



JEE (Main)

PAPER-2 (B.E./B. TECH.)

2022

COMPUTER BASED TEST (CBT) Memory Based Questions & Solutions

Date: 28 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 06.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: MATHEMATICS

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PART : MATHEMATICS

1. Let $f(x)$ be a quadratic polynomial such that $f(-2) + f(3) = 0$. If one root of $f(x) = 0$ is -1 , then the sum of roots of $f(x) = 0$ is

- (1) $\frac{11}{3}$
- (2) $\frac{11}{6}$
- (3) $\frac{14}{3}$
- (4) $\frac{17}{6}$

Ans. (1)

Sol. Let $f(x) = ax^2 + bx + c = a(x+1)(x-\alpha)$
 $f(-2) + f(3) = a(-2+1)(-2-\alpha) + a(3+1)(3-\alpha) = a(2+\alpha)$

$$f(-2) + f(3) = 0 \Rightarrow a(2 + \alpha + 12 - 4\alpha) = 0$$

$$\Rightarrow a \neq 0, -3\alpha + 14 = 0 \Rightarrow \alpha = \frac{14}{3}$$

roots are $= -1, \frac{14}{3}$

sum of roots $= -1 + \frac{14}{3} = \frac{11}{3}$

2. If n, A.M. are inserted between a and 100 such that the ratio of first mean and last mean equal to $\frac{1}{7}$ and

a + n = 33 then value of n is

- (1) 20 (2) 21 (3) 22 (4) 23

Ans. (4)

Sol. If d is common difference then $100 = a + (n + 1)d$

$$d = \frac{100 - a}{n + 1}$$

$$\frac{A_1}{A_n} = \frac{a + d}{100 - d} = \frac{1}{7}$$

$$\Rightarrow \frac{a + \frac{100 - a}{n + 1}}{100 - \frac{100 - a}{n + 1}} = \frac{1}{7}$$

$$\Rightarrow \frac{an + 100}{100n + a} = \frac{1}{7}$$

$$\Rightarrow 7an + 700 = 100n + a$$

$$\Rightarrow 7(33 - n)n + 700 = 100n + 33 - n$$

$$\Rightarrow 7n^2 - 132n - 667 = 0$$

$$\Rightarrow n = 23$$

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3. If e and l are respectively the eccentricity and length of latus rectum of hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ such that

$$e^2 = \frac{11}{14} l. \text{ If } e' \text{ \& } l' \text{ are the eccentricity and latus rectum of the conjugate hyperbola and } (e')^2 = \frac{11}{8} l' \text{ then}$$

the value of $77a + 44b$ is

- (1) 130 (2) 140 (3) 145 (4) 155

Ans. (1)

Sol. $e^2 = \frac{11}{14} l \Rightarrow 1 + \frac{b^2}{a^2} = \frac{11}{14} \cdot \frac{2b^2}{a}$

$$= a^2 + b^2 = \frac{11b^2 \cdot a}{7}$$

$$\Rightarrow 7a^2 + 7b^2 = 11ab^2 \dots\dots\dots(1)$$

$$\therefore (e')^2 = \frac{11}{8} l' \Rightarrow 1 + \frac{a^2}{b^2} = \frac{11}{8} \cdot \frac{2a^2}{b}$$

$$\Rightarrow a^2 + b^2 = \frac{11}{4} a^2 b$$

$$\Rightarrow 4a^2 + 4b^2 = 11a^2 b \dots\dots\dots(2)$$

equation (1) and (2)

$$\frac{7}{4} = \frac{b}{a}$$

$$\therefore 1 + \frac{b^c}{a^2} = \frac{11}{7} \Rightarrow 1 + \frac{49}{16} = \frac{11}{7} \times \frac{7}{4} \times b$$

$$\Rightarrow b = \frac{65}{44} \Rightarrow 44b = 65$$

$$\therefore 1 + \frac{a^2}{b^2} = 1 + \frac{16}{49} = \frac{11}{4} \times \frac{4}{7} \times a$$

$$\Rightarrow 65 = 77a$$

$$77a + 44b = 130$$

4. The term independent of x in $(1 - x^2 - 3x^3) \left(\frac{5}{2}x^3 - \frac{1}{5x^2}\right)^{11}$ is

(1) $\frac{33}{45}$

(2) $\frac{33}{90}$

(3) $\frac{33}{200}$

(4) $\frac{33}{180}$

Ans. (3)

Sol. $(1 - x^2 - 3x^3) \left(\frac{5}{2}x^3 - \frac{1}{5x^2}\right)^{11-r} \left(-\frac{1}{5x^2}\right)^r$

$$(1 - x^2 - 3x^3) \left(\frac{5}{2}\right)^{11-r} \left(-\frac{1}{5}\right)^r (x)^{33-5r}$$

$$33 - 5r \neq 0$$

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$$33 - 5r = -2$$

$$r = 7$$

$$33 - 5r \neq -3$$

$$\text{term independent of x is } = - {}^{11}C_7 \left(\frac{5}{2}\right)^4 \left(-\frac{1}{5}\right)^7$$

$$= \frac{11 \times 10 \times 9 \times 8}{24} \times \frac{5^4}{16} \times \frac{1}{5^7}$$

$$= \frac{33}{200}$$

5. If a curve $y = f(x)$ satisfies the differential equation $2y^2 e^{\frac{x}{y^2}} dx + (y^2 - 4xe^{\frac{x}{y^2}} y) dy = 0$, then the equation of curve is

(1) $2e^{\frac{x}{y^2}} = \frac{2}{y} + c$

(2) $e^{\frac{x}{y^2}} = \frac{1}{y} + c$

(3) $2e^{\frac{2x}{y^2}} = \frac{1}{y} + c$

(4) $2e^{\frac{x}{y^2}} = \frac{1}{y} + c$

Ans. (4)

Sol. $2y^2 e^{\frac{x}{y^2}} dx + (y^2 - 4xe^{\frac{x}{y^2}} y) dy = 0$

$$\Rightarrow (2y^2 dx - 4xy dy) e^{\frac{x}{y^2}} + y^2 dy = 0$$

$$\Rightarrow 2e^{\frac{x}{y^2}} \left(\frac{y^2 dx - 2xy dy}{y^4}\right) = -\frac{1}{y^2} dy$$

$$\Rightarrow \int 2e^{\frac{x}{y^2}} d\left(\frac{x}{y^2}\right) = \int -\frac{1}{y^2} dy$$

$$\Rightarrow 2e^{\frac{x}{y^2}} = \frac{1}{y} + c$$

6. The slope of tangent at a point (x, y) to the curve $y = f(x)$ is equal to $2 \tan x (\cos x - y)$, if the curve passes

through point $(\pi/4, 0)$ then the value of $\int_0^{\pi/2} f(x) dx$ is

(1) $2 - \frac{\pi}{\sqrt{2}}$

(2) $2 + \frac{\pi}{\sqrt{2}}$

(3) $4 - \frac{\pi}{\sqrt{2}}$

(4) $4 + \frac{\pi}{\sqrt{2}}$

Sol. Slope of tangent $\Rightarrow \frac{dy}{dx} = 2 \tan x (\cos x - y)$
 $\Rightarrow \frac{dy}{dx} + 2 \tan x \cdot y = 2 \sin x$
 I.F. = $e^{\int 2 \tan x dx} = e^{2 \int \sec x} = e^{2 \ln \sec x} = \sec^2 x$

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solution of equation

$$y \cdot \sec^2 x = \int \sec^2 x \cdot 2 \sin x dx + C$$

$$\Rightarrow y \sec^2 x = 2 \int \sec x \tan x dx + C$$

$$\Rightarrow y \sec^2 x = 2 \sec x + C$$

$$\because \text{curve passes through } \left(\frac{\pi}{4}, 0\right)$$

$$0 = 2 \sec \frac{\pi}{4} + C$$

$$C = -2\sqrt{2}$$

$$\Rightarrow \text{curve } y \sec^2 x = 2 \sec x - 2\sqrt{2}$$

$$\Rightarrow y = 2 \cos x - 2\sqrt{2} \cos^2 x = 2 \cos x - \sqrt{2} (1 + \cos 2x)$$

$$\int_0^{\pi/2} f(x) dx = \int_0^{\pi/2} (2 \cos x - \sqrt{2} - \sqrt{2} \cos 2x) dx = \left(2 \sin x - \sqrt{2}x - \frac{\sin 2x}{\sqrt{2}} \right)_0^{\pi/2}$$

$$\Rightarrow \left(2(1) - \sqrt{2} \cdot \frac{\pi}{2} - 0 \right) - (0 - 0 - 0) = 2 - \frac{\pi}{\sqrt{2}}$$

7. The value of $\lim_{n \rightarrow \infty} 6 \tan \left(\sum_{r=1}^n \tan^{-1} \frac{1}{r^2 + 3r + 3} \right)$ is

Ans. (3)

Sol. $\sum_{r=1}^n \tan^{-1} \left(\frac{1}{r^2 + 3r + 3} \right) = \sum_{r=1}^n \tan^{-1} \left(\frac{(r+2) - (r+1)}{1 + (r+1)(r+2)} \right)$

$$= \sum_{r=1}^n (\tan^{-1}(r+2) - \tan^{-1}(r+1))$$

$$= (\tan^{-1}(3) - \tan^{-1}(2)) + (\tan^{-1}(4) - \tan^{-1}(3)) + \dots + (\tan^{-1}(n+2) - \tan^{-1}(n+1))$$

$$= \tan^{-1}(n+2) - \tan^{-1}(2) = \tan^{-1} \left(\frac{(n+2) - 2}{1 + 2(n+2)} \right)$$

$$= \tan^{-1} \left(\frac{n}{2n+5} \right)$$

$$\lim_{n \rightarrow \infty} 6 \tan \left(\tan^{-1} \frac{n}{2n+5} \right) = \lim_{n \rightarrow \infty} \frac{6n}{2n+5} = 6 \times \frac{1}{2} = 3$$

8. Equation of plane passing through point (2, -1, 0) and perpendicular to planes $2x - 3y + z = 0$ and $2x - y - 3z = 0$ is.

(1) $5x + 4y + 2z + 6 = 0$

(2) $5x + 4y + 2z - 6 = 0$

(3) $5x - 4y + 2z - 6 = 0$

(4) $5x + 4y - 2z - 6 = 0$

Ans. (2)

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Sol. Normal of required plane

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -3 & 1 \\ 2 & -1 & -3 \end{vmatrix}$$

$$= \hat{i}(10) - \hat{j}(-6-2) + \hat{k}(-2+6)$$

$$= 10\hat{i} + 8\hat{j} + 4\hat{k}$$

equation of plane

$$10(x-2) + 8(y+1) + 4(z-0) = 0$$

$$5x + 4y + 2z - 6 = 0$$

9. If $\cot\alpha = 1$, $\alpha \in (\pi, \frac{3\pi}{2})$ and $\sec\beta = \frac{-5}{3}$, $\beta \in (\frac{\pi}{2}, \pi)$, then the value $\tan(\alpha + \beta)$ and $\alpha + \beta$ lies in quadrant

- (1) $\frac{1}{7}$, Ist quadrant (2) $\frac{-1}{7}$, Ist quadrant
 (3) $\frac{-1}{7}$, IVth quadrant (4) $\frac{1}{7}$, IVth quadrant

Ans. (3)

Sol. $\cot\alpha = 1 \Rightarrow \tan\alpha = 1$

$$\sec\beta = \frac{-5}{3} \Rightarrow \tan\beta = \frac{-4}{3}$$

$$\text{Now } \tan(\alpha + \beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha \tan\beta}$$

$$= \frac{1 - \frac{4}{3}}{1 - 1 \times (\frac{-4}{3})} = \frac{-1}{7}$$

$$\text{also } \pi < \alpha < \frac{3\pi}{2}$$

$$\frac{\pi}{2} < \beta < \pi$$

$$\frac{3\pi}{2} < \alpha + \beta < \frac{5\pi}{2}$$

Since $\tan(\alpha + \beta)$ is negative so $\alpha + \beta$ lies in IV quadrant

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10. Let $f(x)$ be a continuous function such that $f(\pi/4) = \sqrt{2}$, $f(\pi/2) = 0$, $f(3\pi/4) = 1$ and $g(x) =$

$$\int_x^{\pi/4} (f'(t)\sec t + \sec t \cdot \tan t \cdot f(t)) dt, \text{ then the value of } \lim_{x \rightarrow \frac{\pi}{2}} g(x) \text{ is}$$

Ans. (03.00)

Sol. $g(x) = \int_x^{\pi/4} (f'(t)\sec t + \sec t \cdot \tan t \cdot f(t)) dt = (f(t)\sec t)_x^{\pi/4}$

$$= f\left(\frac{\pi}{4}\right) \cdot \sec \frac{\pi}{4} - f(x) \cdot \sec x$$

$$= 2 - \frac{f(x)}{\cos x}$$

$$\lim_{x \rightarrow \frac{\pi}{2}} g(x) = \lim_{x \rightarrow \frac{\pi}{2}} \left(2 - \frac{f(x)}{\cos x} \right) = 2 - \lim_{x \rightarrow \frac{\pi}{2}} \frac{f(x)}{\cos x} \rightarrow \frac{0}{0} \text{ form}$$

$$= 2 - \lim_{x \rightarrow \frac{\pi}{2}} \frac{f'(x)}{-\sin x} = 2 + \frac{f'\left(\frac{\pi}{2}\right)}{\sin \frac{\pi}{2}}$$

$$= 2 + 1 = 3$$

11. Vertex of parabola is (2,-1), and equation of its directrix is $4x - 3y = 21$ then length of latus rectum of parabola is

- (1) 2 (2) 8 (3) 3 (4) 4

Ans. (2)

Sol. Distance between directrix and vertex is $a = \left| \frac{8+3-21}{5} \right| = 2$

Now length of latus rectum = $4a = 8$

12. If $z = x + iy$ is a complex number satisfies $\bar{z} = iz^2 + z - i$ then sum of square of all values of z satisfies given equation is

- (1) 1 (2) 2 (3) 3 (4) 4

Ans. (1)

Sol. $\bar{z} = iz^2 + z - i$

$$x - iy = i(x + iy)^2 + (x + iy) - i$$

$$x - iy = i(x^2 - y^2 + 2xyi) + x + iy - i$$

compare real and imaginary part

$$x = -2xy + x \Rightarrow x = 0 \text{ or } y = 0$$

$$-y = x^2 - y^2 + y - 1 \Rightarrow x^2 - y^2 + 2y - 1 = 0$$

$$\text{when } x = 0 \Rightarrow y^2 - 2y + 1 = 0 \Rightarrow (y - 1)^2 = 0 \Rightarrow y = 1$$

$$\text{when } y = 0 \Rightarrow x^2 - 1 = 0 \Rightarrow x = \pm 1$$

Hence complex number $z = i, 1, -1$

sum of square is $= (i)^2 + (1)^2 + (-1)^2 = 1$

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13. If $\lim_{x \rightarrow 1} \frac{\sin(3x^2 + x - 4) - x^2 + 1}{2x^3 - 7x + ax + b} = -2$, then the value of $b - a$ is

Ans. (08.00)

Sol. For finite non-zero limit it should be $\frac{0}{0}$ form

$$\text{So, by denominator } 2 - 7 + a + b = 0$$

$$\Rightarrow a + b = 5$$

Now

$$\lim_{x \rightarrow 1} \frac{\sin(3x^2 + x - 4) - x^2 + 1}{2x^3 - 7x + ax + b} = -2$$

by L-H rule

$$\lim_{x \rightarrow 1} \frac{\cos(3x^2 + x - 4) \times (6x + 1) - 2x}{6x^2 - 7 + a} = -2$$

$$\Rightarrow \frac{1 \times (7) - 2}{6 - 7 + a} = -2$$

$$5 = -2(a - 1)$$

$$\Rightarrow -\frac{5}{2} + 1 = a$$

$$a = -\frac{3}{2}$$

$$= 5 + \frac{3}{2} = \frac{13}{2}$$

$$\text{so } b - a = \frac{13}{2} + \frac{3}{2} = 8$$

14. The area bounded by x-axis and $y = 3 - |x + 1| - |x - \frac{1}{2}|$ is
- (1) $\frac{27}{7}$ (2) $\frac{27}{8}$ (3) $\frac{29}{7}$ (4) $\frac{25}{7}$

Ans. (2)

Sol. $y = 3 - |x + 1| - |x - \frac{1}{2}|$

$$y = \begin{cases} 3x + x + 1 + x - \frac{1}{2} & x < -1 \\ 3 - x - 1 + x - \frac{1}{2} & -1 \leq x \leq \frac{1}{2} \\ 3 - x - 1 - x + \frac{1}{2} & x \geq \frac{1}{2} \end{cases}$$

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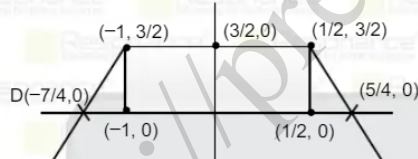
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$$y = \begin{cases} 2x + \frac{7}{2} & x < -1 \\ \frac{3}{2} & -1 \leq x \leq \frac{1}{2} \\ -2x + \frac{5}{2} & x \geq \frac{1}{2} \end{cases}$$



$$\text{Required area} = \frac{3}{2} \times \frac{3}{2} + \frac{1}{2} \left(\frac{3}{2} \times \frac{3}{4} \right) = \frac{1}{2} \left(\frac{3}{2} \times \frac{3}{4} \right)$$

$$= \frac{9}{4} + \frac{19}{28} + \frac{19}{28}$$

$$= \frac{9}{4} + \frac{9}{10} + \frac{9}{16} = \frac{27}{8}$$

15. A chord of circle $(x - 2\sqrt{2})^2 + (y - 2\sqrt{2})^2 = r^2$ is diameter of $x^2 + y^2 - 2\sqrt{2}x - 6\sqrt{2}y + 14 = 0$, then the value of r is

- (1) $\sqrt{10}$ (2) $\sqrt{12}$ (3) $\sqrt{15}$ (4) $\sqrt{20}$

Ans. (1)

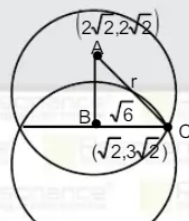
Sol. $AC = r$

$$AB = \sqrt{(2\sqrt{2} - \sqrt{2})^2 + (2\sqrt{2} - 3\sqrt{2})^2}$$

$$= \sqrt{2 + 2} = 2$$

$$AC = \sqrt{AB^2 + BC^2}$$

$$= \sqrt{4 + 6} = \sqrt{10}$$



16. If $f(x)$ satisfying the relation $f(x) + f(x+k) = n$ and $I_1 = \int_0^{4nk} f(x)dx$, $I_2 = \int_k^{3k} f(x)dx$ then

- (1) $I_1 + I_2 = nk(2n+2)$ (2) $I_1 + I_2 = (2n+2)$
 (3) $I_1 + I_2 = (2n+2)k$ (4) $I_1 + I_2 = (2n+2)k$

Ans. (1)

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Sol. $f(x) + f(x+k) = n$... (1)

put $x \rightarrow x+k$

$f(x+k) + f(x+2k) = n$... (2)

subtract $f(x) - f(x+2k) = 0$

period is $2k$

Now, $I_1 = \int_0^{4nk} f(x)dx$

$= 2n \int_0^{2k} f(x)dx$

$I_2 = \int_k^{3k} f(x)dx = 2 \int_0^{2k} f(x)dx$

$I_1 + I_2 = (2n+2) \int_0^{2k} f(x)dx$

$= (2n+2) \left[\int_0^k f(x)dx + \int_k^{2k} f(x)dx \right]$

$= (2n+2) \left[\int_0^k f(x)dx + \int_0^k f(x+k)dx \right]$

$= (2n+2) \int_0^k [f(x) + f(x+k)]dx$

$= (2n+2) nk$

17. In how many ways 30 identical candies are distributed among four persons X_1, X_2, X_3, X_4 , such that X_2 gets atleast 3 and atmost 7 and X_3 gets atleast 2 and atmost 6

- (1) 551 (2) 550 (3) 552 (4) 549

Ans. (2)

Sol. $x_1 + x_2 + x_3 + x_4 = 30$

$3 \leq x_2 \leq 7, 2 \leq x_3 \leq 6, x_1, x_4 \geq 0,$

Total number of ways = coefficient of x^{30} is

$(x^0 + x^1 + x^2 + \dots)^2 \cdot (x^3 + x^4 + x^5 + x^6 + x^7) (x^2 + x^3 + x^4 + x^5 + x^6)$

$\Rightarrow \left(\frac{1}{1-x}\right)^2 \cdot x^3 \left(\frac{1-x^5}{1-x}\right) \cdot x^2 \left(\frac{1-x^5}{1-x}\right) = x^5 (1-x^5)^2 (1-x)^{-4}$

\Rightarrow coefficient of x^{25} in $(1-x^5)^2 \cdot (1-x)^{-4}$

$= (1-2x^5+x^{10}) (1-x)^{-4}$

$\Rightarrow 4+25-1C_{25} - 2 \cdot 4+20-1C_{20} + 4+15-1C_{15}$

$\Rightarrow {}^{28}C_{25} - 2 \cdot {}^{23}C_{20} + {}^{18}C_{15} \Rightarrow \frac{28 \cdot 27 \cdot 26}{3 \cdot 2} - \frac{2 \cdot 23 \cdot 22 \cdot 21}{3 \cdot 2} + \frac{18 \cdot 17 \cdot 16}{3 \cdot 2} = 550$

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