CBSE Board

Class XII Mathematics

Sample Paper - 2

Term 2 – 2021-22

Time: 2 hours **Total Marks: 40**

General Instructions:

1. *This question paper contains three sections – A, B and C. Each part is compulsory.*
2. *Section - A has 6 short answer type (SA1) questions of 2 marks each*
3. *Section – B has 4 short answer type (SA2) questions of 3 marks each.*
4. *Section - C has 4 long answer type questions (LA) of 4 marks each.*
5. *There is an internal choice in some of the questions.*
6. *Q14 is a case-based problem having 2 sub parts of 2 marks each.*

Section A

Q1 – Q6 are of 2 marks each.

1. Integrate $\int \log\left(1+x^2\right)dx$

OR

Integrate $\int \frac{\sin x}{\sin(x-a)}dx$

2. Find the sum of the order and the degree of the differential equation

$$\left(\frac{dy}{dx}\right)^2 + \frac{d}{dx}\left(\frac{dy}{dx}\right) - y = 4$$

3. If $\vec{a}$ and $\vec{b}$ are two vectors of magnitude 3 and $\frac{2}{3}$ respectively such that $\vec{a}\times\vec{b}$ is a unit vector, write the angle between $\vec{a}$ and $\vec{b}$.

4. Find the distance of the plane 3x – 4y + 12z = 3 from the origin.

5. A company has two plants to manufacturing scooters. Plant I manufactures 70% of the scooters and plant II manufactures 30%. At plant I, 30% of the scooters are rated of standard quality and at plant II, 90% of the scooters are rated of standard quality. A scooter is chosen at random and is found to be of standard quality. Find the probability that it is manufactured by plant II.

6. A die, whose faces are marked 1, 2, 3 in red and 4, 5, 6 in green, is tossed. Let A be the event "number obtained is even" and B be the event "Number obtained is red". Find P(A ∩ B) if A and B are independent events.

Section B

Q7 – Q10 are of 3 marks each

7. Evaluate: $\int_0^p \frac{\sqrt{x}}{\sqrt{x}+\sqrt{p-x}}dx$

8. If $e^y(x+1)=1$, then show that $\frac{dy}{dx}=-e^y$.

OR

Obtain the differential equation of the family of circles passing through the points (a, 0) and (-a, 0).

9. Given that $\vec{b}=2\hat{i}+4\hat{j}-5\hat{k}$ and $\vec{c}=\lambda\hat{i}+2\hat{j}+3\hat{k}$, such that the scalar product of $\vec{a}=\hat{i}+\hat{j}+\hat{k}$ and unit vector along sum of the given two vectors $\vec{b}$ and $\vec{c}$ is unity.

10. Find the equation of the plane passing through the points (1, 2, 3) and (0, −1, 0) and parallel to the line $\frac{x-1}{2}=\frac{y+2}{3}=\frac{z}{-3}$.

OR

Find the co-ordinates of points on line $\frac{x-1}{2}=\frac{y+2}{3}=\frac{z-3}{6}$, which are at a distance of 3 units from the point (1, −2, 3).

Section C

Q11 – Q14 are of 4 marks each

11. Integrate $\int \frac{1}{x\log x\left(2+\log x\right)}dx$

12. Calculate the area between the curve $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ and the x-axis between x = 0 to x = a.

OR

If AOB is a triangle in the first quadrant of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, where OA = a and OB = b, then find the area enclosed between the chord AB and the arc AB of the ellipse.

13. Find the distance between the parallel planes $\vec{r}.\ 2i\text{-}1\hat{j}+3\hat{k}\ =4$ and $\vec{r}.\ 6\hat{i}\text{-}3\hat{j}+9\hat{k}\ +13=0$

14. Case Study

In a factory which manufactures bulbs, machines X, Y and Z manufacture 1000, 2000, 3000 bulbs, respectively. Of their outputs, 1%, 1.5% and 2 % are defective bulbs. A bulb is drawn at random and is found to be defective.

Based on the above information, answer the following question.

i. What is the probability that machine X manufactures it?

ii. What is the probability that machine Y manufactures it?

Solution

Section A

1. $I = \int \log\left(1+x^2\right)dx$

$I = \log\left(1+x^2\right)\int 1dx - \int\left(\frac{d}{dx}\log\left(1+x^2\right)\int dx\right)$

$I = x\log\left(1+x^2\right) - \int\left(\frac{1}{1+x^2}\times 2x\times x\right)dx + c$

$I = x\log\left(1+x^2\right) - \int\left(\frac{2x^2}{1+x^2}\right)dx + c$

$I = x\log\left(1+x^2\right) - 2\int\left(\frac{x^2+1-1}{1+x^2}\right)dx + c$

$I = x\log\left(1+x^2\right) - 2\int\left(1-\frac{1}{1+x^2}\right)dx + c$

$I = x\log\left(1+x^2\right) - 2x + 2\tan^{-1}x + c$

OR

$I = \int \frac{\sin x}{\sin(x-a)}dx$

$I = \int \frac{\sin(x-a+a)}{\sin(x-a)}dx$

$I = \int \frac{\sin(x-a)\cos a + \cos(x-a)\sin a}{\sin(x-a)}dx$

$I = \int\left(\cos a + \tan(x-a)\sin a\right)dx$

$I = x\cos a + \sin a\log\left|\sec(x-a)\right| + c$

2. Given DE is $\left(\frac{dy}{dx}\right)^2 + \frac{d}{dx}\left(\frac{dy}{dx}\right) - y = 4$

$\Rightarrow \left(\frac{dy}{dx}\right)^2 + \frac{d^2y}{dx^2} - y = 4$

Order is 2

Degree is 1

So, the sum is 3.

3. We know that $\sin\theta = \dfrac{|\vec{a} \times \vec{b}|}{|\vec{a}||\vec{b}|}$, where θ is the angle between $\vec{a}$ and $\vec{b}$

Since $|\vec{a}| = 3$ (given), $|\vec{b}| = \dfrac{2}{3}$ (given), $|\vec{a} \times \vec{b}| = 1$ (given)

$\Rightarrow \sin\theta = \dfrac{1}{3 \times \frac{2}{3}}$

$\Rightarrow \sin\theta = \dfrac{1}{2}$

$\Rightarrow \sin\theta = \sin\dfrac{\pi}{6}$

$\Rightarrow \theta = \dfrac{\pi}{6}$

Thus, the angle between $\vec{a}$ and $\vec{b}$ is $\dfrac{\pi}{6}$.

4. The distance of the plane 3x − 4y + 12z − 3 = 0 from the origin (0, 0, 0) is

$= \left|\dfrac{3(0) - 4(0) + 12(0) - 3}{\sqrt{(3)^2 + (-4)^2 + (12)^2}}\right|$

$= \left|\dfrac{0 - 0 + 0 - 3}{\sqrt{9 + 16 + 144}}\right|$

$= \left|\dfrac{-3}{\sqrt{169}}\right|$

$= \left|\dfrac{-3}{13}\right|$

$= \dfrac{3}{13}$

5. $P(I) = \dfrac{70}{100}$, $P(II) = \dfrac{30}{100}$

E: standard quality

$P(E / I) = \dfrac{30}{100}$, $P(E / II) = \dfrac{90}{100}$

$P(II / E) = \dfrac{P(II) \cdot P(E / II)}{P(I) \cdot P(E / I) + P(II) \cdot P(E / II)}$

$$= \frac{\frac{30}{100} \times \frac{90}{100}}{\frac{70}{100} \times \frac{30}{100} + \frac{30}{100} \times \frac{90}{100}}$$

$$= \frac{9}{16}$$

6. It is given that

$P(A) = \frac{3}{6} = \frac{1}{2}$ & $P(B) = \frac{3}{6} = \frac{1}{2}$

$P(A \cap B)$ = P(Numbers that are even as well as red)

= P(Number appearing is 2)

$= \frac{1}{6}$

Clearly, $P(A \cap B) \neq P(A) \times P(B)$

Hence, A and B are not independent events.

Section B

7. Let $I = \int_0^p \frac{\sqrt{x}}{\sqrt{x} + \sqrt{p-x}} dx$ ... (1)

According to property,

$$\int_0^a f(x)dx = \int_0^a f(a-x)dx$$

$I = \int_0^p \frac{\sqrt{p-x}}{\sqrt{p-x} + \sqrt{x}} dx$ ...(2)

Adding equations (1) and (2), we get

$$2I = \int_0^p \frac{\sqrt{x} + \sqrt{p-x}}{\sqrt{x} + \sqrt{p-x}} dx$$

$$= \int_0^p 1dx = [x]_0^p = p - 0 = p$$

Thus, $2I = p \Rightarrow I = \frac{p}{2}$

8. On differentiating $e^y(x+1) = 1$ w.r.t x, we get

$$e^y + (x+1)e^y \frac{dy}{dx} = 0$$

$$\Rightarrow e^y + \frac{dy}{dx} = 0$$

$$\Rightarrow \frac{dy}{dx} = -e^y$$

OR

$x^2+(y-b)^2=a^2+b^2$ or $x^2+y^2-2by=a^2$ ... (1)

$2x+2y\frac{dy}{dx}-2b\frac{dy}{dx}=0$

$\Rightarrow 2b=\frac{2x+2y\frac{dy}{dx}}{\frac{dy}{dx}}$ ... (2)

Substituting in (1), we get

$(x^2-y^2-a^2)\frac{dy}{dx}-2xy=0$

9. Given that

$\vec{b}=2\hat{i}+4\hat{j}-5k$

$\vec{c}=\lambda\hat{i}+2\hat{j}+3k$

Now consider the sum of the vectors $\vec{b}+\vec{c}$:

$\vec{b}+\vec{c}=\left(2\hat{i}+4\hat{j}-5k\right)+\left(\lambda\hat{i}+2\hat{j}+3k\right)$

$\Rightarrow \vec{b}+\vec{c}=(2+\lambda)\hat{i}+6\hat{j}-2k$

Let $\hat{n}$ be the unit vector along the sum of vectors $\vec{b}+\vec{c}$:

$$\hat{n}=\frac{(2+\lambda)\hat{i}+6\hat{j}-2k}{\sqrt{(2+\lambda)^2+6^2+2^2}}$$

The scalar product of $\vec{a}$ and n is 1. Thus,

$$\vec{a}\cdot\hat{n}=\left(\hat{i}+\hat{j}+\hat{k}\right)\cdot\left(\frac{(2+\lambda)\hat{i}+6\hat{j}-2\hat{k}}{\sqrt{(2+\lambda)^2+6^2+2^2}}\right)$$

$$\Rightarrow 1=\frac{1(2+\lambda)+1\cdot 6-1\cdot 2}{\sqrt{(2+\lambda)^2+6^2+2^2}}$$

$\Rightarrow \sqrt{(2+\lambda)^2+6^2+2^2}=2+\lambda+6-2$

$\Rightarrow \sqrt{(2+\lambda)^2+6^2+2^2}=\lambda+6$

$\Rightarrow (2+\lambda)^2+40=(\lambda+6)^2$

$\Rightarrow \lambda^2+4\lambda+4+40=\lambda^2+12\lambda+36$

$\Rightarrow 4\lambda+44=12\lambda+36$

$\Rightarrow 8\lambda=8$

$\Rightarrow \lambda=1$

Thus, n is:

$$n = \frac{(2+1)\hat{i} + 6\hat{j} - 2k}{\sqrt{(2+1)^2 + 6^2 + 2^2}}$$

$$\Rightarrow n = \frac{3\hat{i} + 6\hat{j} - 2k}{\sqrt{3^2 + 6^2 + 2^2}}$$

$$\Rightarrow n = \frac{3\hat{i} + 6\hat{j} - 2k}{\sqrt{49}}$$

$$\Rightarrow n = \frac{3\hat{i} + 6\hat{j} - 2k}{7}$$

$$\Rightarrow n = \frac{3}{7}\hat{i} + \frac{6}{7}\hat{j} - \frac{2}{7}k$$

10. Let the plane through (1, 2, 3) be $a(x-1) + b(y-2) + c(z-3) = 0$ ...(1)

This plane is parallel to the line

$$\frac{x-1}{2} = \frac{y+2}{3} = \frac{z}{-3}$$

$\therefore \quad a \times 2 + b \times 3 + c \times (-3) = 0$

$\Rightarrow \quad 2a + 3b - 3c = 0$ ...(2)

Also (1) passes through (0, −1, 0)

So, a + 3b + 3c = 0…………..(3)

Solving (2) and (3), we get

$$\frac{a}{9+9} = \frac{b}{-3-6} = \frac{c}{6-3}$$

$$\Rightarrow \frac{a}{6} = \frac{b}{-3} = \frac{c}{1}$$

Hence the required plane is given by

$$6(x-1) - 3(y-2) + 1(z-3) = 0$$

$$\Rightarrow 6x - 3y + z = 3$$

OR

Given equation is

$$\frac{x-1}{2} = \frac{y+2}{3} = \frac{z-3}{6} = K$$

Any point on this line will be of the form (2K + 1, 3K − 2, 6K + 3)

Distance between points (2K + 1, 3K − 2, 6K + 3) and (1, -2, 3) is 3 units.

i.e., $\sqrt{(2K+1-1)^2 + (3K-2+2)^2 + (6K+3-3)^2} = 3$

$$\sqrt{4K^2 + 9k^2 + 36k^2} = 3$$

$$\Rightarrow 7k = 3 \Rightarrow k = \frac{3}{7}$$

∴ Required point is

$\left(2\times\frac{3}{7}+1, 3\times\frac{3}{7}-2, 6\times\frac{3}{7}+3\right)=\left(\frac{13}{7},\frac{-5}{7},\frac{39}{7}\right)$ is the required point.

Section C

11. $I=\int\frac{1}{x\log x\left(2+\log x\right)}\,dx$

Put log x = t ⇒ dx/x = dt

$I=\int\frac{1}{t\left(2+t\right)}dt$

Consider,

$\frac{1}{t\left(2+t\right)}=\frac{A}{t}+\frac{B}{2+t}$ ... (i)

$\Rightarrow\frac{1}{t\left(2+t\right)}=\frac{A\left(2+t\right)+Bt}{t\left(2+t\right)}$

$\Rightarrow 1=A\left(2+t\right)+Bt$

2A + 2t + Bt = 1

2A + (2 + B)t = 1

Comparing on both sides we get

A = ½ and B = -2

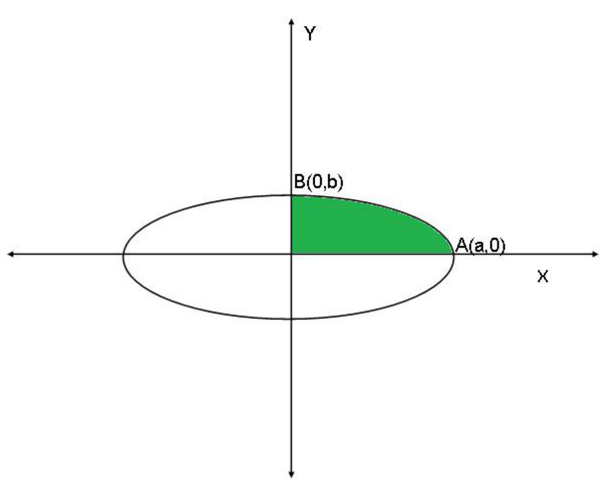
$\Rightarrow\frac{1}{t\left(2+t\right)}=\frac{\frac{1}{2}}{t}+\frac{-2}{2+t}=\frac{1}{2t}-\frac{2}{2+t}$

$\Rightarrow I=\int\left(\frac{1}{2t}-\frac{2}{2+t}\right)dt$

$I=\frac{1}{2}\log|t|-2\log|2+t|+c$

$I=\frac{1}{2}\log\left(\log x\right)-2\log\left(2+\log x\right)+c$

12.



Required area is given by

$$\int_0^a b\sqrt{1-\frac{x^2}{a^2}}\,dx = \frac{b}{a}\int_0^a \sqrt{a^2-x^2}\,dx$$

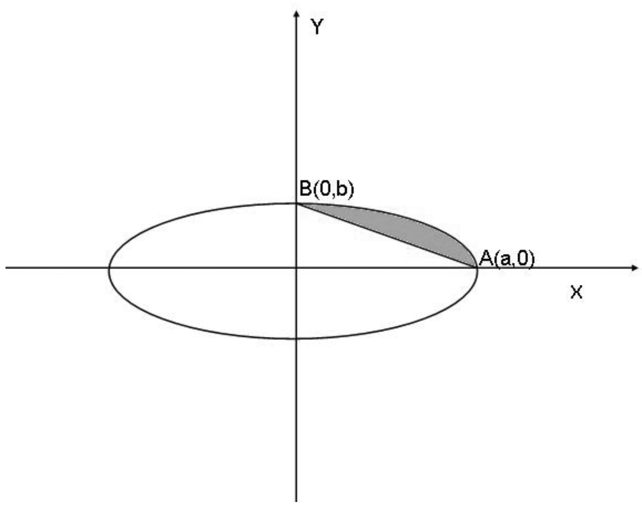
$$= \frac{b}{a}\left[\frac{x\sqrt{a^2-x^2}}{2}+\frac{a^2}{2}\sin^{-1}\frac{x}{a}\right]_0^a$$

$$= \frac{b}{2a}\left[\left(0+a^2\sin^{-1}(1)\right)-\left(0+a^2\sin^{-1}(0)\right)\right]$$

$$= \frac{b}{2a}\left(a^2\times\frac{\pi}{2}\right)$$

$$= \frac{1}{4}\pi ab$$

OR



Area of triangle AOB

$$= \frac{1}{2}\times OA\times OB$$

$$= \frac{1}{2}ab$$

Now, area of ellipse in the first quadrant is given by

$$\int_0^a b\sqrt{1-\frac{x^2}{a^2}}\,dx = \frac{b}{a}\int_0^a \sqrt{a^2-x^2}\,dx$$

$$= \frac{b}{a}\left[\frac{x\sqrt{a^2-x^2}}{2}+\frac{a^2}{2}\sin^{-1}\frac{x}{a}\right]_0^a$$

$$= \frac{b}{2a}\left[\left(0+a^2\sin^{-1}(1)\right)-\left(0+a^2\sin^{-1}(0)\right)\right]$$

$= \frac{b}{2a}\left(a^2 \times \frac{\pi}{2}\right)$

$= \frac{1}{4}\pi ab$

Area enclosed between the chord AB and the arc AB of the ellipse

$=$ Area of ellipse in quadrant I $-$ Area(ΔAOB)

$= \int_0^a b\sqrt{1-\frac{x^2}{a^2}}\ dx - \frac{1}{2}ab$

$= \frac{1}{4}\pi ab - \frac{1}{2}ab$

$= \frac{(\pi-2)ab}{4}$

13. Distance between the parallel planes is given by

$\frac{|d-k|}{|\vec{n}|}$

$\vec{r}.\ 6\hat{i} - 3\hat{j} + 9\hat{k}\ + 13 = 0$

$\Rightarrow \vec{r}.\ 2\hat{i} - \hat{j} + 3\hat{k}\ = -\frac{13}{3}$

$\vec{r}.\ 2i - 1\hat{j} + 3\hat{k}\ = 4$ and $\vec{r}.\ 2\hat{i} - \hat{j} + 3\hat{k}\ = -\frac{13}{3}$

Therefore, the distance between the given parallel planes is

$\frac{\left|4 - \left(-\frac{13}{3}\right)\right|}{\sqrt{2 + -1 + 3}}$

$= \frac{\left|4 + \left(\frac{13}{3}\right)\right|}{\sqrt{4+1+9}} = \frac{\frac{25}{3}}{\sqrt{14}} = \frac{25}{3\sqrt{14}}$

14. B_1: the bulb is manufactured by machine X

B_2: the bulb is manufactured by machine Y

B_3: the bulb is manufactured by machine Z

$P(B_1)$ = 1000/(1000 + 2000 + 3000) = 1/6

$P(B_2)$ = 2000/(1000 + 2000 + 3000) = 1/3

$P(B_3)$ = 3000/(1000 + 2000 + 3000)= 1/2

$P(E|B_1)$ = Probability that the bulb drawn is defective, given that it is manufactured by machine X = 1% = 1/100

Similarly, $P(E|B_2)$ = 1.5% = 1.5/100 = 3/200

$P(E|B_3)$ = 2% = 2/100

i.

$$P(B_1 \mid E) = \frac{P(B_1)P(E|B_1)}{P(B_1)(PE|B_1) + P(B_2)(PE|B_2) + P(B_3)(PE|B_3)}$$

$$= \frac{\frac{1}{6} \times \frac{1}{100}}{\frac{1}{6} \times \frac{1}{100} + \frac{1}{3} \times \frac{3}{200} + \frac{1}{2} \times \frac{2}{100}}$$

$$= \frac{\frac{1}{6}}{\frac{1}{6} + \frac{1}{2} + 1}$$

$$= \frac{1}{1 + 3 + 6} = \frac{1}{10}$$

ii.

$$P(B_2 \mid E) = \frac{P(B_2)P(E|B_2)}{P(B_1)(PE|B_1) + P(B_2)(PE|B_2) + P(B_3)(PE|B_3)}$$

$$= \frac{\frac{1}{3} \times \frac{3}{200}}{\frac{1}{6} \times \frac{1}{100} + \frac{1}{3} \times \frac{3}{200} + \frac{1}{2} \times \frac{2}{100}}$$

$$= \frac{1}{\frac{1}{3} + 1 + 2}$$

$$= \frac{3}{1 + 3 + 6} = \frac{3}{10}$$