**Mathematics for Data Science - 1**
**Graded Assignment(Week 3) Solution**

# 1 Instructions:

- There are some questions which have functions with discrete valued domains (such as day, month, year etc). For simplicity, we treat them as continuous functions.
- For NAT type question, enter only one right answer, even if you get multiple answers for that particular question.
- Notations:
  - $\mathbb{R}$ = Set of real numbers
  - $\mathbb{Q}$ = Set of rational numbers
  - $\mathbb{Z}$ = Set of integers
  - $\mathbb{N}$ = Set of natural numbers
- The set of natural numbers includes 0.

## 2 Multiple Choice Questions (MSQ)

1. If the slope of the parabola $y = ax^2 + bx + c$ at (2, 3) is 5 and the $X-$ coordinate of the vertex of the parabola is 3, then which of the following is/are true? [Ans: (a), (d)](1 mark)

   - ◯ $y = -\frac{5}{2}x^2 + 15x - 17$
   - ◯ $y = \frac{5}{2}x^2 + 15x - 17$
   - ◯ $y = -\frac{5}{2}x^2 + 15x + 17$
   - ◯ $6y = -15x^2 + 90x - 102$

Sol :- Option 1: Slope of parabola $y = -\frac{5}{2}x^2 + 15x - 17$ at $x$ is $-5x + 15$. So at point $(2,3)$ is $-5\times2+15 = 5$.

Option 2: Slope of parabola $y = \frac{5}{2}x^2 + 15x - 17$ at $x$ is $5x + 15$. So at point $(2,3)$ is $5\times2+15 = 25$.

Option 3 :- We have $y = -\frac{5}{2}x^2 + 15x + 17$

$$y(2) = -\frac{5}{2}\times 4 + 15\times 2 + 17 = -10+30+17 = 27 \neq 3$$

This is not satisfying the point $(2,3)$ itself.

Option 4 :-

$$6y = -15x^2 + 90x - 102$$

$$\Rightarrow y = -\frac{5}{2}x^2 + 15x - 17$$

This parabola is the same as in option 1.

2. Two parabolas $y = x^2 + 3x + 2$ and $y = -x^2 - 5x - 4$ are intersecting at two points $A$ (point $A$ is not on the $X-$ axis) and $B$. Suppose a straight line $\ell_1$ passes through the point $A$ with slope equal to the slope of the parabola $y = -x^2 - 5x - 4$ at point $A$ and two straight lines $\ell_2$ and $\ell_3$ pass through the point $B$ with slopes equal to the slopes of the parabolas $y = x^2 + 3x + 2$ and $y = -x^2 - 5x - 4$ at point $B$, respectively.
Which of the following is/are true? [Ans: (a), (c), (d)] (1 mark)

- ○ $\ell_1$ and $\ell_2$ are parallel.
- ○ $\ell_1$ and $\ell_3$ are parallel.
- ○ $\ell_1$ and $\ell_3$ are intersecting at point (-2, 3).
- ○ $\ell_2$ and $\ell_3$ are intersecting at point (-1, 0).
- ○ $\ell_2$ and $\ell_3$ are parallel.

Solu:

To get intersection point of $y = x^2+3x+2$ and $y = -x^2-5x-4$,

$$x^2+3x+2 = -x^2-5x-4 \Rightarrow 2x^2+8x+6=0$$
$$\Rightarrow x^2+4x+3=0$$
$$\Rightarrow (x+1)(x+3)=0$$
$$\Rightarrow x=-1 \text{ or } x=-3$$

If $x=-1 \Rightarrow y(-1) = 1-3+2 = 0$

If $x=-3 \Rightarrow y(-3) = 9-9+2 = 2.$

Hence, intersection points are $(-1,0)$ & $(-3,2)$. So point $A=(-3,2)$, $B=(-1,0)$

Slope of parabola $y=-x^2-5x-4$ at point $A$ is $m_1 = -2(-3)-5 = 1$

and at point $B$ is $m_2 = -2(-1)-5 = -3$

Slope of parabola $y = x^2+3x+2$ at point $B$ is $m_3 = 2(-1)+3 = 1$

Line $l_1$ passes through point $A$ with the slope $m_1$ is

$$y-2 = 1(x+3) \Rightarrow y = x+5.$$

Line $l_2$ passes through point $B$ with the slope $m_3$ is

$$y-0 = 1(x+1) \Rightarrow y = x+1$$

Line $l_3$ passes through point $B$ with the slope $m_2$ is

$$y-0 = -3(x+1) \Rightarrow y = -3x-3.$$

Since $l_1$ & $l$ have slope $m_1$ & $m_2$ resp. and $m_1 = m_3$ so $l_1$ & $l_2$ are parallel. Similarly, $m_1 \neq m_2$ and $m_2 \neq m_3$ so $l_1$ & $l_3$ are not parallel and $l_2$ and $l_3$ are not parallel.

Observe that point $(-2,3)$ satisfying both equations $y = x+5$ & $y = -3x-3$
Hence intersection point of the lines $l_1$ & $l_3$ is $(-2,3)$.
Similarly, the point $(-1,0)$ is the intersection point of $l_2$ and $l_3$.

## 3 Numerical Answer Type (NAT)

3. Suppose $f(x) = ax^2 + bx + c$, where $a, b, c \in \overset{\mathbb{Z}\setminus\{0\}}{\cancel{\mathbb{R}}}$ is a quadratic function. If the sum of roots and product of roots of $f(x)$ are $\frac{-7}{4}$ and $\frac{-1}{2}$ respectively, then find the value of $2a + 4b + 2c$. (1 mark)

Solu:- Let $\alpha$ & $\beta$ are the roots of $f(x)$.

So $\alpha + \beta = -7/4$ & $\alpha \cdot \beta = -1/2$

Hence, quadratic equation which having roots are $\alpha$ and $\beta$ is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\Rightarrow x^2 - \left(\frac{-7}{4}\right)x + \left(-\frac{1}{2}\right) = 0$$

$$\Rightarrow 4x^2 + 7x - 2 = 0$$

Comparing with $ax^2 + bx + c = 0$

$$\Rightarrow a = 4, \; b = 7, \; c = -2$$

So $2a + 4b + 2c = 8 + 28 - 4 = 32$.

4. A class of 140 students are arranged in rows such that the number of students in a row is one less than thrice the number of rows. Find the number of students in each row. [Ans: 20] (1 mark)

Soln: Let number of rows are $p$

so number of students in a row are $3p-1$

Therefore the total number of students are $p(3p-1)$

Given $p(3p-1) = 140$

$$\Rightarrow 3p^2 - p = 140$$

$$\Rightarrow 3p^2 - p - 140 = 0$$

$$\Rightarrow 3p^2 - (21-20)p - 140 = 0$$

$$\Rightarrow 3p^2 - 21p + 20p - 140 = 0$$

$$\Rightarrow 3p(p-7) + 20(p-7) = 0$$

$$\Rightarrow (p-7)(3p+20) = 0$$

$$\Rightarrow p = 7 \text{ or } p = -20/3$$

but $p$ can not be negative. So $p = 7$

Hence, number of students in each row is

$3p-1 = 20$.

## 4 Comprehension type question

The daily production cost (in lakh ₹) of manufacturing an electric device is $p(x) = 7400 - 60x + 15x^2$, where $x$ is the number of electric devices produced per day and the daily transportation cost (in lakh ₹) of $x$ number of electric devices is given by the slope of the function $p(x)$ at point $x$.

Use this information to answer the following questions.

5. How many electric devices should be produced per day to yield minimum production cost? [Ans: 2](1 mark)

Solu :-  $p(x) = 7400 - 60x + 15x^2$

Axis of Symmetry $x = -\frac{(-60)}{2 \times 15} = 2$

So $p(x)$ has the minimum value at $x = 2$.

Hence Two electric devices should be produced.

6. If the transportation cost of the electric devices on a particular day is 30 (in lakh ₹), then find the number of transported electric devices. [Ans: 3](1 mark)

Soln:. Slope of $P(x) = 30x - 60$

$\Rightarrow \quad 30x - 60 = 30$

$\Rightarrow \quad x = 3$

Hence, 3 eletric devices transported.

7. If the production cost on a particular day is 7475 (in lakh ₹), then find the number of electric devices produced on that day. [Ans: 5](1 mark)

Soln :

$$P(x) = 7400 - 60x + 15x^2 = 7475$$

$$\Rightarrow 15x^2 - 60x - 75 = 0$$

$$\Rightarrow x^2 - 4x - 5 = 0$$

$$\Rightarrow x^2 - (5-1)x - 5 = 0$$

$$\Rightarrow x^2 - 5x + x - 5 = 0$$

$$\Rightarrow x(x-5) + (x-5) = 0$$

$$\Rightarrow (x-5)(x+1) = 0$$

$$\Rightarrow x = 5 \text{ or } x = -1$$

But $x$ can not be negative.

Hence 5 electric devices produced on that day.

8. If the slope of parabola $y = ax^2 + bx + c$, where $a, b, c \in \mathbb{R} \setminus \{0\}$ at points (3,2) and (2,3) are 16 and 12 respectively, then find the value of $a$.
(NAT) Answer: 2 (1 mark)

Soln :- Slope of parabola $y = ax^2 + bx + c$ at $x$ is $2ax + b$.

Slope of parabola at the point (3,2) is $6a + b = 16$

and at point (2,3) is $4a + b = 12$

After solving equations $6a + b = 16$

& $4a + b = 12$

We get, $a = 2$

Solving equations.

$3a + b = 16$ — (1)

$4a + b = 16$ — (2)

Substracting equ (1) and (2)

We get

$2a = 4$

$\Rightarrow a = 2$.

9. The product of two consecutive odd natural numbers is 143. Find the largest number among them. [Ans: 13] (1 marks)

Solⁿ:. Let $x$ & $x+2$ are two odd consecutive natural numbers.

$x(x+2) = 143$

$\Rightarrow x^2+2x-143=0$

$\Rightarrow x^2+13x-11x-143=0$

$\Rightarrow x(x+13)-11(x+13)=0$

$\Rightarrow (x+13)(x-11)=0$

$\Rightarrow x=-13$ or $x=11$

But $x$ can not be negative.

So $x=11$

So two consecutive odd natural numbers are 11 & 13.

10. The slope of a parabola $y = 3x^2 - 11x + 10$ at a point $P$ is 7. Find the $y-$ coordinate of the point $P$. [Ans: 4] (1 marks)

Solu :- Slope of a parabola $y = 3x^2 - 11x + 10$ at $x$ is $6x - 11$.

So $6x - 11 = 7$

$\Rightarrow x = 3$

$y(3) = 3 \times 9 - 11 \times 3 + 10 = 27 - 33 + 10 = 4$

So $y$ - co-ordinate of the point $P$ is 4.

Mathematics for Data Science - 1
Week 3 GA Solution

# 1 Instructions:

1. Find out the points where the curve $y = 4x^2 + x$ and the straight line $y = 2x - 3$ intersect with each other.

   - $(\frac{3}{2}, 0)$ and $(\frac{3}{2}, \frac{21}{2})$.
   - Only at the origin.
   - The curve and the straight line do not intersect.
   - $(1, -1)$ and $(1, 5)$.

Solution: Suppose $y = 4x^2 + x$ & $y = 2x - 3$ are intersecting at the point $(a, b)$. So the point $(a, b)$ should satisfy both the equations.

$$b = 4a^2 + a \quad \& \quad b = 4a - 3.$$

$$\Rightarrow 4a^2 + a = 4a - 3$$

$$\Rightarrow 4a^2 - a + 3 = 0.$$

The discriminant of the above quadratic equation is $-47 < 0$. Therefore it has no real root & both the curves can not meet in the real plane.

2. Let $a$ and $b$ two consecutive positive odd natural numbers such that $a^2 + b^2 = 394$. Then find the value of $a + b$.

Solution: Let "$x$" and "$x+2$" be the two consecutive positive odd natural number.

Given, $x^2 + (x+2)^2 = 394$

$\Rightarrow x^2 + x^2 + 4 + 4x = 394$

$\Rightarrow 2x^2 + 4x - 390 = 0$

$\Rightarrow x^2 + 2x - 195 = 0$ (dividing by 2)

$\Rightarrow (x+15)(x-13) = 0$

$\Rightarrow x = 13$ or $x = -15$ (not possible because $x$ is positive)

$\Rightarrow x = 13 = a$ & $b = x+2 = 15$.

Sum: $a + b = 28$.

3. If the slope of parabola $y = ax^2 + bx + c$, where $a, b, c \in \mathbb{R} \setminus \{0\}$ at points (3,2) and (2,3) are 32 and 17 respectively, then find the value of $a$.

**Solution:** Slope of Parabola at "$x$" is $2ax+b$.

By using the given information, we get

$6a+b=32$ at Point $(3,2)$ — ①

$4a+b=17$ at Point $(2,3)$. — ②

eq ① − eq ② : $2a=15 \Rightarrow \boxed{a=7.5}$.

4. A class of 352 students are arranged in rows such that the number of students in a row is one less than thrice the number of rows. Find the number of students in each row.

Solution: Let $x$ be the total number of rows.

Then the number of students in each row is

$$3x-1.$$

Therefore total no. of student is

$$x(3x-1)=352.$$

$$\Rightarrow 3x^2-x-352=0$$

$$\Rightarrow (x-11)\left(x+\frac{32}{3}\right)=0$$

$$\Rightarrow x=11 \text{ or } x=-32/3 \text{ (not possible)}$$

$$\Rightarrow x=11 \text{ (no. of rows).}$$

Number of students in each row is $3x-1=32$.

In order to cover a fixed distance of 48 km, two vehicles start from the same place. The faster one takes 2 hrs less and has a speed 4 km/hr more than the slower one. Using the given information, answer the following sub-questions (5 and 6).

5. What is the speed (in km/hr) of the slower vehicle?

Solution: Let the speed of the slower vehicle be $x$ km/hr. The time taken by the slower one to cover 48km is $48/x$ hr.

The speed of the faster one is $x+4$ km/hr. So the time taken by the faster one to cover 48 km is $48/x+4$.

It is given that the faster one takes 2hrs less than the slower one to cover the distance. Therefore we have,

$$\frac{48}{x} - \frac{48}{x+4} = 2.$$

$$\Rightarrow \frac{x+4-x}{x(x+4)} = \frac{2}{48}$$

$$\Rightarrow x^2+4x-96=0$$



$$\Rightarrow (x+12)(x-8)=0 \Rightarrow x=8.$$

Hence the speed of the slower vehicle is 8km/hr.

6. What is the time (in hrs) taken by the faster one?

The speed of the faster one is $x+4 = 12\,km/hr$.

So the time taken by the faster vehicle is $48/12 = 4$ hrs.

7. The maximum value of a quadratic function $f$ is $-3$, its axis of symmetry is $x = 2$ and the value of the quadratic function at $x = 0$ is $-9$. What will be the coefficient of $x^2$ in the expression of $f$?

- ○ $-1$
- ○ $1$
- ○ $-1.5$
- ○ $-0.5$

Solution: Let $f(x) = ax^2 + bx + c$ be the quadratic equation. We know that $f$ attains its maximum value at $x = -b/2a$ & the line $x = -b/2a$ is the axis of symmetruc.

- Given that $x = 2$ is the axis of Sy. $\Rightarrow -b/2a = 2 \Rightarrow b = -4a$.
- value of $f$ at $x = 0$ is $-9$ $\Rightarrow f(0) = c = -9$.

The function $f$ attains its maximum value at $x = 2$ and the max. value is "$-3$". Therefore $(2,-3)$ Should satisfy the quadratic eq. & we have

$4a + 2b - 9 = -3$ [by Putting $(2,-3)$ & $c = -9$ in the eq. of $f(x)$]

$\Rightarrow 4a + 2b = 6$

$\Rightarrow 4a - 8a = 6$ [using the relation $b = -4a$]

$$\Rightarrow -4a = 6$$

$$\Rightarrow a = -3/2 = -1.5$$

So the coefficient of $x^2$ is $-1.5$.

8. A ball is thrown from 3 m off the ground and reaches a maximum height of 5 m. Assume that the ball was released from the point $(0, 3)$ in the $xy$-plane as shown in the Figure M1W3GA-3. The ball returns to a height of 3 m after 2 seconds. Let $h(t) = at^2 + bt + c$ be the quadratic function which represents the height of the ball after $t$ seconds. What is the value of $a$ ?

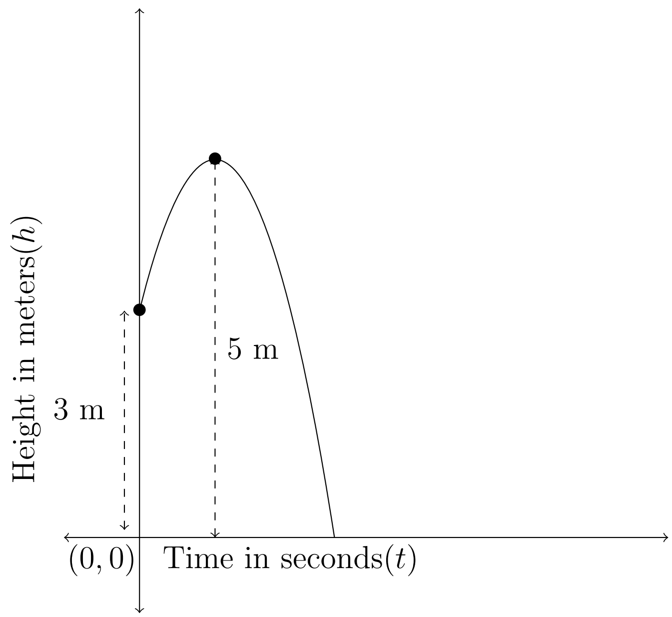
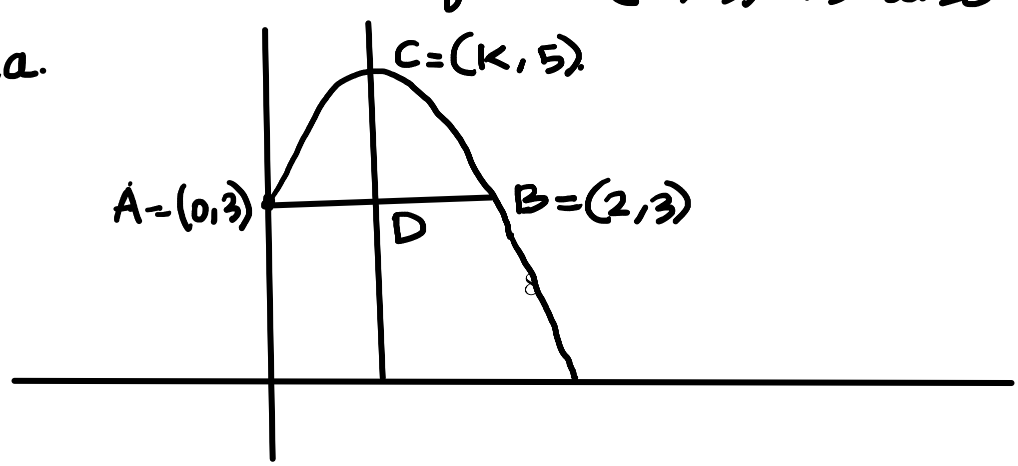



Figure M1W3GA-3

Solution: The ball was released from the point $(0,3)$ and returns to height of 3-met after 2-seconds. So $(0,3)$ & $(3,2)$ are on the Parabola.

Let the ball reaches a maximum height of 5cm after K seconds. Therefore $(K,5)$ is also on the Parabola.



$x=k$ is the axis of Symmetry and "D" is the middle Point of AB. Therefore $k=1$.

Finally, we have three points $(0,3)$, $(1,5)$ & $(2,3)$ on the parabola $h(t)=at^2+bt+c$.

$$h(0)=3 \Rightarrow c=3$$

$$h(1)=5 \Rightarrow a+b+3=5. \quad \text{— ①}$$

$$h(2)=3 \Rightarrow 4a+2b+3=3. \quad \text{— ②}$$

From eq ① and ②, we get $\boxed{a=-2.}$.

9. The product of two consecutive odd natural numbers is 255. Find the largest number among them.

Solution: Let $x$ and $x+2$ be two consecutive odd natural numbers.

$$x(x+2) = 255$$

$$\Rightarrow x^2+2x-255=0$$

$$\Rightarrow (x-15)(x+17)=0$$

$$\Rightarrow x=15 \quad \text{or} \quad x=-17 \text{ (not possible).}$$

$$x=15 \text{ \& } x+2=17.$$

Therefore. the largest number is 17.

10. The slope of a parabola $y = 3x^2 - 11x + 10$ at a point $P$ is 1. Find the $y$-coordinate of the point $P$.

Solution : The slope of parabola $y = ax^2 + bx + c$ at '$x$' is given by $2ax + b$.

Here, $y = 3x^2 - 11x + 10$ so the slope is $6x - 11$.

Let $P = (x, y)$, then slope of the parabola at P is

$$6x - 11 = 1$$

$$\Rightarrow x = 2.$$

The "y"-coordinate of P is

$$y = 3 \times 2^2 - (11 \times 2) + 10$$

$$= 22 - 22 = 0.$$

Mathematics for Data Science - 1
Week 3 GA Solution

# 1 Instructions:

Qustion 1

Solution . let speed of the flight 1 is $x$ km/h

Distance between A and C is 1200 km

Hence take time $= \frac{1200}{x}$ hr.

Because of bad weather speed of flight is reduced by 200 km/h and took extra time $\frac{1}{2}$ hr.

Hence ~~Total time~~

$$\frac{1200}{x} = \frac{1200}{x-200} - \frac{1}{2}$$

After solving we get

$$x^2 - 200x - 480000 = 0$$

$$\Rightarrow (x-800)(x+600) = 0$$

$\Rightarrow \quad x = 800 \quad \text{or} \quad -600$

but $x$ can not be negative.

Hence speed of flight 1 = 800 km

Now time taken by Maduri $= \frac{1800}{720}$ hr

$= 2.5$ hr.

time taken by Ananya $= \frac{1200}{600}$

$= 2$ hr.

Hence Ananya will wait for

30 min.

3. If the slope of parabola $y = ax^2 + bx + c$, where $a, b, c \in \mathbb{R} \setminus \{0\}$ at points (3,2) and (2,3) are 32 and 17 respectively, then find the value of $a$.

**Solution:** Slope of Parabola at "$x$" is $2ax+b$.

By using the given information, we get

$6a + b = 32$ at Point $(3,2)$. —— ①

$4a + b = 17$ at Point $(2,3)$. —— ②

eq ① − eq ② : $2a = 15 \Rightarrow \boxed{a = 7.5}$.

4. A class of 352 students are arranged in rows such that the number of students in a row is one less than thrice the number of rows. Find the number of students in each row.

Solution: Let $x$ be the total number of rows.

Then the number of students in each row is

$3x-1$.

Therefore total no. of student is

$$x(3x-1) = 352.$$

$$\Rightarrow 3x^2 - x - 352 = 0$$

$$\Rightarrow (x-11)\left(x+\frac{32}{3}\right) = 0$$

$$\Rightarrow x = 11 \text{ or } x = -32/3 \text{ (not possible)}$$

$$\Rightarrow x = 11 \text{ (no. of rows)}.$$

Number of students in each row is $3x-1 = 32$.

Question 5

Solution $h(t) = -0.5t^2 + 4t + 1$

The maximum height will be reached at the axis of symmetry $t = \frac{-4}{2(-0.5)} = \frac{4}{1} = 4$

So time taken to reach the maximum height $t = 4$

Question 6.

And the maximum height taken after $t = 4$ is $h(4) =$

$-0.5 \times 16 + 4 \times 4 + 1$

$= -8 + 16 + 1$

$= 9.$

Question 7

Solution

$$y = 4x^2 + x + 1$$

Line passing through the points $(1,6), (4,5)$ is

$$y - 6 = \frac{5-6}{4-1}(x-1)$$

$$\Rightarrow y - 6 = \frac{-1}{3}(x-1)$$

$$\Rightarrow 3y - 18 = -x + 1$$

$$\Rightarrow x + 3y - 19 = 0$$

$$\Rightarrow y = (19 - x)/3$$

Let's find the intersection point.

$$\frac{19-x}{3} = 4x^2 + x + 1$$

$$\Rightarrow 19 - x = 12x^2 + 3x + 18$$

$$\Rightarrow 12x^2 + 4x - 1 = 0$$

$$\Rightarrow 12x^2 + 6x - 2x - 1 = 0$$

$$\Rightarrow 6x(2x+1) - 1(2x+1) = 0$$

$$\Rightarrow (2x+1)(6x-1) = 0$$

$\Rightarrow \quad x = 1/6 \;, \; -1/2$

So $y = \dfrac{19 - \frac{1}{6}}{3} = \dfrac{113}{18}$

or $y = \dfrac{19 + 1/2}{3} = \dfrac{39}{6} = \dfrac{13}{2}$

So intersection points are

$\left(\frac{1}{6}, \frac{113}{18}\right), \left(-\frac{1}{2}, \frac{13}{2}\right).$

Question-8

Solution

Option 1 : $x$ intercept is nothing but the root of quadratic.

option 2 : let $f(x) = x^2 - 2x - 1$

$g(x) = -x^2 - 2x + 1$

Discriminant ~~Discrimant~~ of $f(x) = b^2 - 4ac$

$= 4 - 4 \times 1 \times (-1)$

$= 8$

Discriminant ~~Discrimant~~ of $g(x) = 4 - 4 \times (-1) \times 1$

$= 8$

We have two different quadratic function with the same discriminant

Option -3 : let $f(x) = ax^2 + bx + c$,

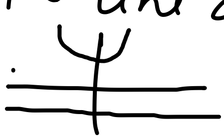
vertex $= \left(\frac{-b}{2a}, f(-b/2a)\right)$.

slope ~~$= 2ax + b$~~ at vertex $= 2a \times \left(\frac{-b}{2a}\right) + b = 0$

Hence true.

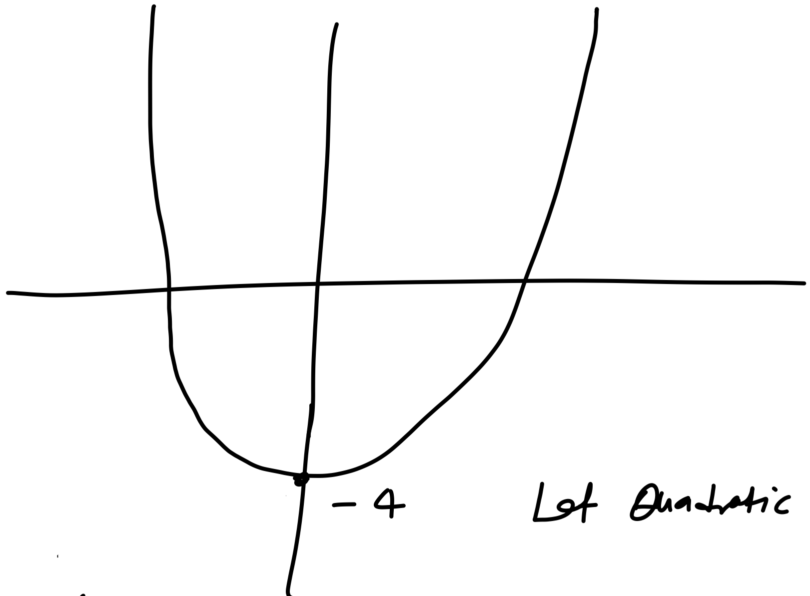
Option -4 : For any quadratic function $ax^2+bx+c$ axis of symmetry $= -b/2a$ so true.

option 5 : Consider the line and quadratic function as here



let $f(x) = x^2 + 1$, and line $x = -1$ so false.

Qustion 9



Let Quadratic is $f(x) = ax^2+bx+c$

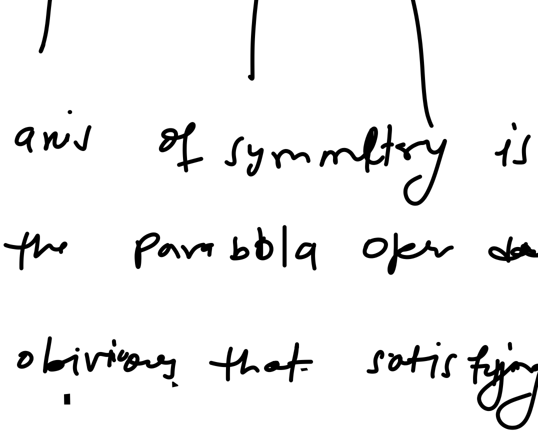
from figure axis of symmetry is $x = 0$

$$\Rightarrow -b/2a = 0$$

$$\Rightarrow b = 0$$

Hence option B is true.

Qustion-12



Here axis of symmetry is $x = 0$

and the parabola open downwards hence

It is obivious that satisfying Quadratic function

is $f(x) = -3x^2+20$

10. The product of two consecutive odd natural numbers is 255. Find the largest number among them.

Solution: Let $x$ and $x+2$ be two consecutive odd natural numbers.

$$x(x+2) = 255$$

$$\Rightarrow x^2+2x-255=0$$

$$\Rightarrow (x-15)(x+17)=0$$

$$\Rightarrow x=15 \quad \text{or} \quad x=-17 \text{ (not possible).}$$

$$x=15 \ \& \ x+2=17.$$

Therefore, the largest number is 17.

~~10~~ 4. The slope of a parabola $y = 3x^2 - 11x + 10$ at a point $P$ is 1. Find the $y$-coordinate of the point $P$.

Solution : The Slope of parabola $y = ax^2 + bx + c$ at '$x$' is given by $2ax + b$.

Here, $y = 3x^2 - 11x + 10$ so the Slope is $6x - 11$.

Let $P = (x, y)$, then Slope of the parabola at $P$ is

$$6x - 11 = 1$$

$$\Rightarrow x = 2.$$

The "$y$"-coordinate of $P$ is

$$y = 3 \times 2^2 - (11 \times 2) + 10$$

$$= 22 - 22 = 0.$$