d) 17P

**Ans. (b)**

| | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | **7**<br>**G** |
| H | I | J | **11**<br>**K** | L | **13**<br>**M** | N |
| O | P | **17**<br>**Q** | R | S | T | U |

End of Solution

**Q.8** A man can row at 8 km/hr in still water. If it takes him thrice as long to row upstream as compared to row downstream velocity of flow in km/hr is

**Solution:**

Let the velocity of man in still water and velocity of flow is $V_1$ and $V_2$ respectively.

Given, $V_1 = 8$ km/hr

Time taken by the man when it rows along the flow direction

$$t = \frac{x}{V_1 + V_2} = \frac{x}{8 + V_2} \quad \text{...(i)}$$

and time taken when rows against the flow direction

$$3t = \frac{x}{8 - V_2} \quad \text{...(ii)}$$

Dividing eq. (ii) by (i), we get

$$3 = \frac{1}{(8 - V_2)} \times (8 + V_2)$$

$$\Rightarrow \quad 8 + V_2 = 24 - 3V_2$$

$$\Rightarrow \quad V_2 = 4 \text{ km/hr}$$

End of Solution

**Q.9** Consider objective function $Z(x_1, x_2) = 3x_1 + 9x_2$, with the constrains

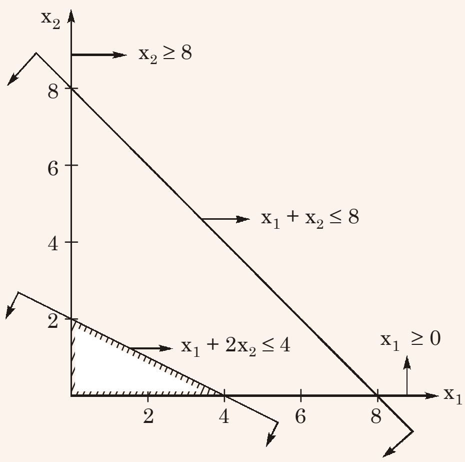
$x_1 + x_2 \le 8$

$x_1 + 2x_2 \le 4$

$x_1 \ge 0,\ x_2 \ge 0$

Then maximum value of objective function is ______

**Solution:**




$$(Z)_{4,\,0} = 3 \times 4 + 9 \times 0 = 12$$

$$(Z)_{0,\,2} = 3 \times 0 + 9 \times 2 = 18$$

$$(Z)_{max} = 18$$

End of Solution

**Q.10** The damping ratio of single DOF spring mass damping system, with mass of 1 kg, stiffness = 100 N/m and viscous damping coefficient of 25 Ns/m is

**Solution:**

Damping ratio, $\zeta = \dfrac{C}{C_c} = \dfrac{C}{2\sqrt{km}}$

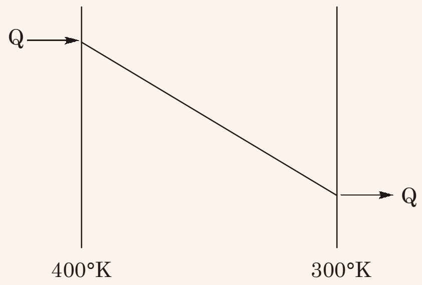
$$= \frac{25}{2\sqrt{1 \times 100}} = \frac{25}{20}$$

$$= 1.25$$

End of Solution

**Q.11** An amount of 100 kW of heat is transferred through a wall in steady state. One side of wall is maintained at 127°C and other at 27°C. The entropy generation (in W/K) is

**Solution:**




$$(S_2 - S_1) = \int_1^2 \frac{dQ}{T} + (\Delta S)_{gen}$$

$$\Rightarrow \quad 0 = \frac{100}{400} - \frac{100}{300} + (\Delta S)_{gen}$$

$$\Rightarrow \quad (\Delta S)_{gen} = 0.083 \text{ kW/K}$$

$$= 83.33 \text{ W/K}$$

**Alternate:**

$$\Delta S_1 = \frac{Q}{T_1} = \frac{Q}{400}$$

$$\Delta S_2 = \frac{Q}{T_2} = -\frac{Q}{300}$$

$$\therefore \quad \Delta S = \Delta S_1 + \Delta S_2$$

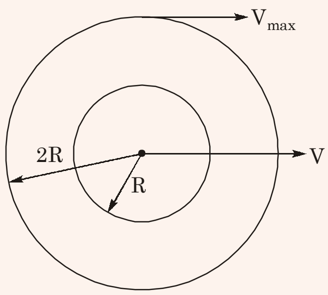
$$= \frac{100 \times 10^3}{400} - \frac{100 \times 10^3}{300}$$

$$= -\frac{1000}{12} = -83.33 \text{ W/K}$$

End of Solution

**Q.12** Annular disc has mass m, inner radius R, outer radius = 2R. Disc rolls on a flat surface without slipping. If the velocity of centre of mass is V. Then kinetic energy is

**Solution:**




$$I = \frac{m\left[(2R)^2 - R^2\right]}{2} = \frac{3}{2}mR^2$$

$$V_{max} = 2\omega R$$
$$V_{min} = 0$$

$$V = \frac{V_{max} + V_{min}}{2} = \omega R$$

Rotational K.E. $= \frac{1}{2}I\omega^2$

$$= \frac{1}{2} \times \frac{3}{2}mR^2 \times \frac{V^2}{R^2} = \frac{3}{4}mV^2$$

Linear K.E. $= \frac{1}{2}mV^2$

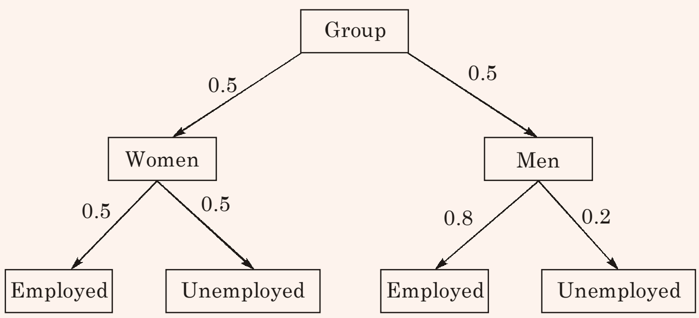
Total K.E. $= \frac{3}{4}mV^2 + \frac{1}{2}mV^2$

$$= \frac{5}{4}mV^2$$

End of Solution

**Q.13** A group consisting of equal no. of men and women. Of the group 20% of men and 50% of women are unemployed. If a person is selected at random from this group. The probability of selected person being employed is

**Solution:**



Probability of selected person being employed

$$= 0.5 \times 0.5 + 0.5 \times 0.8$$
$$= 0.25 + 0.40$$
$$= 0.65$$

End of Solution

**Q.14** Next term of the series 81, 54, 36, 24 is

**Solution:**

81, 54, 36, 24

$1 \times 3^4$, $2 \times 3^3$, $4 \times 3^2$, $8 \times 3^1$, $16 \times 3^0$

Ans. 16

End of Solution

**Q.15** Actual scales of product in different month of a particular year are given below

| Sep. | Oct. | Nov. | Dec. | Jan. | Feb |
|---|---|---|---|---|---|
| 180 | 280 | 250 | 190 | 240 | ? |

The forecast at the sales, using the 4 month moving average method for the month of Feb is

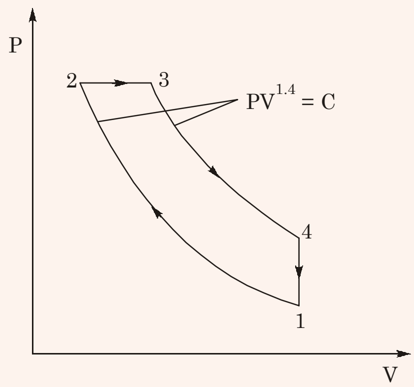
**Solution:**

$$f_{Feb} = \frac{250 + 250 + 190 + 240}{4}$$
$$= 240$$

End of Solution

**Q.16** A Diesel engine has a compression ratio 17 and cutoff take place at 10% of the stroke. Assuming ratio of specific heat $\gamma$ = 1.4. The air standard efficiency in percent is

**Solution:**



$$(V_3 - V_2) = \frac{10}{100}(V_1 - V_2)$$

$$\Rightarrow \quad \frac{V_3 - V_2}{V_1 - V_2} = 0.1$$

$$\Rightarrow \quad \frac{\frac{V_3}{V_2} - 1}{\frac{V_1}{V_2} - 1} = 0.1$$

$$\Rightarrow \quad \frac{\rho - 1}{r - 1} = 0.1$$

$$\Rightarrow \quad \frac{\rho - 1}{17 - 1} = 0.1$$

$$\Rightarrow \quad \rho = 2.6$$

($\rho$ = cut off ratio and r = compression ratio)

Thermal efficiency,

$$\eta_{th} = 1 - \frac{1}{r^{\gamma-1}}\left[\frac{\rho^{r} - 1}{\gamma(\rho - 1)}\right]$$

$$= 1 - \frac{1}{17^{0.4}}\left[\frac{2.6^{1.4} - 1}{1.4 \times (2.6 - 1)}\right]$$

$$= 59.6\%$$

End of Solution

**Q.17** Consider a simply supported beam of length 50h with a rectangular cross-section of depth 'h' and width 2h, the load carried at mid point. Find the ratio of the maximum shear stress to the maximum bending stress in the beam.

(a) 0.02 (b) 0.10
(c) 0.05 (d) 0.01

**Ans. (d)**

$$\gamma_{max} = \frac{3}{2}\frac{P}{A} = \frac{3P}{4h^2}$$

$$M_{max} = \frac{PL}{4} = \frac{P \times 50h}{4} = 12.5\,Ph$$

$$I = \frac{bh^2}{12}, \quad z = \frac{bh^2}{6}\ \frac{bh^2}{6} = \frac{2h \times h^2}{6} = \frac{h^3}{6}$$

$$\sigma_{max} = \frac{M_{max}}{z} = \frac{12.5Ph}{h^3} \times 6 = \frac{75P}{h^2}$$

$$\frac{\gamma_{max}}{\sigma_{max}} = \frac{0.75}{75} = 0.01$$

End of Solution

**Q.18** Which one of the following pair of equation describes an irreversible heat engine

(a) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} < 0$
(b) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} < 0$
(c) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} > 0$
(d) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} > 0$

**Ans. (a)**

Classius inequality for irreversible heat engine $\oint \frac{dQ}{T} < 0$.

Heat content of irreversible heat engine $dQ > 0$.

End of Solution

**Q.19** Definite integration $\int_1^3 \frac{1}{x} dx$ is evaluated using trapezoidal rule with size of 1. The correct answer is

**Solution:**

$$I = h\left[\frac{1}{2} f(a) + f(x_1) + \frac{1}{2} f(b)\right]$$

$$f(x) = \frac{1}{x},\ f(a) = f(1) = 1$$

$$f(x)_1 = f(2) = \frac{1}{2},\ f(b) = f(3) = \frac{1}{3}$$

$$\therefore \quad I = 1\left[\frac{1}{2} + \frac{1}{2} + \frac{1}{6}\right] = \frac{7}{6} = 1.167$$

End of Solution

**Q.20** If a function is continuous at a point

(a) the limit of function may not exist at that point

(b) the function must be derivative at that point

(c) limit of function at the point tends to infinity

(d) the limit must exist at the point and this value of limit should be same as the value of function at a point

**Ans. (d)**

End of Solution

**Q.21** A cylindrical riser of dia. 'd', height 'h' is situated at the top of casting and casting is of close type sand mold. Assume riser has constant volume, for the least rate of solidification h : d will be

(a) 1 : 2 (b) 2 : 1

(c) 1 : 4 (d) 4 : 1

**Ans. (a)**

For least solidification time, surface area should be minimum.

$$A = \pi dh + \frac{\pi d^2}{4} \quad \text{(for top riser)}$$

$$V = \frac{\pi}{4} d^2 h$$

$$\Rightarrow \quad h = \frac{4V}{\pi d^2}$$

$$A = \frac{4V}{d} + \frac{\pi}{4} d^2$$

For A to be minimum,

$$\frac{\partial A}{\partial d} = 0$$

$$\Rightarrow \quad -\frac{4V}{d^2} + \frac{\pi d}{2} = 0$$

$$\text{or} \quad d^3 = \frac{8V}{\pi} = \frac{8}{\pi}\frac{\pi}{4} d^2 \times h$$

$$\Rightarrow \quad \frac{h}{d} = \frac{1}{2} = 1 : 2$$

End of Solution

**Q.22** A machine produce 0, 1 and 2 defective piece in a day with associated probability $\frac{1}{6}, \frac{2}{3}$ and $\frac{1}{6}$ respectively. The mean value and variance of number of defective piece produced by machining in a day respectively are

(a) 1 and $\frac{1}{3}$  (b) $\frac{1}{3}$ and 1

(c) 1 and $\frac{4}{3}$  (d) $\frac{1}{3}$ and $\frac{4}{3}$

**Ans. (a)**

| x | 0 | 1 | 2 |
|---|---|---|---|
| f(x) | $\frac{1}{6}$ | $\frac{2}{3}$ | $\frac{1}{6}$ |

Mean, $\mu = \Sigma x_i f(x_i) = 0\times\frac{1}{6}+1\times\frac{2}{3}+2\times\frac{1}{6}=1$

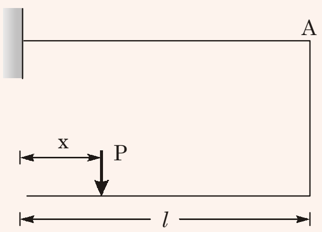
$$E(x)^2 = \Sigma x_i^2 f(x_i) = 0\times\frac{1}{6}+1^2\times\frac{2}{3}+2^2\times\frac{1}{6} = \frac{2}{3}+\frac{2}{3}=\frac{4}{3}$$

$$s^2 = \text{var}(x) = E(x^2) - \mu^2$$

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

End of Solution

**Q.23**

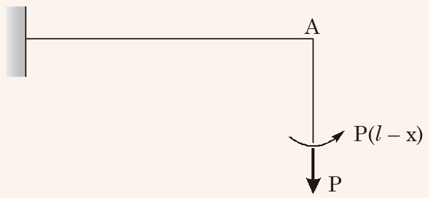



For what value of x deflection of A will be zero

(a) 0.25 $l$  (b) 0.50 $l$

(c) 0.33 $l$  (d) $l$

**Ans. (c)**




$$\frac{P(l-x)l^2}{2EI}-\frac{Pl^3}{3EI} = 0$$

$$\Rightarrow \quad \frac{l-x}{2} - \frac{l}{3} = 0$$

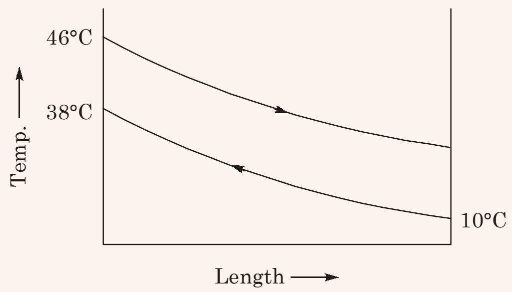
$$\Rightarrow \quad \frac{3l-3x-2l}{6} = 0$$

$$\Rightarrow \quad x = \frac{l}{3}$$

End of Solution

**Q.24** A double pipe counter flow heat exchanger transfers heat between two water streams. Tube side water at 19 *l*tr/s is heated from 10°C to 38°. Shell side water of 25 *l*ts/s is entering at 46°C. Assume constant properties of water, density is 1000 kg/m$^3$ and specific heat is 4186 J/kgK. The LMTD (in °C) is

**Solution:**




$$\rho = 1000 \text{ kg/m}^3$$

$$\dot{m}_c = 19 \text{ lit./s}$$

$$\dot{m}_h = 25 \text{ lit./s}$$

From energy balance,

$$\dot{m}_c C_w (38-10) = \dot{m}_h C_w (46-x)$$

$$\Rightarrow \quad \frac{19}{25} \times 28 = 46 - x$$

or $\quad x = 24.72°C$

$$T_{h_1} = 46°C, \; T_{h_2} = 24.72°C, \; T_{c_1} = 10°C, \; T_{c_2} = 38°C$$

$$\Delta T_1 = T_{h_1} - T_{c_1} = 46 - 38 = 8°C$$

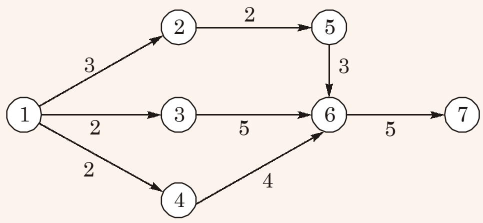
$$\Delta T_2 = T_{h_2} - T_{c_1} = 24.72 - 10 = 14.72°C$$

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\log_e\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{\Delta T_2 - \Delta T_1}{\log_e\left(\frac{\Delta T_2}{\Delta T_1}\right)} \qquad (\because \Delta T_2 > \Delta T_1)$$

$$\Delta T_{lm} = \frac{14.72 - 8}{\log_e\left(\frac{14.72}{8}\right)} = 11.0206°C$$

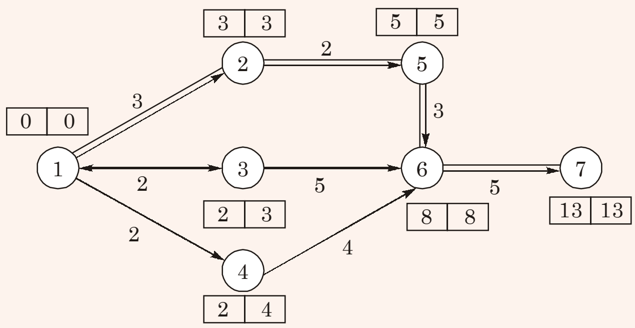
End of Solution

**Q.25** Consider the given project network, where numbers along various activities represent the normal time, the free float on activity 4-6 and project duration, respectively are




(a) 2, 13
(b) 0, 13
(c) –2, 13
(d) 2, 12

**Ans. (a)**




Project duration = 13
For 4-6 activity, free float = 8 – 4 – 2 = 2

End of Solution

**Q.26** The divergence of the vector field $x^2 y\hat{i} + xy\hat{j} + z^2\hat{k}$, P (1, 1, 1) is

(a) 2
(b) 4
(c) 5
(d) 1

**Ans. (c)**

$$\text{div}\left[x^2 y^2 \hat{i} + xy\hat{j} + z^2\hat{k}\right]$$

$$= \frac{\partial}{\partial x}\left(x^2 y\right) + \frac{\partial}{\partial y}(xy) + \frac{\partial}{\partial z}\left(z^2\right)$$

$$=- 2xy + x + 2z$$

At P(1, 1, 1)

div. at (1, 1, 1) is

$$= 2 \times 1 \times 1 + 1 + 2 \times 1$$

$$= 5$$

End of Solution

**Q.27** An analytic function of a complex variable $z = x + iy$ is expressed as $f(z) = u(x, y) + iv(x, y)$ where $l = \sqrt{-1}$, if $u = x^2 - y^2$ the expression for v should be

(a) $xy + C$
(b) $2xy + C$
(c) $xy - C$
(d) $x^2y^2 + C$

**Ans. (b)**

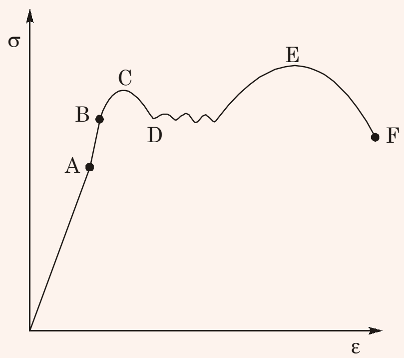
$$\frac{\partial u}{\partial z} = \frac{\partial v}{\partial y}$$

$$\Rightarrow \quad \frac{\partial v}{\partial y} = 2x$$

$$\therefore \quad v = 2xy + C$$

End of Solution

**Q.28** Match the following




1. Elastic limit
2. Limit of proportionality
3. Upper yield point
4. Ultimate stress
5. Lower yield point
6. Failure point

(a) A-2, B-1, C-3, D-5, E-4, F-6
(b) A-1, B-3, C-2, D-4, E-5, F-6
(c) A-3, B-2, C-1, D-4, E-5, F-6
(d) A-2, B-3, C-4, D-5, E-1, F-6

**Ans. (a)**

End of Solution

**Q.29** In a hollow cylindrical tube of length L, conductivity 'k', '$r_i$' is the inner radius and '$r_o$' is outer radius. $T_i$ is greater than $T_o$. The thermal resistance is

(a) $\frac{1}{2\pi kL}\ln\left(\frac{r_i}{r_o}\right)$

(b) $\frac{1}{2\pi kL}\ln\left(\frac{r_o}{r_i}\right)$

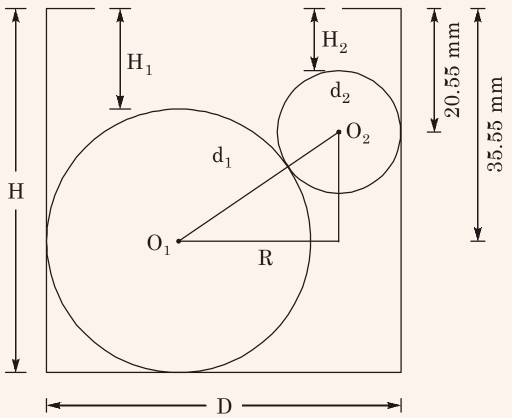
(c) $\frac{1}{2\pi kL}\ln(r_i \times r_o)$

(d) $2\pi kL\ln\left(\frac{r_i}{r_o}\right)$

**Ans.** **(b)**

End of Solution

**Q.30** Given, $d_1 = 60$, $d_2 = 40$. Find D = ?




**Solution:**

$d_1 = 60,\ d_2 = 40$

$$H = H_1 + d_1$$

$$O_1O_2 = \frac{d_1 + d_2}{2} = 50$$

$$H = H_2 + \frac{d_2}{2} + O_2P + \frac{d_1}{2} = H_1 + d_1$$

$$H = H_2 + 50 + O_2P = H_1 + 60$$

$$O_2P = (H_1 - H_2) + 10$$

$$H_1 = 35.55 - \frac{d_1}{2} = 35.5 - \frac{60}{2} = 5.55$$

$$H_2 = 20.55 - \frac{d_2}{2} = 20.55 - \frac{40}{2} = 0.55$$

$$D = \frac{d_1}{2} + O_1P + \frac{d_2}{2}$$

$$O_1P = \sqrt{(O_1O_2)^2 - (O_2P)^2}$$

$$= \sqrt{50^2 - [(H_1 - H_2) + 10]^2}$$

$$D = 50 + \sqrt{50^2 - [10 + (H_1 - H_2)]^2}$$

$$= 50 + \sqrt{50^2 - [10 + (5.55 - 0.55)]^2}$$

$$= 97.7$$

End of Solution

**Q.31** A fair coin is tossed infinite times then find the probability of 4th head occurs exactly at 10th times.

**Ans. (0.205)**

End of Solution

**Q.32** 100 bulbs produced by a company it having of 5 defective bulbs with it. For checking section verifies with by taking 4 bulbs at a time from 100 bulbs of there is any bulb is defective then it will be rejected otherwise it allow to marketing. The probability of getting non defective section of 100 bulbs is

**Ans. (0.95)**

End of Solution

**Q.33** India is a land of rich heritage and cultural diversity, which of the following points corroborates this

(a) In Indian cricket team, players are selected from more than 10 states
(b) There are more than 25 languages and over 2000 dialects
(c) India has 29 of states and 7 union tertiaries
(d) India population has 1.1 million people

**Ans. (b)**

End of Solution

**Q.34** The real root of the equation $5x - 2\cos x - 1 = 0$ (upto two decimal accuracy) is

**Solution:**

$$f(x) = 5x - 2\cos x - 1$$

$$f'(x) = 5 + 2\sin x$$

By Newton Raphson's equation

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Assuming $x_0 = 1$ $\quad$ (x = 1 rad. = 57.32°)

$\Rightarrow$ $$x_1 = 1 - \frac{5 \times 1 - 2\cos(57.32) - 1}{5 + 2\sin(57.32)}$$

$\Rightarrow$ $x_1 = 0.5632$

Iterating again

$$x_2 = 0.5632 - \frac{5 \times 0.5632 - 2\cos(32.27) - 1}{5 + 2\sin(32.27)}$$

$$= 0.5425$$

Iterating again

$$x_3 = 0.5425 - \frac{5 \times 0.5425 - 2\cos(31.09) - 1}{5 + 2\sin(31.09)}$$

$$= 0.5424$$

Required answer is 0.54

End of Solution

■■■■