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PAPER-1 (B.E./B. TECH.)

JEE (Main) 2020

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 02 September, 2020 (SHIFT-1) | TIME : (9.30 a.m. to 12.30 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT : MATHEMATICS

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PART : MATHEMATICS

Single Choice Type (एकल विकल्पीय प्रकार)

This section contains **20 Single choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

इस खण्ड में **20 एकल विकल्पी प्रश्न** हैं। प्रत्येक प्रश्न के 4 विकल्प (1), (2), (3) तथा (4) हैं, जिनमें से **सिर्फ एक सही** है।

1. Box-I contains 30 cards marked from 1 to 30 and box-II contains 20 cards marked from 31 to 50. A box is selected and a card is drawn. If the number on card is non-prime then what is prob. That it came from box-I .

(1) $\frac{4}{17}$ (2) $\frac{6}{17}$ (3) $\frac{7}{17}$ (4) $\frac{8}{17}$

Ans. **4**

Sol. $P(B_1) = \frac{1}{2} = P(B_2)$

$P(\text{Non-prime}) = P(B_1).\ P(N.P/B_1) + P(B_2).\ P(N.P/B_2)$

$= \frac{1}{2}.\frac{20}{30} + \frac{1}{2}.\frac{15}{20}$

$P(B_1/N.P) = \dfrac{\frac{1}{2}.\frac{20}{30}}{\frac{1}{2}.\frac{20}{30} + \frac{1}{2}.\frac{15}{20}} = \frac{8}{17}$

2. The contrapositive of "If I reach the station on time then I will get the train" is-

(1) If I reach the station on time then I will not get the train

(2) If I will not get the train then I don't reach the station on time

(3) If I will get the train then I reach the station on time

(4) If I will not get the train then I reach the station on time

Ans. **(2)**

Sol. If I will not get the train then I don't reach the station on time

3. Evaluate $\int_0^2 |x-1-x|\,dx$

(A) $\frac{9}{2}$ (B) $\frac{5}{2}$ (C) $\frac{7}{2}$ (D) $\frac{3}{2}$

Ans. **(D)**

Sol. $\int_0^2 |x-1-x|\,dx = \int_0^1 |1-x-x|\,dx + \int_1^2 ||x-1-x|\,dx$

$= \int_0^{1/2}(1-2x)dx + \int_{1/2}^1 (2x-1)dx + \int_1^2 dx$

$= \left[x-x^2\right]_0^{\frac{1}{2}} + \left[x^2-x\right]_{\frac{1}{2}}^1 + [x]_1^2 = \frac{1}{2}-\frac{1}{4}+(1-1)-\left(\frac{1}{4}-\frac{1}{2}\right)+2-1 = \frac{1}{4}+\frac{1}{4}+1 = \frac{3}{2}$

4. If $\frac{1+\sin x}{1+y}\frac{dy}{dx} = -\cos x$ such that y (0) = 1, y(π) = a and $\left(\frac{dy}{dx}\right)_{(x=\pi)}$ = b, then (a, b) =

(1) (1, –2) (2) (1, 2) (3) (–1, –2) (4) (–1, 2)

Ans. **(2)**

Sol. $\frac{dy}{1+y} = \frac{-\cos x}{1+\sin x}dx$

$\ell n(1 + y) = -\ell n(1 + \sin x) + \ell nc$

$(1 + y)(1 + \sin x) = c$

$2.1 = c \Rightarrow c = 2$

$1 + y = \frac{2}{1+\sin x} \Rightarrow y = \frac{2}{1+\sin x} - 1$

$y(\pi) = 2 - 1 = 1$

$\frac{dy}{dx} = \frac{-2}{(1+\sin x)^2}.\cos x = 2$ at $x = \pi$

(a, b) = (1, 2)

5. Number of points of local maxima & minima of the function $f(x) = -\frac{3}{4}x^4 - 8x^3 - \frac{45}{2}x^2 + 105$ are

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

Ans. **(3)**

Sol. $f'(x) = -3x^3 - 24x^2 - 45x + 0$

$= -3x(x^2 + 8x + 15)$

$= -3x(x + 3)(x + 5)$

Clearly x = –5, 0 is point of maximum

x = –3 is point of minimum

Hence number of point of maximum and minimum are 3.

6. Length of perpendicular and foot of perpendicular from the point $\left(1, \frac{3}{2}, 2\right)$ to the plane

2x – 2y + 4z + 5 = 0 is

(1) $\sqrt{6}$, $\left(0, \frac{-5}{2}, 0\right)$ (2) $\sqrt{6}$, $\left(0, \frac{5}{2}, 0\right)$ (3) $\sqrt{6}$, $\left(1, \frac{5}{2}, 1\right)$ (4) $\sqrt{6}$, $\left(1, \frac{-5}{2}, 1\right)$

Ans. **(2)**

Sol. $p\left(1, \frac{3}{2}, 2\right)$, 2x – 2y + 4z + 5 = 0

foot of perpendicular $\frac{x-1}{2} = \frac{y-\frac{3}{2}}{-2} = \frac{z-2}{4} = \frac{-(2-3+8+5)}{4+4+16}$

$\Rightarrow \quad \dfrac{x-1}{2} = \dfrac{y-\frac{3}{2}}{-2} = \dfrac{z-2}{4} = -\dfrac{12}{24} = \dfrac{-1}{2}$

$\Rightarrow \quad x = 1 - 1,\ y = \dfrac{3}{2} + 1,\ z = 2 - 2$

$\Rightarrow \quad x = 0,\ y = \dfrac{5}{2},\ z = 0$

$\therefore$ Length of perpendicular $= \sqrt{(1-0)^2 + \left(\dfrac{3}{2} - \dfrac{5}{2}\right)^2 + (2-0)^2} = \sqrt{1+1+4} = \sqrt{6}$

7. Solution of equation $\sin^{-1}6x + \sin^{-1} 6\sqrt{3}x = -\dfrac{\pi}{2}$ is

(1) $\pm\dfrac{1}{12}$ (2) $\dfrac{1}{12}$ (3) $-\dfrac{1}{12}$ (4) None of these

Ans. **(3)**

Sol. $\sin^{-1} 6x = \sin^{-1}(-1) - \sin^{-1}\left(6\sqrt{3}x\right) \quad \Rightarrow \quad \sin^{-1} 6x = \sin^{-1}\left(-1\sqrt{1-108x^2} - 6\sqrt{3}x\sqrt{1-1}\right)$

$\Rightarrow \quad 36x^2 = 1 - 108x^2 \quad \Rightarrow \quad 144x^2 = 1$

$\Rightarrow \quad x = \pm\dfrac{1}{12}$

Ans. $x = -\dfrac{1}{12}$

8. If all letters of word 'MOTHER' are written in all possible order and these words are written in dictionary form then find position of word 'MOTHER'

(1) 307 (2) 309 (3) 311 (4) 305

Ans. (2)

Sol. M O T H E R

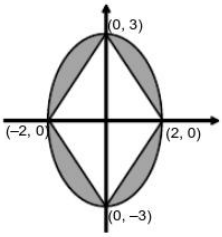
3 4 6 2 1 5 $\Rightarrow$ 2 5! + 2 4! + 3 3! + 2! + 1 = 240 + 48 + 18 + 2 + 1 = 309

9. Area enclosed by the region given by $\dfrac{|x|}{2} + \dfrac{|y|}{3} \ge 1$ and $\dfrac{x^2}{4} + \dfrac{y^2}{9} \le 1$ is

(1) $6\pi - 10$ (2) $6\pi - 11$ (3) $6\pi - 12$ (4) $6\pi - 12$

Ans. (3)

Sol.



Area of Ellipse $= \pi ab = 6\pi$

Area enclose by $\frac{|x|}{2}+\frac{|y|}{3}=1$ is

$= \frac{1}{2}(d_1\, d_2) = \frac{1}{2}(4)(6) = 12$

so required Area is $= 6\pi - 12$

10. A plane passes through (2, 1, 2) and (1, 2, 1) and parallel to line 2x = 3y and z = 1, then plane also passes through the point

(1) (–6, 2, 0) (2) (6, –2, 0) (3) (–2, 0, 1) (4) (2, 0, 1)

Ans. **(3)**

Sol. Plane passes through (2, 1, 2) is

$a(x-2) + b(y-1) + (z-2) = 0$

it also passes through (1, 2, 1)

$\therefore \quad -a + b - c = 0 \Rightarrow a - b + c = 0$ .....(1)

given line

$\frac{x}{3}=\frac{y}{2}=\frac{z-1}{0}$ is parallel to (1)

$\therefore \quad 3a + 2b + c0 = 0 \Rightarrow$

$\frac{a}{0-2}=\frac{b}{3-0}=\frac{c}{2+3}$

$\frac{a}{2}=\frac{b}{-3}=\frac{c}{2+3}$

$\frac{a}{2}=\frac{b}{-3}=\frac{c}{-5}$

$\therefore$ plane is $2x - 4 - 3y + 3 - 5z + 10 = 0 \Rightarrow 2x - 3y - 5z + 9 = 0$

11. P(x) is a polynomial of degree 3 which have maximum value 8 at x = 1, min 6 at x = 2 find P(0)

Sol. Clearly $P'(x) = \lambda(x-1)(x-2)$ where $\lambda > 0$

$P(x) = \lambda\left[\frac{x^3}{3}-\frac{3x^2}{2}+2x\right]+C$

given $P(1) = 8 \Rightarrow \lambda\left(\frac{1}{3}-\frac{3}{2}+2\right) + C = 8 \quad \Rightarrow \frac{5\lambda}{6}+C=8$ .....(i)

also $P(2) = 6 \Rightarrow 6 \Rightarrow \lambda\left(\frac{8}{3}-6+4\right)+C=6 \quad \Rightarrow \frac{2}{3}\lambda+C = 6$ .....(ii)

By (i) and (ii) $\Rightarrow C = -2$

$\Rightarrow P(0) = -2$

12. Sum of series $(x + y) + (x^2 + xy + y^2) + (x^3 + x^2y + xy^2 + y^3) + \ldots\ldots$ is

(1) $\frac{x+y-xy}{(1-x)(1-y)}$ (2) $\frac{x+y+xy}{(1-x)(1-y)}$ (3) $\frac{x-y-xy}{(1+x)(1+y)}$ (4) $\frac{x-y+xy}{(1+x)(1+y)}$

Ans. **(1)**

Sol. $(x + y) + (x^2 + xy + y^2) + (x^3 + x^2y + xy^2 + y^3) + \ldots\ldots$

$= \frac{1}{x-y}\left(\frac{x^2}{1-x}-\frac{y^2}{1-y}\right) = \frac{1}{x-y}\left(\frac{x^2-x^2y-y^2+xy^2}{(1-x)(1-y)}\right) = \frac{x+y-xy}{(1-x)(1-y)}$

13. Value of $\left(\frac{1+\sin\frac{2\pi}{9}+i\cos\frac{2\pi}{9}}{1+\sin\frac{2\pi}{9}-i\cos\frac{2\pi}{9}}\right)^3$ is

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

Ans. **(1)**

Sol. $\left(\frac{1+\cos\frac{5\pi}{18}+i\sin\frac{5\pi}{18}}{1+\cos\frac{5\pi}{18}-i\sin\frac{5\pi}{18}}\right)^3 = \left(\frac{2\cos^2\frac{5\pi}{36}+i2\sin\frac{5\pi}{36}.\cos\frac{5\pi}{36}}{2\cos^2\frac{5\pi}{36}-i2\sin\frac{5\pi}{36}.\cos\frac{5\pi}{36}}\right)^3$

$=\left(\frac{\cos\frac{5\pi}{36}+i\sin\frac{5\pi}{36}}{\cos\frac{5\pi}{36}-i\sin\frac{5\pi}{36}}\right)^3 = \left(\cos\frac{5\pi}{36}+i\sin\frac{5\pi}{36}\right)^6$

$= \cos\left(6\times\frac{5\pi}{36}\right)+i\sin\left(6\times\frac{5\pi}{36}\right) = \cos\frac{5\pi}{6} + i\sin\frac{5\pi}{6} \Rightarrow -\frac{\sqrt{3}}{2}+i\frac{1}{2}$

14. $\frac{z-\alpha}{z+\alpha}$ is purely imaginary and $|z| = 82$ then $|\alpha|$ is

(1) 80 (2) 82 (3) $\sqrt{82}$ (4) $2\sqrt{82}$

Ans. **(2)**

Sol. $\frac{z-\alpha}{z+\alpha}+\frac{\bar{z}-\bar{\alpha}}{\bar{z}+\bar{\alpha}}=0$

$2z\bar{z} - \alpha\bar{z} + \bar{\alpha}z - z\bar{\alpha} + \alpha\bar{z} - 2\alpha\bar{\alpha} = 0$

$2|z|^2 = 2|\alpha|^2$

$|\alpha| = 82$

15. $A = \{x \in N : 1 \le x \le 17\}$

$B = \{ax + b : x \in A\}$ $a > 0$

Variance of set B is 216 and mean is 17 find a + b

(1*) – 7 (2) 7 (3) 6 (4) – 6

Ans. **(1)**

Sol. $B(\bar{x}) = a\bar{x}+b = \frac{a(1+2+3+....+17)}{17}+b = 17$

$\frac{a.(17.18)}{17.2}+b = 17$

$9a + b = 17$ .....(i)

$\sigma A^2 = \frac{\Sigma x^2}{n} - \left(\frac{\Sigma x}{n}\right)^2 = \frac{1^2+2^2+...+17^2}{17} - \left(\frac{1+2+...+17}{17}\right)^2$

$= \frac{17.18.35}{6.17} - \left(\frac{17.18}{2.17}\right)^2$

$= 105 - 81 = 24$

$\therefore \sigma^2_B = a^2\,\sigma_A^2 = a^2.24 = 216$

$a^2 = \frac{216}{24} = 9$

$a = 3 \therefore b = 17 - 27$

$\therefore b = 17 - 27$

$b = -10$

$\therefore a + b = -7$

16. $\lim_{x\to1}\frac{x+x^2+x^3+....+x^n-n}{x-1} = 820$

(1) 39 (2) 40 (3)41 (4) 42

Ans. **(2)**

Sol. $\lim_{x\to1}\frac{x+x^2+x^3+....+x^n-n}{x-1} = 820 \left(\frac{0}{0}\right)$

$\lim_{x\to1}\frac{1+2x+3x^2+....+nx^{n-1}}{1} = 820$

$\Rightarrow 1 + 2 + 3 + \quad + n = 820$

$\Rightarrow 1 + 2 + 3 + \ldots\ldots + n = 820$

$\Rightarrow \frac{n(n+1)}{2} = 820$

$\Rightarrow n^2 + n - 1640$

$\Rightarrow n^2 + n - 1640 = 0$

$\Rightarrow n = 40 \qquad n \in N$

17. If equation $6x^2 + 5x - 2 = 0$ has roots α, β and $S_n = \alpha^n + \beta^n$. then select the correct option

(1) $6S_6 + 5S_5 = 2S_4$ (2) $6S_4 + 2S_5 = 5S_6$

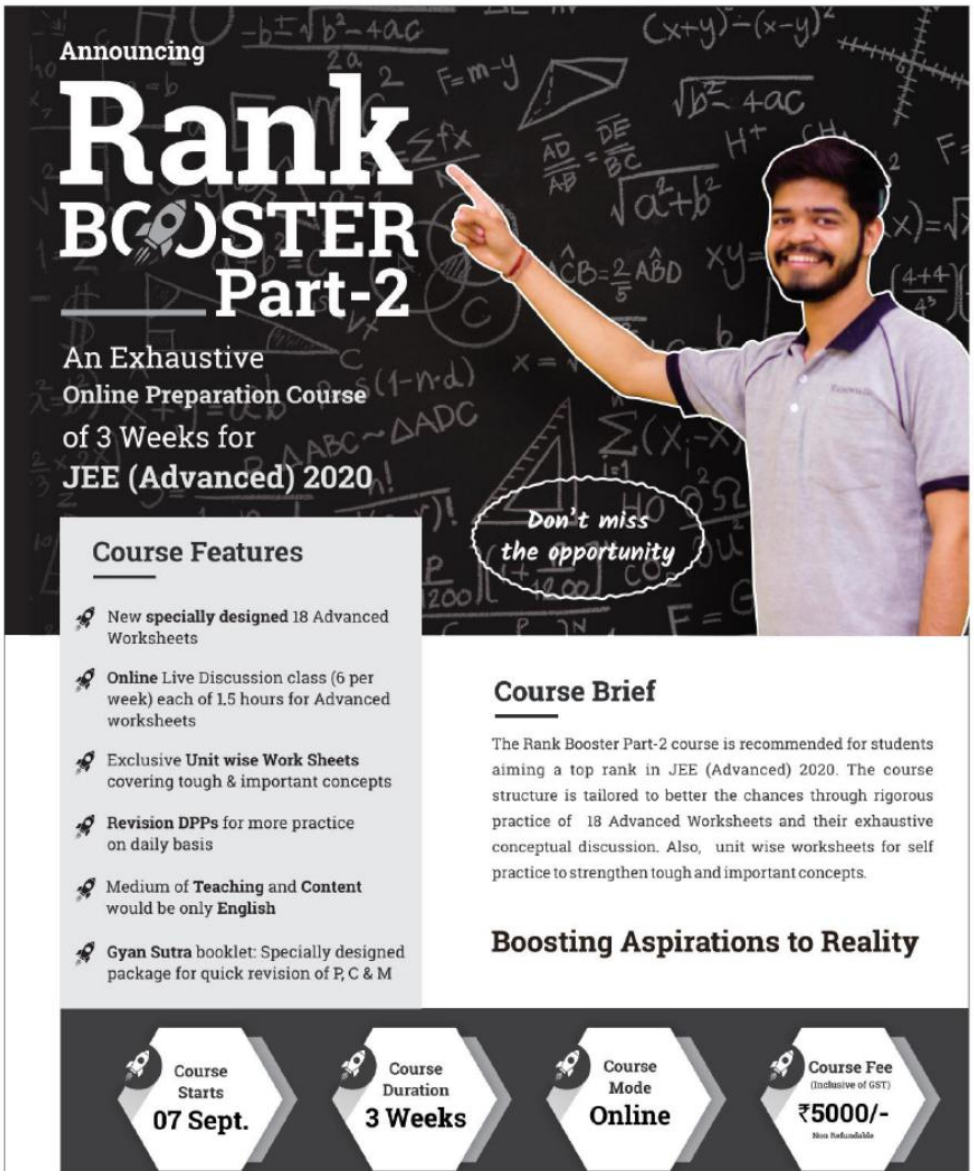
(3) $6S_2 + 5S_6 = 6S_4$ (4) $6S_2 + 5S_4 = 2S_6$

Ans. **(1)**

Sol. $6\alpha^2 + 5\alpha = 2$

$6S_6 + 5 + S_5 = \alpha^4 (6\alpha^2 + 5\alpha) + \beta^4 (6\beta^2 + 5\beta)$

$= 2(\alpha^4 + \beta^4) = 2S_4$



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