NCERT Solutions for 12th Class Maths: Chapter 8-Application of Integrals

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Class 12: Maths Chapter 8 solutions. Complete Class 12 Maths Chapter 8 Notes.

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Ex 8.1 Class 12 Maths Question 1.

Find the area of the region bounded by the curve $y^2 = x$ and the lines $x = 1$, $x = 4$, and the x-axis.

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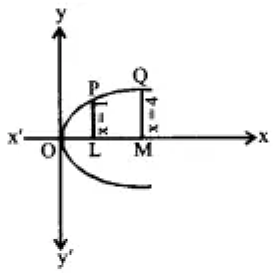
Solution:

The curve y² = x is a parabola with vertex at origin.Axis of x is the line of symmetry, which is the axis of parabola. The area of the region bounded by the curve, x = 1, x=4 and the x-axis. Area LMQP

$$= \int_1^4 y\,dx = \int_1^4 \sqrt{x}\,dx$$

$$= \frac{2}{3}\left[x^{3/2}\right]_1^4$$



$$= \frac{2}{3}\left[4^{3/2} - 1^{3/2}\right] = \frac{2}{3}[8 - 1] = \frac{14}{3} \text{ sq. units.}$$

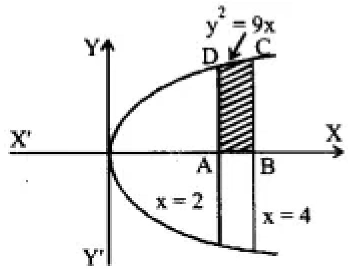
Ex 8.1 Class 12 Maths Question 2.

Find the area of the region bounded by y² = 9x, x = 2, x = 4 and x-axis in the first quadrant

Solution:

The given curve is y² = 9x, which is a parabola with vertex at (0, 0) and axis along x-axis. It is symmetrical about x-axis, as it contains only even powers of y. x = 2 and x = 4 are straight lines parallel toy-axis at a positive distance of 2 and 4 units from it respectively.

∴ Required area = Area ABCD



$$= \int_2^4 y\,dx$$

$$= \int_2^4 \sqrt{9x}\,dx$$

$$= 3\int_2^4 \sqrt{x}\,dx = 3\left[\frac{x^{3/2}}{\frac{3}{2}}\right]_2^4 = 3\times\frac{2}{3}[x^{3/2}]_2^4$$

$$= 2[4^{3/2} - 2^{3/2}] = 2[8 - 2\sqrt{2}] = (16 - 4\sqrt{2}) \text{ sq. units.}$$

Ex 8.1 Class 12 Maths Question 3.

Find the area of the region bounded by $x^2 = 4y$, $y = 2$, $y = 4$ and the y-axis in the first quadrant.

Solution:

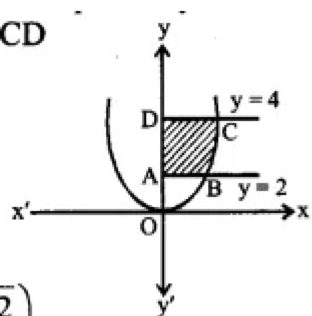
The given curve $x^2 = 4y$ is a parabola with vertex at (0,0). Also since it contains only even powers of x,it is symmetrical about y-axis.y = 2 and y = 4 are straight lines parallel to x-axis at a positive distance of 2 and 4 from it respectively.

Required area = area ABCD

$$= \int_2^4 x\,dy = \int_2^4 2\sqrt{y}\,dy$$

$$= 2\int_2^4 \sqrt{y}\,dy$$

$$= 2\left[\frac{y^{3/2}}{\frac{3}{2}}\right]_2^4 = \left(\frac{32 - 8\sqrt{2}}{3}\right) \text{ sq. units}$$



Ex 8.1 Class 12 Maths Question 4.

Find the area of the region bounded by the ellipse

$$\frac{x^2}{16} + \frac{y^2}{9} = 1$$

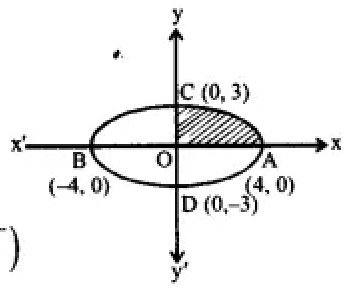
Solution:

The equation of the ellipse is

$$\frac{x^2}{16} + \frac{y^2}{9} = 1$$

The given ellipse is symmetrical about both axis as it contains only even powers of y and x.

Now, $\frac{x^2}{16}+\frac{y^2}{9}=1$



$\Rightarrow \frac{y^2}{9}=1-\frac{x^2}{16}$

$\Rightarrow \quad y=\pm\frac{3}{4}\left(\sqrt{16-x^2}\right)$

Now, area bounded by the ellipse = 4 (area of ellipse in first quardant) = 4 (area OAC)

$=4\int_0^4 y\,dx=\int_0^4\frac{3}{4}\sqrt{16-x^2}\,dx$

Put x = 4 sin θ so that dx = 4 cos θ dθ,

Now when $x=0, \theta=0$ and when $x=4, \theta=\frac{\pi}{2}$

$\therefore$ Req. area $=\frac{4\times 3}{4}\int_0^{\frac{\pi}{2}}\sqrt{16-16\sin^2\theta}\cdot 4\cos\theta\,d\theta$

$=3\int_0^{\frac{\pi}{2}}4\sqrt{1-\sin^2\theta}\cdot 4\cos\theta\,d\theta$

$=48\int_0^{\frac{\pi}{2}}\cos^2\theta\,d\theta=24\int_0^{\frac{\pi}{2}}(1+\cos 2\theta)\,d\theta$

$=24\left[\theta+\frac{\sin 2\theta}{2}\right]_0^{\frac{\pi}{2}}=12\pi$ sq. units.

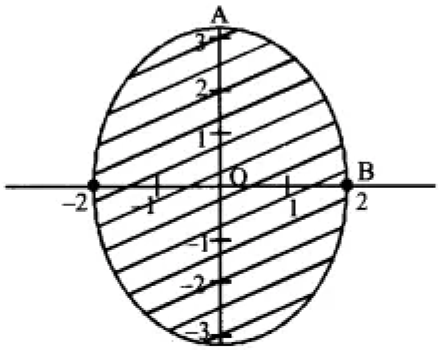
Ex 8.1 Class 12 Maths Question 5.

Find the area of the region bounded by the ellipse

Solution:

$$\frac{x^2}{4}+\frac{y^2}{9}=1$$

It is an ellipse with centre (0,0) and length of major axis = 2a = 2×3 = 6 and length of minor axis = 2b = 2 × 2 = 4.



Its rough sketch is shown in Fig.

$\therefore$ Area bounded by ellipse = 4 × area of region AOB

$$= 4\int_0^2 \frac{3}{2}\sqrt{4-x^2}\,dx = 6\int_0^2 \sqrt{4-x^2}\,dx$$

$$= 6\left[\frac{x\sqrt{4-x^2}}{2} + \frac{4}{2}\sin^{-1}\frac{x}{2}\right]_0^2 = 6\pi \text{ sq. units.}$$

Ex 8.1 Class 12 Maths Question 6.

Find the area of the region in the first quadrant enclosed by x-axis, line $x = \sqrt{3}y$ and the circle $x^2 + y^2 = 4$. .

Solution:

Consider the two equations $x^2 + y^2 = 4$ … (i)

and $x = \sqrt{3}y$ i.e.

$$y = \frac{1}{\sqrt{3}}x$$

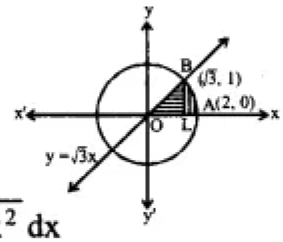
…(ii)

(1) $x^2 + y^2 = 4$ is a circle with centre O (0,0) and radius = 2.

(2) $y = \frac{1}{\sqrt{3}} x$ is a straight line passing through

(0, 0) and intersecting the circle at $B(\sqrt{3}, 1)$.

required area



= shaded region,
= area OBL + area LBA

$$= \frac{1}{\sqrt{3}} \int_0^{\sqrt{3}} x dx + \int_{\sqrt{3}}^{2} \sqrt{4 - x^2}\, dx$$

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

$$= \frac{\sqrt{3}}{2} - \frac{\sqrt{3}}{2} + 2\left(\frac{\pi}{2} - \frac{\pi}{3} \right) = \pi - \frac{2\pi}{3} = \frac{\pi}{3} \text{ sq. units.}$$

Ex 8.1 Class 12 Maths Question 7.

Find the area of the smaller part of the circle $x^2 + y^2 = a^2$ cut off by the line

$$x = \frac{a}{\sqrt{2}}$$

Solution:

The equation of the given curve are

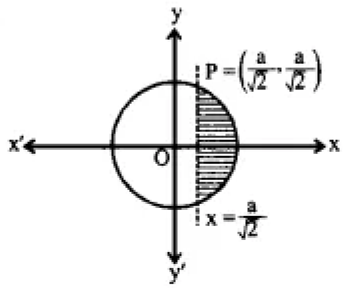
$x^2 + y^2 = a^2$ …(i) and

$$x = \frac{a}{\sqrt{2}}$$

…(ii)

Clearly, (i) represent a circle and (ii) is the equation of a straight line parallel to y-axis at a distance $\frac{a}{\sqrt{2}}$ units to the right of y-axis.

Solving (i) and (ii).



$$\frac{a^2}{2} + y^2 = a^2$$

$$\Rightarrow \ y = \frac{a}{\sqrt{2}}$$

$\therefore \ P\left(\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right)$ is the point of interection of curve (1) and (2) in the first quardant.

The smaller region bounded by these two curve is the shaded portion shown in the figure.

$\therefore$ Required Area = shaded region

$$= 2\int_{\frac{a}{\sqrt{2}}}^{a} \sqrt{a^2 - x^2}\,dx$$

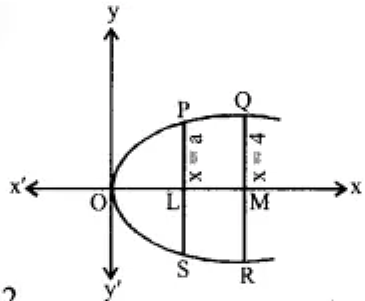
$$= 2\left[\frac{1}{2}x\sqrt{a^2 - x^2} + \frac{1}{2}a^2 \sin^{-1}\frac{x}{a}\right]_{\frac{a}{\sqrt{2}}}^{a} = \frac{a^2}{2}\left(\frac{\pi}{2} - 1\right) \text{sq.units.}$$

Ex 8.1 Class 12 Maths Question 8.

The area between $x = y^2$ and $x = 4$ is divided into two equal parts by the line $x = a$, find the value of a.

Solution:

Graph of the curve $x = y^2$ is a parabola as given in the figure. Its vertex is O and axis is x-axis. QR is the ordinate along $x = 4$



$\therefore$ Req. area is

$$A_1 = 2\int_0^4 y\,dx$$

$$= 2\int_0^4 \sqrt{x}\,dy$$

$$= 2 \times \frac{2}{3}\left[x^{\frac{3}{2}}\right]_0^4 = \frac{32}{3} \text{ sq. units.}$$

Area of the region bounded by the curve and ordinate x = a is

$$A_2 = 2\int_0^a y\,dx = 2\int_0^a \sqrt{x}\,dy = 2.\frac{2}{3}\left[x^{\frac{3}{2}}\right]_0^a = \frac{4}{3}.\left(a^{\frac{3}{2}} - 0\right)$$

Now PS [x = a] devided the area of the region ORQ into two equal parts

$\therefore$ Area of rregion ORQ = 2 Area of the region OPS,

$\therefore$ $A_1 = 2A_2$

$$\Rightarrow \frac{32}{3} = 2 \cdot \frac{4}{3} a^{\frac{3}{2}} \Rightarrow a^{\frac{3}{2}} = 4 \quad \Rightarrow a = 4^{\frac{2}{3}} \text{ units.}$$

Ex 8.1 Class 12 Maths Question 9.

Find the area of the region bounded by the parabola $y = x^2$ and $y = |x|$.

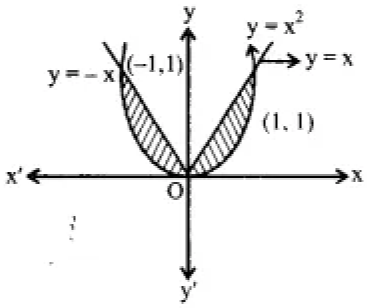
Solution:

Clearly $x^2 = y$ represents a parabola with vertex at (0, 0) positive direction of y-axis as its axis it opens upwards.

$y = |x|$ i.e., $y = x$ and $y = -x$ represent two lines passing through the origin and making an angle of 45° and 135° with the positive direction of the x-axis.

The required region is the shaded region as shown in the figure. Since both the curve are symmetrical about y-axis. So,

Required area = 2 (shaded area in the first quadrant)



$$= 2\int_0^1 (x - x^2)dx = 2\left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = \frac{1}{3} \text{sq. units.}$$

Ex 8.1 Class 12 Maths Question 10.

Find the area bounded by the curve $x^2 = 4y$ and the line $x = 4y – 2$

Solution:

Given curve is $x^2 = 4y$ …(i)

which is an upward parabola with vertex at (0,0) and it is symmetrical about y-axis

Equation of the line is $x = 4y – 2$ …(ii)

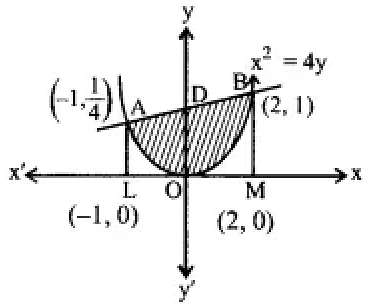
Solving (i) and (ii) simultaneously, we get; $(4y – 2)^2 = 4y$

$\Rightarrow 16y^2 – 16y + 4 = 4y$

$\Rightarrow 4y^2 – 5y + 1 = 0$

$\Rightarrow$ $(4y-1)(y-1)=0 \Rightarrow$ $y=\frac{1}{4}, 1$

From (ii),



when $y=\frac{1}{4}$, $x=-1$;

When $y = 1$, $x = 2$

$\therefore A\left(-1, \frac{1}{4}\right)$ and B (2, 1) are the points of intersection of (i) and (ii). Clearly, from the figures the shaded portion OBDAO is the region of the required area.

Required area = area LOMBDA − area LMBOAL ...(iii)

Now area LMBDA $= \int_{-1}^{2} y\,dx$, $\frac{1}{4}\int_{-1}^{2}(x+2)\,dx$

(where $x = 4y \Rightarrow y = \frac{1}{4}$ $(x+2)$)

$=\frac{1}{4}\left[\frac{x^2}{2}+2x\right]_{-1}^{2}=\frac{1}{4}\left(6+\frac{3}{2}\right)=\frac{15}{8}$ sq. units ...(iv)

and area LMBOAL $= \int_{-1}^{2} y\,dx$, where $x^2 = 4y$

$=\frac{1}{4}\int_{-1}^{2} x^2\,dx=\frac{1}{4}\left[\frac{x^3}{3}\right]_{-1}^{2}=\frac{3}{4}$ sq. units. ...(v)

From (iii), (iv) and (v), the required area ,

$=\frac{15}{8}-\frac{3}{4}=\frac{9}{8}$ sq. units.

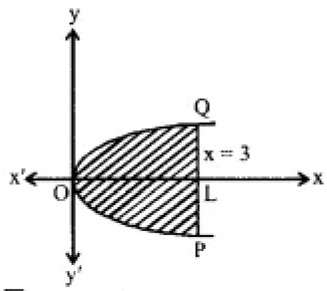
Ex 8.1 Class 12 Maths Question 11.

Find the area of the region bounded by the curve $y^2 = 4x$ and the line $x = 3$.

Solution:

The curve $y^2 = 4x$ is a parabola as shown in the figure. Axis of the parabola is x-axis. The area of the region bounded by the curve $y^2 = 4x$ and the line $x = 3$ is

A = Area of region OPQ = 2 (Area of the region OLQ)



$$= 2\int_0^3 y\,dx$$

$$= 2\int_0^3 2\sqrt{x}\,dx$$

$$= 4 \times \frac{2}{3}\left(x^{3/2}\right)_0^3$$

$$= \frac{8}{3}.3^{\frac{3}{2}} = \frac{8}{3}.\sqrt{27} = 8\sqrt{3} \text{ sq. units}$$

Choose the correct answer in the following Exercises 12 and 13:

Ex 8.1 Class 12 Maths Question 12.

Area lying in the first quadrant and bounded by the circle $x^2 + y^2 = 4$ and the lines $x = 0$ and $x = 2$ is

(a) π

(b)

$\frac{\pi}{2}$

(c)

$\frac{\pi}{3}$

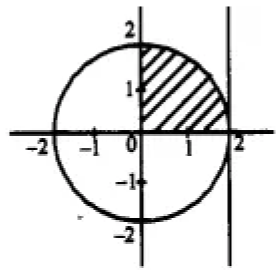
(d)

$\frac{\pi}{4}$

Solution:

(a) $x^2 + y^2 = 4$. It is a circle at the centre (0,0) and r=2

Area $= \int_0^2 \sqrt{4 - x^2}\,dx$



Let $x = 2\sin\theta$

$\Rightarrow dx = 2\cos\theta\, d\theta$

When $x = 0$, $\theta = 0$

and when $x = 2$, $\theta \frac{\pi}{2}$

$$\therefore \quad \text{Area} = \int_0^{\pi/2} 4\cos^2\theta\, d\theta$$

$$= 4\int_0^{\pi/2} \left(\frac{1+\cos 2\theta}{2}\right) d\theta = 2\left(\theta + \frac{\sin 2\theta}{2}\right)\Bigg]_0^{\pi/2} = \pi$$

Ex 8.1 Class 12 Maths Question 13.

Area of the region bounded by the curve $y^2 = 4x$, y-axis and the line y = 3 is

(a) 2

(b)

$\frac{9}{4}$

(c)

$\frac{9}{3}$

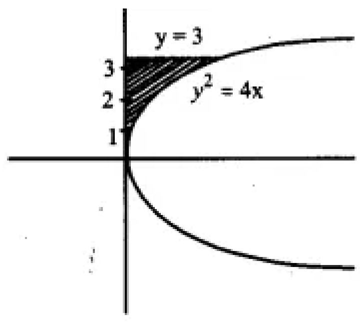
(d)

$\frac{9}{2}$

Solution:

(b) $y^2 = 4x$ is a parabola

$$\text{Area} = \int_0^3 x\,dy$$
$$= \int_0^3 \frac{y^2}{4}\,dy$$
$$= \left[\frac{1}{4} \times \frac{y^3}{3}\right]_0^3 = \frac{9}{4}$$



Ex 8.2 Class 12 Maths Question 1.

Find the area of the circle $4x^2 + 4y^2 = 9$ which is interior to the parabola $x^2 = 4y$.

Solution:

Area is bounded by the circle $4x^2 + 4y^2 = 9$ and interior of the parabola $x^2 = 4y$.

Putting $x^2 = 4y$ in $x^2 + y^2 =$

$\frac{9}{4}$

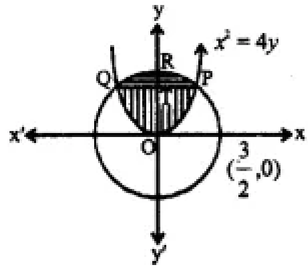
We get $4y + y^2 =$

or $4y^2 + 16y - 9 = 0$,

$(2y+9)(2y-1) = 0$

$\Rightarrow y = \frac{1}{2}, -\frac{9}{2}$

$\Rightarrow y \neq -\frac{9}{2} \quad \therefore \quad y = \frac{1}{2}$



Radius of the circle $= \frac{3}{2}$,

Area of the region required=Area of the region OPRQ.

= {(area of the region OPQ) + (area of the region PQR)]

= 2 × area of the region OPT + 2 × area of the region TPR

$$= 2 \cdot 2\int_0^{\frac{1}{2}} \sqrt{y}\,dy + 2\int_{1/2}^{3/2} \sqrt{\frac{9-4y^2}{4}}\,dy$$

$$= 4\int_0^{1/2} \sqrt{y}\,dy + 2\int_{1/2}^{3/2} \sqrt{\frac{9}{4} - y^2}\,dy$$

$$= 4 \times \frac{2}{3}\left[y^{\frac{3}{2}}\right]_0^{1/2} + 2\left[\frac{y}{2}\sqrt{\frac{9}{4} - y^2} + \frac{9}{8}\sin^{-1}\left(\frac{y}{3/2}\right)\right]_{1/2}^{3/2}$$

$\frac{9}{4}$ $$= \frac{\sqrt{2}}{6} + \frac{9}{4}\sin^{-1}\left(1 \cdot \frac{2\sqrt{2}}{3} - 0\right) = \frac{\sqrt{2}}{6} + \frac{9}{4}\sin^{-1}\frac{2\sqrt{2}}{3}$$

Ex 8.2 Class 12 Maths Question 2.

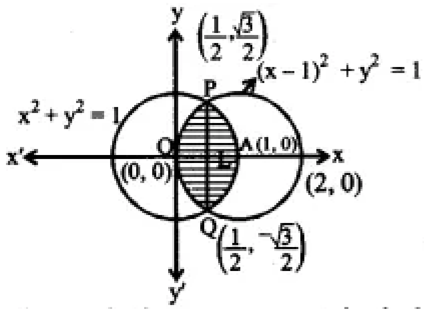
Find the area bounded by curves $(x - 1)^2 + y^2 = 1$ and $x^2 + y^2 = 1$.

Solution:

Given circles are $x^2 + y^2 = 1$ …(i)

and $(x - 1)^2 + y^2 = 1$ …(ii)

Centre of (i) is O (0,0) and radius = 1



Both these circle are symmetrical about x-axis

solving (i) and (ii) we get, $-2x+1=0 \Rightarrow x=\frac{1}{2}$

then $y^2=1-\left(\frac{1}{2}\right)^2=\frac{3}{4} \Rightarrow y=\frac{\sqrt{3}}{2}$

$\therefore$ The points of intersection are

$$P\left(\frac{1}{2},\frac{\sqrt{3}}{2}\right) \text{ and } Q\left(\frac{1}{2},-\frac{\sqrt{3}}{2}\right)$$

It is clear from the figure that the shaded portion in region whose area is required.

$\therefore$ Req. area = area OQAPO = 2 × area of the region OLAP = 2 × (area of the region OLPO + area of LAPL)

$$=2\left[\int_0^{1/2}\sqrt{1-(x-1)^2}\,dx+\int_{1/2}^{1}\sqrt{1-x^2}\,dx\right]$$

$$=2\left[\frac{(x-1)\sqrt{1-(x-1)^2}}{2}+\frac{1}{2}\sin^{-1}(x-1)\right]_0^{1/2}+2\left[\frac{x\sqrt{1-x^2}}{2}+\frac{1}{2}\sin^{-1}x\right]_{1/2}^{1}$$

$$=\frac{\sqrt{3}}{4}-\frac{\pi}{6}-\left(-\frac{\pi}{2}\right)+\frac{\pi}{2}-\frac{\sqrt{3}}{4}-\frac{\pi}{6}=\left(\frac{2\pi}{3}-\frac{\sqrt{3}}{2}\right)$$

sq. units.

Ex 8.2 Class 12 Maths Question 3.

Find the area of the region bounded by the curves $y = x^2 + 2$, $y = x$, $x = 0$ and $x = 3$.

Solution:

Equation of the parabola is $y = x^2 + 2$ or $x^2 = (y – 2)$

Its vertex is (0,2) axis is y-axis.

Boundary lines are $y = x$, $x = 0$, $x = 3$.

Graphs of the curve and lines have been shown in the figure.

Area of the region PQRO = Area of the region OAQR-Area of region OAP

Ex 8.2 Class 12 Maths Question 4.

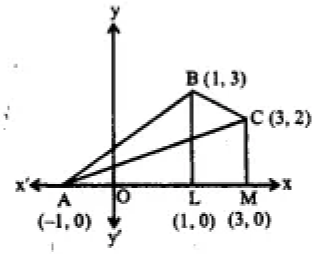
Using integration find the area of region bounded by the triangle whose vertices are (-1,0), (1,3) and (3,2).

Solution:

The points A (-1,0), B(1,3) and C (3,2) are plotted and joined.

Area of ∆ABC = Area of ∆ ABL + Area of trap. BLMC – Area of ∆ACM …(i)

The equation of the line joining the points



(x_1, y_1) and (x_2, y_2) is $y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$,

The equation of AB is $y = \frac{3}{2}(x+1)$ ...(ii)

Equation of BC, $y - 3 = \frac{2-3}{3-1}(x-1)$ or

$y = -\frac{x}{2} + \frac{7}{2}$ or $y = \frac{7-x}{2}$ ...(iii)

Ex 8.2 Class 12 Maths Question 5.

Using integration find the area of the triangular region whose sides have the equations y = 2x + 1,y = 3x + 1 and x = 4.

Solution:

The given lines are y = 2x + 1 …(i)

y = 3x + 1 …(ii)

x = 4 …(iii)

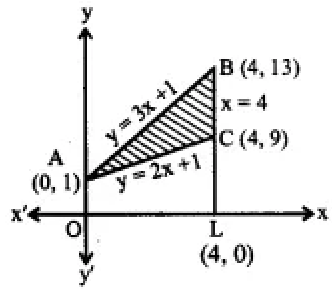
Subtract (i) from eq (ii) we get x = 0, Putting x = 0 in eq(i) y = 1

∴ Lines (ii) and (i) intersect at A (0,1) putting x = 4 in eq. (2) =>y = 12 + 1 = 13

The lines (ii) and (iii) intersect at B (4,13) putting x=4ineq. (i):y = 8 + 1 = 9

∴ Lines (i) and (ii); Intersect at C (4,9),

Area of ΔABC
= Area bounded
by OB :
$y = 3x + 1, x = 0,$
$y = 0$ and $x = 4$



$$= \int_0^4 (3x + 1)dx$$

$$= \left[3\frac{x^2}{2} + x\right]_0^4 = 24 + 4 = 28 \text{ sq. units}$$

Area of trapezium OLCA
= Area of region bounded by OC: $y = 2x + 1$,
$x = 0, x = 4, y = 0$

$$= \int_0^4 (2x + 1)\, dx = [x^2 + x]_0^4 , = (16 - 0) + (4 - 0) = 2$$

Putting these values we get
Area of $\Delta ABC = 28 - 20 = 8$ sq units.

Ex 8.2 Class 12 Maths Question 6.

Smaller area bounded by the circle $x^2 + y^2 = 4$ and the line $x + y = 2$

(a) $2 (\pi – 2)$

(b) $\pi – 2$

(c) $2\pi – 1$

(d) $2(\pi + 2)$

Solution:

(b) A circle of radius 2 and centre at O is drawn.The line AB: $x + y = 2$ is passed through (2,0) and (0,2). Area of the region ACB

= Area of quadrant OAB – Area of ΔOAB …(i)

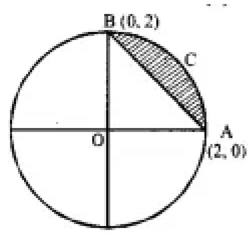
Now $x^2 + y^2 = 4$

$\therefore\ y^2 = 4 - x^2$ or

$y = \sqrt{4 - x^2}$,

$\therefore$ Area of quadrant OAB

$= \int_0^2 y\,dx = \int_0^2 \sqrt{4 - x^2}\,dx$



$= \left[\frac{x}{2}\sqrt{4 - x^2} + \frac{4}{2}\sin^{-1}\frac{x}{2}\right]_0^2 = 2 \times \frac{\pi}{2} = \pi$ sq. units

Area of the ΔABO = Area of the region bounded by AB. AB : $x + y = 2$ or $y = 2 - x$ and $x = 0, y = 0$

$= \int_0^2 (2 - x)\,dx = \left[2x - \frac{x^2}{2}\right]_0^2 = \left(4 - \frac{4}{2}\right) - (0) = 2$

Putting these values in (i), Area of region ACB $= \pi - 2$

Ex 8.2 Class 12 Maths Question 7.

Area lying between the curves $y^2 = 4x$ and $y = 2x$.

(a)

$\frac{2}{3}$

(b)

$\frac{1}{3}$

(c)

(d)

Solution:

(b) The curve is $y^2 = 4x$ …(1)

and the line is $y = 2x$ …(2)

from (1) and (2) : $(4x^2) = 4x$

$\Rightarrow \quad x = 0, \quad$ or $\quad x = 1$

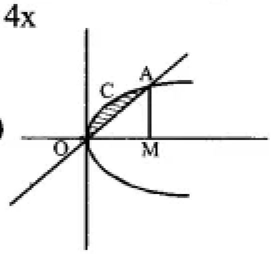
curves (1) and (2)

intersect at O (0, 0), A (1, 2)

Area of region OACO

= Area of region OMACO

− area of OMA ...(3)



Now Area of region OMACO = Area of region bounded by OCA

$$= \int_0^1 \sqrt{4x}\,dx = 2 \cdot \frac{2}{3}[x^{3/2}]_0^1 = \frac{4}{3} \times 1 = \frac{4}{3} \text{ sq. units.}$$

Area of ΔOMA = Area of region bounded by OA :

$$y = 2x,\ x = 1 \text{ and x-axis.} = \int_0^1 2x\,dx = [x^2]_0^1 = 1$$

Putting these values in (3), We get :

$$\therefore \text{ Area of region OMACO} = \frac{4}{3} - 1 = \frac{1}{3} \text{ sq units.}$$

Chapterwise NCERT Solutions for Class 12 Maths :

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