PRACTICAL - 10
TO COMPUTE THE POLES AND CORRESPONDING RESIDUES OF COMPLEX FUNCTIONS

```
Normal[Series[1 / z, {z, 0, 5}]]
Residue[1 / z, {z, 0}]
```

Out[∘]= $\frac{1}{z}$

Out[∘]= 1

```
Series[z^2 / (z - 2), {z, 2, 3}]
Residue[z^2 / (z - 2), {z, 2}]
```

Out[∘]= $\frac{4}{z-2} + 4 + (z-2) + O[z-2]^4$

Out[∘]= 4

```
Series[z^3 / ((z - 2) ^3), {z, 2, 5}]
Residue[z^3 / ((z - 2) ^3), {z, 2}]
```

Out[∘]= $\frac{8}{(z-2)^3} + \frac{12}{(z-2)^2} + \frac{6}{z-2} + 1 + O[z-2]^6$

Out[∘]= 6

```
Series[z^4 / ((z - 4) (z - 1)), {z, 1, 5}]
Residue[z^4 / ((z - 4) (z - 1)), {z, 1}]
```

Out[∘]= $-\frac{1}{3(z-1)} - \frac{13}{9} - \frac{67(z-1)}{27} - \frac{175}{81}(z-1)^2 - \frac{256}{243}(z-1)^3 - \frac{256}{729}(z-1)^4 - \frac{256(z-1)^5}{2187} + O[z-1]^6$

Out[∘]= $-\frac{1}{3}$

```
Residue[z^4 / ((z - 4) (z - 1)), {z, 4}]
```

Out[∘]= $\frac{256}{3}$

Ques 1) Find all the residue of f[z]= 1/(z^4-z^3-2 z^2) by locating the singularities.

```
f[z_] := 1 / (z^4 - z^3 - 2 z^2);
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ 4, i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are {-1, 0, 0, 2}

Residue at -1 is $-\frac{1}{3}$

Residue at 0 is $\frac{1}{4}$

Residue at 0 is $\frac{1}{4}$

Residue at 2 is $\frac{1}{12}$

In[◦]:=
```
ClearAll[z, s, res]
```

Ques 2) Find all the residue of f[z]=(5 z-2)/(z (z-1)) by locating the singularities.

```
f[z_] := (5 z - 2) / (z (z - 1));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ 2, i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are {0, 1}

Residue at 0 is 2

Residue at 1 is 3

Ques 3) Find all the residue of f[z]= z^2/ ((z-2)(z-1)(z-3)) by locating the singularities.

```
f[z_] := z^2 / ((z - 2) (z - 1) (z - 3));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

```
Singularities are {1, 2, 3}
```

Residue at 1 is $\frac{1}{2}$

Residue at 2 is -4

Residue at 3 is $\frac{9}{2}$

Ques 4) Find all the residue of f[z]= (z^2+16)/ (((z-I)^2)(z+3)) by locating the singularities.

```
f[z_] := (z^2 + 16) / (((z - I)^2) (z + 3));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-3, i, i\}$

Residue at -3 is $2 - \frac{3 i}{2}$

Residue at i is $-1 + \frac{3 i}{2}$

Residue at i is $-1 + \frac{3 i}{2}$

Ques 5) Find all the residue of f[z]= 1/((z+1)^3) by locating the singularities.

```
f[z_] := 1 / ((z + 1)^3);
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

```
Singularities are {-1, -1, -1}
Residue at -1 is 0
Residue at -1 is 0
Residue at -1 is 0
```

Ques 6) Find all the residue of f[z]= - ((Log[z])^3)/((z^2)+1) by locating the singularities.

```
f[z_] := -((Log[z])^3)/((z^2)+1);
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-i, i\}$

Residue at $-i$ is $\frac{\pi^3}{16}$

Residue at i is $\frac{\pi^3}{16}$

Ques 7) Find all the residue of f[z]= z/((z-1)*(z+1)) by locating the singularities.

```
f[z_] := z/((z-1)*(z+1));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-1, 1\}$

Residue at -1 is $\frac{1}{2}$

Residue at 1 is $\frac{1}{2}$

Ques 8) Find all the residue of f[z]=(2 z+1)/((z^2)-z-2) by locating the singularities.

In[1]:=
```
f[z_] := (2 z+1)/((z^2)-z-2);
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-1, 2\}$

Residue at -1 is $\frac{1}{3}$

Residue at 2 is $\frac{5}{3}$

Ques 9) Find all the residue of f[z]=(z^3)/(((z-1)^4)*(z-2)*(z-3)) by locating the singularities.

```
f[z_] := (z^3) / (((z - 1) ^4) * (z - 2) * (z - 3));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are {1, 1, 1, 1, 2, 3}

Residue at 1 is $\frac{101}{16}$

Residue at 1 is $\frac{101}{16}$

Residue at 1 is $\frac{101}{16}$

Residue at 1 is $\frac{101}{16}$

Residue at 2 is -8

Residue at 3 is $\frac{27}{16}$

Ques 10) Find all the residue of f[z]=(ⅇ^z)/((z^4)+(2 z^3)+(2 z^2)) by locating the singularities.

```
f[z_] := (ⅇ^z) / ((z^4) + (2 z^3) + (2 z^2));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-1 - i, -1 + i, 0, 0\}$

Residue at $-1 - i$ is $\frac{e^{-1-i}}{4}$

Residue at $-1 + i$ is $\frac{e^{-1+i}}{4}$

Residue at 0 is 0

Residue at 0 is 0

Ques 11) Find all the residue of f[z]=(z^2-2 z)/((z+1)^2*(z^2+4)) by locating the singularities.

```
f[z_] := (z^2 - 2 z) / ((z + 1)^2 * (z^2 + 4));
s = z /. Solve[Denominator[f[z]] == 0, z];
Print["Singularities are ", s];
For[i = 1, i ≤ Length[s], i++,
res = Residue[f[z], {z, s[[i]]}];
Print["Residue at ", s[[i]], " is ", res]]
```

Singularities are $\{-1, -1, -2 i, 2 i\}$

Residue at -1 is $-\frac{14}{25}$

Residue at -1 is $-\frac{14}{25}$

Residue at $-2 i$ is $\frac{7}{25} - \frac{i}{25}$

Residue at $2 i$ is $\frac{7}{25} + \frac{i}{25}$