# Class XII : Maths
# Chapter 6 : Application Of Derivatives

## Questions and Solutions | Exercise 6.2 - NCERT Books

**Question 1:**

Show that the function given by $f(x) = 3x + 17$ is strictly increasing on **R**.

Answer

Let $x_1$ and $x_2$ be any two numbers in **R**.

Then, we have:

$$x_1 < x_2 \Rightarrow 3x_1 < 3x_2 \Rightarrow 3x_1 + 17 < 3x_2 + 17 \Rightarrow f(x_1) < f(x_2)$$

Hence, $f$ is strictly increasing on **R.**

**Alternate method:**

$f'(x) = 3 > 0$, in every interval of **R**.

Thus, the function is strictly increasing on **R**.

**Question 2:**

Show that the function given by $f(x) = e^{2x}$ is strictly increasing on **R**.

Answer

Let $x_1$ and $x_2$ be any two numbers in **R**.

Then, we have:

$$x_1 < x_2 \Rightarrow 2x_1 < 2x_2 \Rightarrow e^{2x_1} < e^{2x_2} \Rightarrow f(x_1) < f(x_2)$$

Hence, $f$ is strictly increasing on **R**.

**Question 3:**

Show that the function given by $f(x) = \sin x$ is

(a) strictly increasing in $\left(0, \frac{\pi}{2}\right)$ (b) strictly decreasing in $\left(\frac{\pi}{2}, \pi\right)$

(c) neither increasing nor decreasing in (0, π)

Answer

The given function is $f(x) = \sin x$.

$$\therefore f'(x) = \cos x$$

(a) Since for each $x \in \left(0, \frac{\pi}{2}\right), \cos x > 0$, we have $f'(x) > 0$.

Hence, *f* is strictly increasing in $\left(0, \frac{\pi}{2}\right)$.

(b) Since for each $x \in \left(\frac{\pi}{2}, \pi\right), \cos x < 0$ , we have $f'(x) < 0$.

Hence, *f* is strictly decreasing in $\left(\frac{\pi}{2}, \pi\right)$.

(c) From the results obtained in (a) and (b), it is clear that *f* is neither increasing nor decreasing in (0, π).

**Question 4:**

Find the intervals in which the function *f* given by $f(x) = 2x^2 - 3x$ is

(a) strictly increasing (b) strictly decreasing

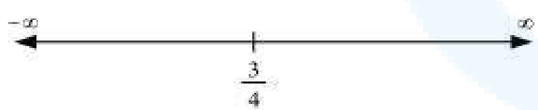
Answer

The given function is $f(x) = 2x^2 - 3x$.

$$f'(x) = 4x - 3$$

$$\therefore f'(x) = 0 \Rightarrow x = \frac{3}{4}$$

Now, the point $\frac{3}{4}$ divides the real line into two disjoint intervals i.e., $\left(-\infty, \frac{3}{4}\right)$ and $\left(\frac{3}{4}, \infty\right)$.




In interval $\left(-\infty, \frac{3}{4}\right), f'(x) = 4x - 3 < 0.$

Hence, the given function (*f*) is strictly decreasing in interval $\left(-\infty, \frac{3}{4}\right)$.

In interval $\left(\frac{3}{4}, \infty\right), f'(x) = 4x - 3 > 0.$

Hence, the given function ($f$) is strictly increasing in interval $\left(\frac{3}{4}, \infty\right)$.

**Question 5:**

Find the intervals in which the function $f$ given by $f(x) = 2x^3 - 3x^2 - 36x + 7$ is

(a) strictly increasing (b) strictly decreasing

Answer

The given function is $f(x) = 2x^3 - 3x^2 - 36x + 7$.

$$f'(x) = 6x^2 - 6x - 36 = 6(x^2 - x - 6) = 6(x+2)(x-3)$$

$\therefore f'(x) = 0 \Rightarrow x = -2, 3$

The points $x = -2$ and $x = 3$ divide the real line into three disjoint intervals i.e.,

$(-\infty, -2), (-2, 3)$, and $(3, \infty)$.


In intervals $(-\infty, -2)$ and $(3, \infty)$, $f'(x)$ is positive while in interval

$(-2, 3)$, $f'(x)$ is negative.

Hence, the given function ($f$) is strictly increasing in intervals

$(-\infty, -2)$ and $(3, \infty)$, while function ($f$) is strictly decreasing in interval

$(-2, 3)$.

**Question 6:**

Find the intervals in which the following functions are strictly increasing or decreasing:

(a) $x^2 + 2x - 5$ (b) $10 - 6x - 2x^2$

(c) $-2x^3 - 9x^2 - 12x + 1$ (d) $6 - 9x - x^2$

(e) $(x + 1)^3 (x - 3)^3$

Answer

(a) We have,

$f(x) = x^2 + 2x - 5$

$\therefore f'(x) = 2x + 2$

Now,

$f'(x) = 0 \Rightarrow x = -1$

Point $x = -1$ divides the real line into two disjoint intervals i.e., $(-\infty, -1)$ and $(-1, \infty)$.

In interval $(-\infty, -1)$, $f'(x) = 2x + 2 < 0$.

$\therefore f$ is strictly decreasing in interval $(-\infty, -1)$.

Thus, $f$ is strictly decreasing for $x < -1$.

In interval $(-1, \infty)$, $f'(x) = 2x + 2 > 0$.

$\therefore$ $f$ is strictly increasing in interval $(-1, \infty)$.

Thus, $f$ is strictly increasing for $x > -1$.

(b) We have,

$f(x) = 10 - 6x - 2x^2$

$\therefore f'(x) = -6 - 4x$

Now,

$f'(x) = 0 \Rightarrow x = -\frac{3}{2}$

The point $x=-\frac{3}{2}$ divides the real line into two disjoint intervals

i.e., $\left(-\infty,-\frac{3}{2}\right)$ and $\left(-\frac{3}{2},\infty\right)$.

In interval $\left(-\infty,-\frac{3}{2}\right)$ i.e., when $x<-\frac{3}{2}$, $f'(x)=-6-4x<0$.

$\therefore$ *f* is strictly increasing for $x<-\frac{3}{2}$.

In interval $\left(-\frac{3}{2},\infty\right)$ i.e., when $x>-\frac{3}{2}$, $f'(x)=-6-4x<0$.

$\therefore$ *f* is strictly decreasing for $x>-\frac{3}{2}$.

(c) We have,

$f(x) = -2x^3 - 9x^2 - 12x + 1$

$\therefore f'(x)=-6x^2-18x-12=-6\left(x^2+3x+2\right)=-6(x+1)(x+2)$

Now,

$f'(x)=0 \Rightarrow x=-1 \text{ and } x=-2$

Points $x = -1$ and $x = -2$ divide the real line into three disjoint intervals

i.e., $(-\infty,-2),(-2,-1)$, and $(-1,\infty)$.

In intervals $(-\infty,-2)$ and $(-1,\infty)$ i.e., when $x < -2$ and $x > -1$,

$f'(x)=-6(x+1)(x+2)<0$.

∴ $f$ is strictly decreasing for $x < -2$ and $x > -1$.

Now, in interval $(-2, -1)$ i.e., when $-2 < x < -1$, $f'(x) = -6(x+1)(x+2) > 0$.

∴ $f$ is strictly increasing for $-2 < x < -1$.

(d) We have,

$f(x) = 6 - 9x - x^2$

$\therefore f'(x) = -9 - 2x$

Now, $f'(x) = 0$ gives $x = -\frac{9}{2}$

The point $x = -\frac{9}{2}$ divides the real line into two disjoint intervals i.e., $\left(-\infty, -\frac{9}{2}\right)$ and $\left(-\frac{9}{2}, \infty\right)$.

In interval $\left(-\infty, -\frac{9}{2}\right)$ i.e., for $x < -\frac{9}{2}$, $f'(x) = -9 - 2x > 0$.

∴ $f$ is strictly increasing for $x < -\frac{9}{2}$.

In interval $\left(-\frac{9}{2}, \infty\right)$ i.e., for $x > -\frac{9}{2}$, $f'(x) = -9 - 2x < 0$.

∴ $f$ is strictly decreasing for $x > -\frac{9}{2}$.

(e) We have,

$f(x) = (x + 1)^3 (x - 3)^3$

$$\begin{aligned} f'(x) &= 3(x+1)^2(x-3)^3 + 3(x-3)^2(x+1)^3 \\ &= 3(x+1)^2(x-3)^2[x-3+x+1] \\ &= 3(x+1)^2(x-3)^2(2x-2) \\ &= 6(x+1)^2(x-3)^2(x-1) \end{aligned}$$

Now,

$f'(x) = 0 \Rightarrow x = -1,\ 3,\ 1$

The points $x = -1$, $x = 1$, and $x = 3$ divide the real line into four disjoint intervals i.e., $(-\infty, -1)$, $(-1, 1)$, $(1, 3)$, and $(3, \infty)$.

In intervals $(-\infty, -1)$ and $(-1, 1)$, $f'(x) = 6(x+1)^2(x-3)^2(x-1) < 0$.

∴ $f$ is strictly decreasing in intervals $(-\infty, -1)$ and $(-1, 1)$.

In intervals $(1, 3)$ and $(3, \infty)$, $f'(x) = 6(x+1)^2(x-3)^2(x-1) > 0$.

∴ $f$ is strictly increasing in intervals $(1, 3)$ and $(3, \infty)$.

**Question 7:**

Show that $y=\log(1+x)-\frac{2x}{2+x}, x>-1$, is an increasing function of *x* throughout its domain.

Answer

We have,

$$y=\log(1+x)-\frac{2x}{2+x}$$

$$\therefore \frac{dy}{dx}=\frac{1}{1+x}-\frac{(2+x)(2)-2x(1)}{(2+x)^2}=\frac{1}{1+x}-\frac{4}{(2+x)^2}=\frac{x^2}{(2+x)^2}$$

$$\text{Now, } \frac{dy}{dx}=0$$

$$\Rightarrow \frac{x^2}{(2+x)^2}=0$$

$$\Rightarrow x^2=0 \qquad [(2+x)\neq 0 \text{ as } x>-1]$$

$$\Rightarrow x=0$$

Since $x > -1$, point $x = 0$ divides the domain $(-1, \infty)$ in two disjoint intervals i.e., $-1 < x < 0$ and $x > 0$.

When $-1 < x < 0$, we have:

$$x<0 \Rightarrow x^2>0$$

$$x>-1 \Rightarrow (2+x)>0 \Rightarrow (2+x)^2>0$$

$$\therefore y'=\frac{x^2}{(2+x)^2}>0$$

Also, when $x > 0$:

$$x>0 \Rightarrow x^2>0,\ (2+x)^2>0$$

$$\therefore y'=\frac{x^2}{(2+x)^2}>0$$

Hence, function *f* is increasing throughout this domain.

**Question 8:**

Find the values of *x* for which $y=\left[x(x-2)\right]^2$ is an increasing function.

Answer

We have,

$$y=\left[x(x-2)\right]^2=\left[x^2-2x\right]^2$$

$$\therefore \frac{dy}{dx}=y'=2\left(x^2-2x\right)(2x-2)=4x(x-2)(x-1)$$

$$\therefore \frac{dy}{dx}=0 \Rightarrow x=0, x=2, x=1.$$

The points *x* = 0, *x* = 1, and *x* = 2 divide the real line into four disjoint intervals i.e.,

$(-\infty,0)$, $(0,1)$ $(1,2)$, and $(2,\infty)$.

In intervals $(-\infty,0)$ and $(1,2)$, $\frac{dy}{dx}<0$.

∴ *y* is strictly decreasing in intervals $(-\infty,0)$ and $(1,2)$.

However, in intervals (0, 1) and (2, ∞), $\frac{dy}{dx}>0.$

∴ *y* is strictly increasing in intervals (0, 1) and (2, ∞).

∴ *y* is strictly increasing for 0 < *x* < 1 and *x* > 2.

**Question 9:**

Prove that $y=\frac{4\sin\theta}{(2+\cos\theta)}-\theta$ is an increasing function of *θ* in $\left[0,\frac{\pi}{2}\right]$.

Answer

We have,

$$y=\frac{4\sin\theta}{(2+\cos\theta)}-\theta$$

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

$$=\frac{8\cos\theta+4\cos^2\theta+4\sin^2\theta}{(2+\cos\theta)^2}-1$$

$$=\frac{8\cos\theta+4}{(2+\cos\theta)^2}-1$$

Now, $\frac{dy}{dx}=0.$

$$\Rightarrow\frac{8\cos\theta+4}{(2+\cos\theta)^2}=1$$

$$\Rightarrow 8\cos\theta+4=4+\cos^2\theta+4\cos\theta$$

$$\Rightarrow\cos^2\theta-4\cos\theta=0$$

$$\Rightarrow\cos\theta(\cos\theta-4)=0$$

$$\Rightarrow\cos\theta=0\text{ or }\cos\theta=4$$

Since cos $\theta \neq 4$, cos $\theta$ = 0.

$$\cos\theta=0\Rightarrow\theta=\frac{\pi}{2}$$

Now,

$$\frac{dy}{dx}=\frac{8\cos\theta+4-(4+\cos^2\theta+4\cos\theta)}{(2+\cos\theta)^2}=\frac{4\cos\theta-\cos^2\theta}{(2+\cos\theta)^2}=\frac{\cos\theta(4-\cos\theta)}{(2+\cos\theta)^2}$$

In interval $\left(0, \frac{\pi}{2}\right)$, we have cos $\theta$ > 0. Also, 4 > cos $\theta$ ⇒ 4 − cos $\theta$ > 0.

$$\therefore \cos\theta(4-\cos\theta)>0 \text{ and also } (2+\cos\theta)^2>0$$
$$\Rightarrow \frac{\cos\theta(4-\cos\theta)}{(2+\cos\theta)^2}>0$$
$$\Rightarrow \frac{dy}{dx}>0$$

Therefore, $y$ is strictly increasing in interval $\left(0, \frac{\pi}{2}\right)$.

Also, the given function is continuous at $x=0 \text{ and } x=\frac{\pi}{2}$.

Hence, $y$ is increasing in interval $\left[0, \frac{\pi}{2}\right]$.

**Question 10:**

Prove that the logarithmic function is strictly increasing on (0, ∞).

Answer

The given function is $f(x)=\log x$.

$$\therefore f'(x)=\frac{1}{x}$$

It is clear that for $x$ > 0, $f'(x)=\frac{1}{x}>0.$

Hence, $f(x)$ = log $x$ is strictly increasing in interval (0, ∞).

**Question 11:**

Prove that the function $f$ given by $f(x) = x^2 - x + 1$ is neither strictly increasing nor strictly decreasing on (−1, 1).

Answer

The given function is $f(x) = x^2 - x + 1$.

$\therefore f'(x) = 2x - 1$

Now, $f'(x) = 0 \Rightarrow x = \frac{1}{2}$.

The point $\frac{1}{2}$ divides the interval $(-1, 1)$ into two disjoint intervals

i.e., $\left(-1, \frac{1}{2}\right)$ and $\left(\frac{1}{2}, 1\right)$.

Now, in interval $\left(-1, \frac{1}{2}\right), f'(x) = 2x - 1 < 0$.

Therefore, $f$ is strictly decreasing in interval $\left(-1, \frac{1}{2}\right)$.

However, in interval $\left(\frac{1}{2}, 1\right), f'(x) = 2x - 1 > 0$.

Therefore, $f$ is strictly increasing in interval $\left(\frac{1}{2}, 1\right)$.

Hence, $f$ is neither strictly increasing nor decreasing in interval $(-1, 1)$.

**Question 12:**

Which of the following functions are strictly decreasing on $\left(0, \frac{\pi}{2}\right)$?

(A) cos $x$ (B) cos $2x$ (C) cos $3x$ (D) tan $x$

Answer

(A) Let $f_1(x) = \cos x$.

$\therefore f_1'(x) = -\sin x$

In interval $\left(0, \frac{\pi}{2}\right), f_1'(x) = -\sin x < 0$.

$\therefore f_1(x) = \cos x$ is strictly decreasing in interval $\left(0, \frac{\pi}{2}\right)$.

(B) Let $f_2(x) = \cos 2x.$

$\therefore f_2'(x) = -2\sin 2x$

Now, $0 < x < \frac{\pi}{2} \Rightarrow 0 < 2x < \pi \Rightarrow \sin 2x > 0 \Rightarrow -2\sin 2x < 0$

$\therefore f_2'(x) = -2\sin 2x < 0 \ on \left(0, \frac{\pi}{2}\right)$

$\therefore f_2(x) = \cos 2x$ is strictly decreasing in interval $\left(0, \frac{\pi}{2}\right)$.

(C) Let $f_3(x) = \cos 3x.$

$\therefore f_3'(x) = -3\sin 3x$

Now, $f_3'(x) = 0.$

$\Rightarrow \sin 3x = 0 \Rightarrow 3x = \pi, as\ x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow x = \frac{\pi}{3}$

The point $x = \frac{\pi}{3}$ divides the interval $\left(0, \frac{\pi}{2}\right)$ into two disjoint intervals

i.e., 0 $\left(0, \frac{\pi}{3}\right)$ and $\left(\frac{\pi}{3}, \frac{\pi}{2}\right)$.

Now, in interval $\left(0, \frac{\pi}{3}\right)$, $f_3(x) = -3\sin 3x < 0 \left[as\ 0 < x < \frac{\pi}{3} \Rightarrow 0 < 3x < \pi\right]$.

$\therefore f_3$ is strictly decreasing in interval $\left(0, \frac{\pi}{3}\right)$.

However, in interval $\left(\frac{\pi}{3}, \frac{\pi}{2}\right)$, $f_3(x) = -3\sin 3x > 0 \left[as\ \frac{\pi}{3} < x < \frac{\pi}{2} \Rightarrow \pi < 3x < \frac{3\pi}{2}\right]$.

$\therefore$ $f_3$ is strictly increasing in interval $\left(\frac{\pi}{3}, \frac{\pi}{2}\right)$.

Hence, $f_3$ is neither increasing nor decreasing in interval $\left(0, \frac{\pi}{2}\right)$.

(D) Let $f_4(x) = \tan x$.

$\therefore f_4'(x) = \sec^2 x$

In interval $\left(0, \frac{\pi}{2}\right), f_4'(x) = \sec^2 x > 0$.

$\therefore$ $f_4$ is strictly increasing in interval $\left(0, \frac{\pi}{2}\right)$.

Therefore, functions cos $x$ and cos $2x$ are strictly decreasing in $\left(0, \frac{\pi}{2}\right)$.

Hence, the correct answers are A and B.

**Question 13:**

On which of the following intervals is the function $f$ given by $f(x) = x^{100} + \sin x - 1$ strictly decreasing?

(A) $(0, 1)$ (B) $\left(\frac{\pi}{2}, \pi\right)$

(C) $\left(0, \frac{\pi}{2}\right)$ (D) None of these

Answer

We have,

$f(x) = x^{100} + \sin x - 1$

$\therefore f'(x) = 100x^{99} + \cos x$

In interval $(0,\ 1)$, $\cos x > 0$ and $100x^{99} > 0$.

$\therefore f'(x) > 0$.

Thus, function *f* is strictly increasing in interval (0, 1).

In interval $\left(\frac{\pi}{2}, \pi\right)$, $\cos x < 0$ and $100x^{99} > 0$. Also, $100x^{99} > \cos x$

$\therefore f'(x) > 0$ in $\left(\frac{\pi}{2}, \pi\right)$.

Thus, function *f* is strictly increasing in interval $\left(\frac{\pi}{2},\ \pi\right)$.

In interval $\left(0,\ \frac{\pi}{2}\right)$, $\cos x > 0$ and $100x^{99} > 0$.

$\therefore 100x^{99} + \cos x > 0$

$\Rightarrow f'(x) > 0$ on $\left(0,\ \frac{\pi}{2}\right)$

$\therefore$ *f* is strictly increasing in interval $\left(0,\ \frac{\pi}{2}\right)$.

Hence, function *f* is strictly decreasing in none of the intervals.

The correct answer is D.

**Question 14:**

Find the least value of *a* such that the function *f* given $f(x) = x^2 + ax + 1$ is strictly increasing on (1, 2).

Answer

We have,

$f(x) = x^2 + ax + 1$

$\therefore f'(x) = 2x + a$

Now, function *f* will be increasing in (1, 2), if $f'(x) > 0$ in (1, 2).

$f'(x) > 0$

⇒ 2*x* + *a* > 0

⇒ 2*x* > −*a*

⇒ $x > \frac{-a}{2}$

Therefore, we have to find the least value of *a* such that

$x > \frac{-a}{2}$, when $x \in (1, 2)$.

$\Rightarrow x > \frac{-a}{2}$ (when $1 < x < 2$)

Thus, the least value of *a* for *f* to be increasing on (1, 2) is given by,

$\frac{-a}{2} = 1$

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

Hence, the required value of *a* is −2.

**Question 15:**

Let **I** be any interval disjoint from (−1, 1). Prove that the function *f* given by

$f(x)=x+\frac{1}{x}$ is strictly increasing on **I**.

Answer

We have,

$$f(x)=x+\frac{1}{x}$$

$$\therefore f'(x)=1-\frac{1}{x^2}$$

Now,

$$f'(x)=0 \Rightarrow \frac{1}{x^2}=1 \Rightarrow x=\pm 1$$

The points $x = 1$ and $x = -1$ divide the real line in three disjoint intervals i.e.,

$(-\infty,-1),(-1,\ 1)$, and $(1,\ \infty)$.

In interval (−1, 1), it is observed that:

$$-1<x<1$$

$$\Rightarrow x^2<1$$

$$\Rightarrow 1<\frac{1}{x^2},\ x\neq 0$$

$$\Rightarrow 1-\frac{1}{x^2}<0,\ x\neq 0$$

$$\therefore f'(x)=1-\frac{1}{x^2}<0 \text{ on } (-1,\ 1)\sim\{0\}.$$

$\therefore$ *f* is strictly decreasing on $(-1,\ 1)\sim\{0\}$.

In intervals $(-\infty,-1)$ and $(1,\ \infty)$, it is observed that:

$x<-1$ or $1<x$

$\Rightarrow x^2>1$

$\Rightarrow 1>\dfrac{1}{x^2}$

$\Rightarrow 1-\dfrac{1}{x^2}>0$

$\therefore f'(x)=1-\dfrac{1}{x^2}>0$ on $(-\infty,-1)$ and $(1,\infty)$.

$\therefore$ *f* is strictly increasing on $(-\infty,1)$ and $(1,\infty)$.

Hence, function *f* is strictly increasing in interval **I** disjoint from (−1, 1).

Hence, the given result is proved.

**Question 16:**

Prove that the function *f* given by *f*(*x*) = log sin *x* is strictly increasing on $\left(0,\dfrac{\pi}{2}\right)$ and strictly decreasing on $\left(\dfrac{\pi}{2},\pi\right)$.

Answer

We have,

$f(x)=\log\sin x$

$\therefore f'(x)=\dfrac{1}{\sin x}\cos x=\cot x$

In interval $\left(0,\dfrac{\pi}{2}\right)$, $f'(x)=\cot x>0$.

$\therefore$ *f* is strictly increasing in $\left(0,\dfrac{\pi}{2}\right)$.

In interval $\left(\frac{\pi}{2}, \pi\right)$, $f'(x) = \cot x < 0.$

∴*f* is strictly decreasing in $\left(\frac{\pi}{2}, \pi\right)$.

**Question 17:**

Prove that the function *f* given by *f*(*x*) = log cos *x* is strictly decreasing on $\left(0, \frac{\pi}{2}\right)$ and strictly increasing on $\left(\frac{\pi}{2}, \pi\right)$.

Answer

We have,

$f(x) = \log \cos x$

$\therefore f'(x) = \frac{1}{\cos x}(-\sin x) = -\tan x$

In interval $\left(0, \frac{\pi}{2}\right)$, $\tan x > 0 \Rightarrow -\tan x < 0.$

$\therefore f'(x) < 0$ on $\left(0, \frac{\pi}{2}\right)$

∴*f* is strictly decreasing on $\left(0, \frac{\pi}{2}\right)$.

In interval $\left(\frac{\pi}{2}, \pi\right)$, $\tan x < 0 \Rightarrow -\tan x > 0.$

$\therefore f'(x) > 0$ on $\left(\frac{\pi}{2}, \pi\right)$

∴*f* is strictly increasing on $\left(\frac{\pi}{2}, \pi\right)$.

**Question 18:**

Prove that the function given by $f(x)=x^3-3x^2+3x-100$ is increasing in **R**.

Answer

We have,

$$f(x)=x^3-3x^2+3x-100$$

$$\begin{aligned} f'(x) &= 3x^2-6x+3 \\ &= 3(x^2-2x+1) \\ &= 3(x-1)^2 \end{aligned}$$

For any $x \in$ **R**, $(x-1)^2 > 0$.

Thus, $f'(x)$ is always positive in **R**.

Hence, the given function ($f$) is increasing in **R**.

**Question 19:**

The interval in which $y=x^2e^{-x}$ is increasing is

(A) $(-\infty,\infty)$ (B) (−2, 0) (C) $(2,\infty)$ (D) (0, 2)

Answer

We have,

$$y=x^2e^{-x}$$

$\therefore \frac{dy}{dx} = 2xe^{-x} - x^2e^{-x} = xe^{-x}(2-x)$

Now, $\frac{dy}{dx} = 0.$

$\Rightarrow x = 0$ and $x = 2$

The points $x = 0$ and $x = 2$ divide the real line into three disjoint intervals

i.e., $(-\infty, 0), (0, 2),$ and $(2, \infty).$

In intervals $(-\infty, 0)$ and $(2, \infty), f'(x) < 0$ as $e^{-x}$ is always positive.

$\therefore f$ is decreasing on $(-\infty, 0)$ and $(2, \infty).$

In interval (0, 2), $f'(x) > 0.$

$\therefore$ $f$ is strictly increasing on (0, 2).

Hence, $f$ is strictly increasing in interval (0, 2).

The correct answer is D.