Practical 6
Lagrange and Newton interpolation

Lagrange Interpolation:

Find the for polynomial for the given function data:
Ques 2: (-1,5),(0,1),(1,1),(2,11)

In[25]:=
```
xi = {-1, 0, 1, 2};
fi = {5, 1, 1, 11};
n = Length[xi];
For[k = 1, k ≤ n, k++,
  Lk[x_] = (∏_{j=1}^{k-1} (x - xi[[j]])/(xi[[k]] - xi[[j]])) * (∏_{j=k+1}^{n} (x - xi[[j]])/(xi[[k]] - xi[[j]]))];
P[x_] = ∑_{k=1}^{n} Lk[x] * fi[[k]];
Print["Lagrange polynomial P(x)=", P[x]]
Print["Simplified polynomial p(x)=", Simplify[P[x]]]
Print["Approximate value of x at x=1.5 is", P[1.5]]
```

$$L_k[x\_] = \left(\prod_{j=1}^{k-1} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}\right) * \left(\prod_{j=k+1}^{n} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}\right)$$

$$P[x\_] = \sum_{k=1}^{n} L_k[x] * fi[[k]]$$

Lagrange polynomial P(x)=

$$-\frac{5}{6}(1-x)(2-x)x + \frac{1}{2}(1-x)(2-x)(1+x) + \frac{1}{2}(2-x)x(1+x) + \frac{11}{6}(-1+x)x(1+x)$$

Simplified polynomial p(x)= $1 - 3x + 2x^2 + x^3$

Approximate value of x at x=1.5 is4.375

Ques 2: f(x)=ln(x),x=1,2,3

In[33]:=
```
Clear [x, k, f, L, p]
xi = {1, 2, 3};
f[x_] := Log[x];
n = Length[xi];
For[k = 1, k ≤ n, k++,
  L_k[x_] = (Product[(x - xi[[j]])/(xi[[k]] - xi[[j]]), {j, 1, k-1}]) * (Product[(x - xi[[j]])/(xi[[k]] - xi[[j]]), {j, k+1, n}])];
P[x_] = Sum[L_k[x] * N[f[xi[[k]]]], {k, 1, n}];
Print["Lagrange polynomial P(x)=", P[x]]
Print["Simplified polynomial p(x)=", Simplify[P[x]]]
Print["Approximate value of x at x=1.5 is", P[1.5]]
```

$$L_k[x\_] = \left(\prod_{j=1}^{k-1} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}\right) * \left(\prod_{j=k+1}^{n} \frac{x - xi[[j]]}{xi[[k]] - xi[[j]]}\right)$$

$$P[x\_] = \sum_{k=1}^{n} L_k[x] * N[f[xi[[k]]]]$$

Lagrange polynomial P(x)=$0. + 0.693147\,(3 - x)\,(-1 + x) + 0.549306\,(-2 + x)\,(-1 + x)$

Simplified polynomial p(x)=$-0.980829 + 1.12467\,x - 0.143841\,x^2$

Approximate value of x at x=1.5 is0.382534

Newton Interpolation:

```
In[42]:= sum = 0;
points = {{3, 293}, {5, 508}, {6, 585}, {9, 764}};
n = Length [points]
y = points[[All, 1]]
f = points[[All, 2]]
dd[k_] :=
 Sum[
  (f[[i]] / Product[If [Equal[j, i], 1, (y[[i]] - y[[j]])], {j, 1, k}]), {i, 1, k}]
P[x_] =
 Sum[
  (dd[i] * Product[If[i ≤ j, 1, x - y[[j]]], {j, 1, i - 1}]), {i, 1, n}]
Simplify[P[x]]
Evaluate[P[2.5]]
```

Out[44]= 4

Out[45]= {3, 5, 6, 9}

Out[46]= {293, 508, 585, 764}

Out[48]= $293 + \frac{215}{2} (-3 + x) - \frac{61}{6} (-5 + x) (-3 + x) + \frac{35}{36} (-6 + x) (-5 + x) (-3 + x)$

Out[49]= $\frac{1}{36} \left(-9702 + 9003 x - 856 x^2 + 35 x^3\right)$

Out[50]= 222.288