# CS Assignment

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**Q1** Given the values

| $x$ | $f(x)$ |
|---|---|
| 0 | 2 |
| 1 | 3 |
| 2 | 12 |
| 5 | 147 |

find the polynomial of the lowest possible degree using Newton's divided difference interpolation.

$$x_0 = 0, \quad x_1 = 1, \quad x_2 = 2, \quad x_3 = 5$$
$$f(x_0) = 2, \quad f(x_1) = 3, \quad f(x_2) = 12, \quad f(x_3) = 147$$

Divided difference table :-

| $x$ | $f(x)$ | $\Delta$ | $\Delta^2$ | $\Delta^3$ |
|---|---|---|---|---|
| 0 | 2 | $\frac{3-2}{1-0} = 1$ | $\frac{9-1}{2-0} = 4$ | $\frac{9-4}{5-0} = 1$ |
| 1 | 3 | $\frac{12-3}{2-1} = 9$ | $\frac{45-9}{5-1} = 9$ | |
| 2 | 12 | $\frac{147-12}{5-2} = 45$ | | |
| 5 | 147 | | | |

So, the newton divided difference for interpolating polynomial becomes :-

$$P_3(x) = f(x_0) + (x-x_0) f[x_0, x_1] + (x-x_0)(x-x_1) f[x_0, x_1, x_2]$$
$$+ (x-x_0)(x-x_1)(x-x_2) f[x_0, x_1, x_2, x_3]$$

$$= 2 + (x-0) \cdot 1 + (x-0)(x-1) \cdot 4 + (x-0)(x-1)(x-2) \cdot 1$$

$$= 2 + x + 4x(x-1) + x(x-1)(x-2)$$

$$\Rightarrow 2 + x + 4x^2 - 4x + x^3 - 3x^2 + 2x$$

$$\Rightarrow x^3 + x^2 - x + 2$$

So, $P_3(x) = x^3 + x^2 - x + 2$