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# JEE (Main) 2021

## COMPUTER BASED TEST (CBT)



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Memory Based Questions & Solutions

**Date: 20 July, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)**

**Duration: 3 Hours | Max. Marks: 300**

**SUBJECT: MATHEMATICS**

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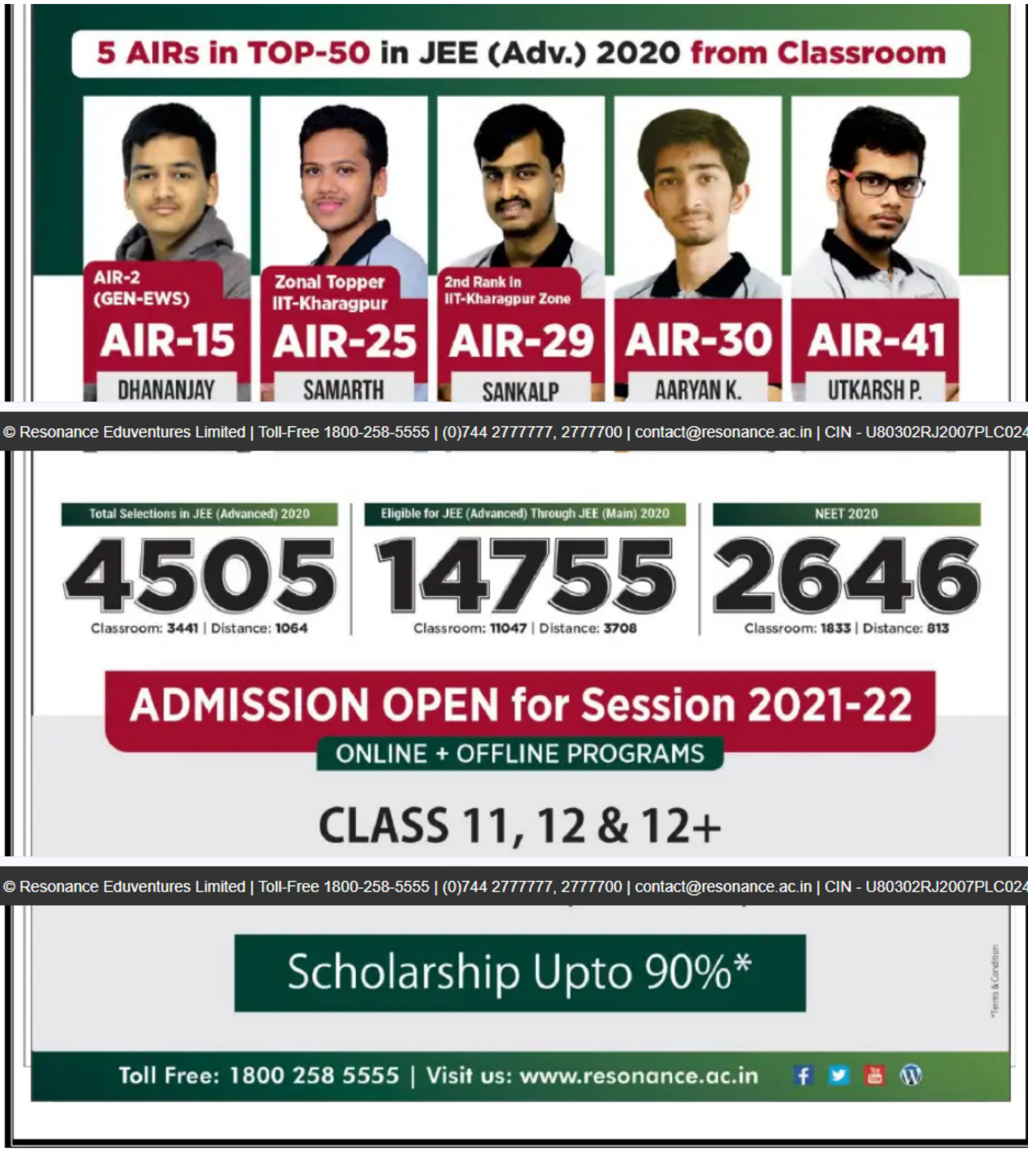




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1 If element of matrix A is defined as $A = [a_{ij}]_{3\times3}$ where $A = \begin{cases} (-1)^{j-i} & i<j \\ 2 & i=j \\ (-1)^{i+j} & i>j \end{cases}$, then the value of $|3\text{Adj}(2A^{-1})|$ is:

(1) 72 (2) 36 (3) 108 (4) 48

**Ans.** (3)

**Sol.** $A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$

So, $|A| = \begin{vmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{vmatrix}$

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$= 2(3) + 1(-1) + 1(-1)$

$= 4$

$|3\text{Adj}(2A^{-1})| = 3^3\,|\text{Adj}(2A^{-1})| = 3^3 \times |2A^{-1}|^2$

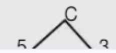
$= 3^3 \times 2^6 \times |A^{-1}|^2 = 3^3 \times 2^6 \times \frac{1}{|A|^2} = 108$

2 In a $\Delta ABC$, if $|\overrightarrow{AB}| = 7$, $|\overrightarrow{BC}| = 5$, and $|\overrightarrow{CA}| = 3$. If projection of $\overrightarrow{BC}$ on $\overrightarrow{CA}$ is $\left(\frac{n}{\ }\right)$, then the value of n

**2.** In a $\Delta ABC$, if $|\overrightarrow{AB}| = 7$, $|\overrightarrow{BC}| = 5$, and $|\overrightarrow{CA}| = 3$. If projection of $\overrightarrow{BC}$ on $\overrightarrow{CA}$ is $\left|\frac{\ }{2}\right|$, then the value of n is:

**Ans.** 05.00

**Sol.** $|\overrightarrow{AB}| = 7, \quad |\overrightarrow{BC}| = 5, \quad |\overrightarrow{CA}| = 3,$






B 7

Projection of $\overrightarrow{BC}$ on $\overrightarrow{CA}$ is $= |\overrightarrow{BC}| \cos\angle BCA$

$$5\left|\left(\frac{3^2+5^2-7^2}{2.3.5}\right)\right| = = 5\left|\frac{-15}{30}\right| = \frac{5}{2}$$



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**3.** The value of $\tan(2\tan^{-1}(3/5) + \sin^{-1}(5/13))$ is :

(1) $\frac{220}{21}$ (2) $\frac{110}{21}$ (3) $\frac{55}{21}$ (4) $\frac{20}{11}$

**Ans.** **(1)**

**Sol.** $\tan\left(\tan^{-1}\frac{\frac{6}{5}}{1-\frac{9}{}} + \tan^{-1}\frac{5}{12}\right)$

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$$\tan\left(\tan^{-1}\left(\frac{15}{8}\right) + \tan^{-1}\left(\frac{5}{12}\right)\right) = \frac{\frac{15}{8}+\frac{5}{12}}{1-\frac{15}{8}\cdot\frac{5}{12}} = \frac{220}{21}$$

**4.** Mean of 6 observations is 10 and their variance is $\frac{20}{3}$. If observations are 15, 11, 10, 7, a, b then $|a-b|$ is equal to :

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

**Ans.** **(2)**

**Sol.** Mean = 10

$$\frac{7+10+11+15+a+b}{6} = 10$$

a + b = 17 .............(1)

Variance = $\frac{20}{3}$

$49+100+121+225+a^2+b^2$ ... 20

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$a^2 + b^2 = 145$ .............(2)

$(a + b)^2 = 289$

ab = 72

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

$(a - b)^2 = 289 - 288 = 1$

$|a - b| = 1$

**5.** If f(x) = x + 1, then find $\lim\limits_{n\to\infty}\frac{1}{n}\left[f(0)+f\left(\frac{5}{n}\right)+f\left(\frac{10}{n}\right)+..........+f\left(\frac{5(n-1)}{n}\right)\right]$

(1) $\frac{7}{2}$ (2) $\frac{3}{2}$ (3) $\frac{5}{2}$ (4) $\frac{1}{2}$

**Ans.** **(1)**

**Sol.** $= \lim\frac{1}{n}\sum^{n-1} f\left(\frac{5r}{n}\right) = \int_0^1 f(5x)dx = \int_0^1 (5x+1)dx$

$n \to \infty \; n \sum_{r=0} \left( n \right) \quad \int_0 f(3x)dx = \int_0 (3x+1)dx$



$= \left( \frac{}{2} + x \right)_0 = \frac{}{2} + 1 = \frac{}{2}$ Ans.







x is :

(1) 7 (2) 243 (3) 9 (4) 81

**Ans.** (3)

**Sol.** $2 \log_9 x + 3 \log_9 x + 4 \log_9 x$ ......21 terms

$= (2 + 3 + 4 + 5 + \ldots\ldots + 22) \log_9 x = \frac{21}{2}(2+22)\log_9 x$

$= 21 \times 12 \log_9 x$

$= 252 \log_9 x$

Given sum $= 252 \Rightarrow \log_9 x = 1$

$\Rightarrow x = 9$



(1) –2 (2) 1 (3) 0 (4) –1

**Ans.** **(3)**

**Sol.** $I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} ([x] - [\sin x])dx$

using property $\int_{-a}^{a} f(x)dx = \int_0^a f(x)dx + \int_0^a f(-x)dx$

$I = \int_0^{\frac{\pi}{2}} ([x]+[-x])dx - \int_0^{\frac{\pi}{2}} ([\sin x]+[-\sin x])dx = 0$

$\alpha x e^x - \beta \ell n(1+x) + \gamma x^2 e^{-x}$



**Ans.** (3)

**Sol.** $\lim\limits_{x \to 0} \frac{\alpha x\left(1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\ldots\right) - \beta\left(x-\frac{x^2}{2}+\frac{x^3}{3}+\ldots\right) + \gamma x^2\left(1-x+\frac{x^2}{2!}-\frac{x^3}{3!}+\ldots\right)}{x^3} = 10$

$\Rightarrow \alpha - \beta = 0, \Rightarrow \alpha = \beta$

$\Rightarrow \alpha + \frac{\beta}{2} + \gamma = 0 \Rightarrow \gamma = -\frac{3\beta}{2}$

$\Rightarrow \frac{\alpha}{2} - \frac{\beta}{3} - \gamma = 10$

$\Rightarrow \frac{\beta}{2} - \frac{\beta}{3} + \frac{3\beta}{2} = 10 \Rightarrow \frac{3\beta - 2\beta + 9\beta}{6} = 10$

$\because \beta = 6, \alpha = 6, \gamma = -9$

So, the value of $\alpha + \beta + \gamma = 3$

**9.** The value of x satisfying the equation $\log_{(x+1)} (2x^2 + 7x+5) + \log_{(2x+5)} (x+1)^2 = 4$ is :



**Ans.** (2)

**Sol.** $\log_{(x+1)} ((2x+5)(x+1)) + \log_{(2x+5)} (x+1)^2 = 4$

$1 + \log_{(x+1)} (2x+5) + 2\log_{(2x+5)} (x+1) = 4$

Put $\log_{(x+1)} (2x+5) = t$

$\therefore 1 + t + \frac{2}{t} = 4$

$t^2 + t + 2 = 4t \Rightarrow t^2 - 3t + 2 = 0$

$t = 1, t = 2$

For $t = 1$ | For $t = 2$

$2x + 5 = x + 1$ | $2x+5 = (x+1)^2$

$\Rightarrow x = -4$ (rejected) | $x = 2, x = -2$ (rejected)

**10.** If $(\alpha, \beta)$ is the point on $y^2 = 6x$ that is closest to $\left(3, \frac{3}{2}\right)$ then find $2(\alpha + \beta)$

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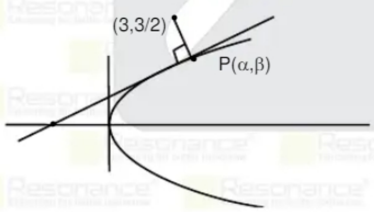
(1) 6 (2) 9 (3) 7 (4) 5

**Ans.** (2)

**Sol.**




$y^2 = 6x$

$2yy' = 6$

$\frac{dy}{dx} = \frac{3}{y}$

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$-\frac{\beta}{3} = \frac{\beta - \frac{3}{2}}{\alpha - 3}$



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$-\frac{\beta}{3} = \frac{2\beta - 3}{2\alpha - 6}$

$-\beta(2\alpha - 6) = 6\beta - 9$

$6\beta - 2\alpha\beta = 6\beta - 9$

$\alpha\beta = \frac{9}{2} \Rightarrow \beta = \frac{9}{2\alpha}$

$\therefore \beta^2 = 6\alpha$

$\frac{81}{4\alpha^2} = 6\alpha$

$\alpha^3 = \frac{27}{8}$ $\alpha = \frac{3}{2}$ , $\beta^2 = 9 \Rightarrow \beta = \pm 3$

$\alpha = \frac{3}{2}$ , $\beta = 3$



**11.** Two circles pass through (–1,4) and their centres lie on $x^2 + y^2 + 2x + 4y = 4$ r. If $r_1$ and $r_2$ are maximum 4 minimum radii and $\frac{r_1}{r_2} = a + b\sqrt{2}$ then the value of a + b is

**Ans.** 3

**Sol.** Given circle

$(x + 1)^2 + (y + 2)^2 = (3)^2$

any point on this circle is (3cosθ – 1, 3sinθ2) equation of circle having centre (3cosθ – 1, 3sinθ –2)

$\Rightarrow$ radius of circle is

$r = \sqrt{(3\cos\theta - 1 + 1)^2 + (3\sin\theta - 2 - 4)^2}$

$= \sqrt{9\cos^2\theta + 9\sin^2\theta + 36 - 36\sin\theta}$

$\sqrt{45 - 36\sin\theta}$



$\Rightarrow \frac{r_1}{r_2} = \frac{9}{3} = 3$ $3 + 0\sqrt{2}$

$\Rightarrow a + b = 3$

**12.** If ΔABC is right angled triangle with sides a,b & c and smallest angle θ. If $\frac{1}{a}, \frac{1}{b}$ and $\frac{1}{c}$ are also the sides of right angled triangle then find sin θ

(1) $\sqrt{\frac{3-\sqrt{5}}{2}}$ (2) $\frac{3-\sqrt{5}}{2}$ (3) $\sqrt{\frac{3+\sqrt{5}}{2}}$ (4) $\frac{3+\sqrt{5}}{2}$

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**Ans.** (1)

**Sol.** Let a > b > c

$\sin\theta = \frac{c}{a}$

$\frac{1}{a} < \frac{1}{b} < \frac{1}{c}$

$\frac{1}{c^2} = \frac{1}{a^2} + \frac{1}{b^2}$

$1 = \frac{c^2}{a^2} + \frac{c^2}{b^2}$

$1 = \frac{c^2}{a^2} + \frac{c^2}{a^2 - c^2}$ [As $a^2 = b^2 + c^2$]



$\frac{}{c^2} - 1$

$$1 = \frac{1-\sin^2\theta+1}{\operatorname{cosec}^2\theta-1} \Rightarrow \sin^2 q + \operatorname{cosec}^2\theta = 3$$

**13.** If Re $[(1+\cos\theta + 2i\sin\theta)^{-1}] = 4$ then value of $\theta$ is :

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

**Ans.** (4)

**Sol.** $$\frac{1}{1+\cos^2\theta+2i\sin\theta} \times \frac{1+\cos\theta-2i\sin\theta}{1+\cos\theta-2i\sin\theta}$$

$$= \frac{1+\cos\theta-2i\sin\theta}{(1+\cos\theta)^2+4\sin^2\theta}$$



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



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$$\Rightarrow \frac{1+\cos\theta}{5+2\cos\theta-3\cos^2\theta} = 4$$

$\Rightarrow 1 + \cos\theta = 20 + 8\cos\theta - 12\cos^2\theta$

$\Rightarrow 12\cos^2\theta - 7\cos\theta - 19 = 0$

$\Rightarrow 12\cos^2\theta - 19\cos\theta + 12\cos\theta - 19 = 0$

$\Rightarrow \cos\theta(12\cos\theta - 19) + 1(12\cos\theta - 19) = 0$

$\Rightarrow \cos\theta = -1$ or $\cos\theta = \frac{19}{12}$ (rejected)

$\Rightarrow \theta = \pi$

**14.** If $x = ay - 1 = z - 2$, and $x = 3y - 2 = bz - 2$ lie in same plane then the value of a, b, is

(1) $a = 2, b = 3$  (2) $a = 1, b = 1$  (3) $b = 1, a \in R - \{0\}$  (4) $a = 3, b = 2$

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**Sol.** $$\frac{x}{1} = \frac{y-\frac{1}{a}}{\frac{1}{a}} = \frac{z-2}{1}, \qquad x = \frac{y-\frac{2}{3}}{\frac{1}{3}} = \frac{z-\frac{2}{b}}{\frac{1}{b}}$$

$$(\vec{a}_1 - \vec{a}_2)\cdot(\vec{b}_1 \times \vec{b}_2) = 0$$

$$\begin{vmatrix} 0 & \frac{1}{a}-\frac{2}{3} & 2-\frac{2}{b} \\ 1 & \frac{1}{a} & 1 \\ 1 & \frac{1}{3} & \frac{1}{b} \end{vmatrix} = 0$$

$$\Rightarrow \frac{1}{ab} - \frac{1}{a} = 0$$

$b = 1$, $a \in R - \{0\}$

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$P(\bar{A} \cap C) + P(A \cap \bar{C}) = 1 - 2K$

$P(\bar{B} \cap C) + P(B \cap \bar{C}) = 1 - K$

$P(A \cap B \cap C) = K^2, K \in (0,1)$

Then the value of P(at least one of A,B,C) is:

(1) $> \frac{1}{\ldots}$  (2) $\left[\frac{1}{\ldots}, \frac{1}{\ldots}\right]$  (3) $< \frac{1}{\ldots}$  (4) $\frac{1}{\ldots}$

2 [8 4] 4 4

**Ans.** (1)









**Sol.** $P(A) + P(B) - 2P(A \cap B) = 1 - K$

$P(A) + P(C) - 2P(A \cap C) = 1 - 2K$

$P(B) + P(C) - 2P(B \cap C) = 1 - K$

$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(A \cap C) + P(A \cap B \cap C)$



$\because$ The value of $2k^2 - 4k + 3$ is greater than 1

$\therefore$ $P(A \cup B \cup C) > \frac{1}{2}$

**16.** If $f(x) = \frac{5x+3}{6x+a}$ and $f(f(x)) = x$ then the value of a is :

(1) –5 (2) 5 (3) 6 (4) –6

**Ans.** (1)

**Sol.** $f(f(x)) = \frac{5f(x)+3}{6f(x)+a} = x \Rightarrow 5f(x) + 3 = 6x\,f(x) + ax$

$\Rightarrow \frac{25x+15}{6x+a} + 3 = 6x\left(\frac{5x+3}{6x+a}\right) + ax$

$\Rightarrow 25x + 15 + 18x + 3a = 30x^2 + 18x + 6ax^2 + a^2x$



$\Rightarrow a+5 = 0 \Rightarrow a = -5$

**17.** If $g(t) = \begin{cases} \max(t^3 - 6t^2 + 9t - 3, 0), & t \in [0,3] \\ 4 - t, & t \in (3,4] \end{cases}$ then the number of points at which g(t) is non differentiable is :

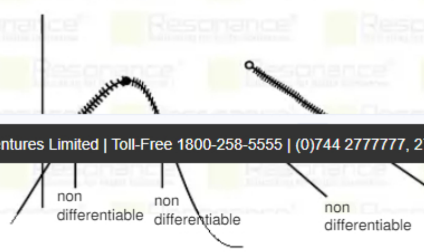
(1) 1 (2) 3 (3) 2 (4) 4

**Ans.** **(2)**

**Sol.** $y = t^3 - 6t^2 + 9t - 3$

$y' = 3t^2 - 12t + 9$

$= 3(t^2 - 4t + 3)$



**18.** A : if 2 + 4 = 7, then 3+4 = 8

B : if 3 + 5 = 8, then earth is flat

C : if A and B are true, then 5+4 = 11

(1) A is true, B and C are false (2) B is true, A and C are false

(3) C is true, A and B are false (4) B is false, A and C are true

**Ans.** (4)

**Sol.** Truth table $p \to q$

| p | q | $p \to q$ |
|---|---|---|
| T | T | T |
| T | F | F |
| F | T | T |

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A is true, B is false, C is true .

**19.** If $A=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$, $B\sum_{r=1}^{2021} A^r$ then value of $|B|$ is

(1)2021 (2) $(2021)^2$ (3) –2021 (4) 0

**Ans.** (2)

**Sol.** A=I, B = I + I +….. 2021 times

$$B = 2021\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix},$$

$|B| = (2021)^2$

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