Task 7)

A)

```
Z=[];
P=[-0.01 -0.2 -1];
K=8;
sys=zpk(Z,P,K)
```

```
sys =
 
            8
  ----------------------
  (s+0.01) (s+0.2) (s+1)
 
Continuous-time zero/pole/gain model.
```

```
[A,B,C,D] = zp2ss(Z,P,K);

system_order = length(A)
```

```
system_order = 3
```

```

M = ctrb(A, B);
rank_of_M = rank(M)
```

```
rank_of_M = 3
```

```
N = obsv(A, C);
rank_of_N = rank(N)
```

```
rank_of_N = 3
```

```

desiredpoles = [-0.2+0.2i;-0.2-0.2i;-10]
```

```
desiredpoles = 3×1 complex
  -0.2000 + 0.2000i
  -0.2000 - 0.2000i
 -10.0000 + 0.0000i
```

```

K = acker(A,B,desiredpoles)
```

```
K = 1×3
    9.1900   -7.1600   -2.3255
```

```

[num2,den2] = ss2tf(A - B * K,B,C,D);
G2 = tf(num2,den2)
```

```
G2 =
 
                8
  -----------------------------
```

```
  s^3 + 10.4 s^2 + 4.08 s + 0.8

Continuous-time transfer function.
```

```
K2 = place(A,B,desiredpoles)
```

```
K2 = 1×3
    9.1900   -7.1600   -2.3255
```

```
[num3,den3] = ss2tf(A - B * K,B,C,D);
G3 = tf(num3,den3)
```

```
G3 =
 
                8
  -----------------------------
  s^3 + 10.4 s^2 + 4.08 s + 0.8
 
Continuous-time transfer function.
```

```
stepinfo(G3)
```

```
ans = struct with fields:
         RiseTime: 7.5999
    TransientTime: 21.1814
     SettlingTime: 21.1814
      SettlingMin: 9.1071
      SettlingMax: 10.4319
        Overshoot: 4.3186
       Undershoot: 0
             Peak: 10.4319
         PeakTime: 15.8878
```

Matlab functions like Acker or Place ensure good stability, performance and ease of use due to being optimized for Matlab. While Acker is better suited for lower order systems (up to 4th) and Place function performs better for higher order systems, both yielded the same result for a 3rd order system.

The Root-Locus method is quick to solve and provides a good visualization of pole mobility making this method very intuitive. Unfortunately it introduces a lot of human error, lacking precision and problematic for higher order systems.

Ziegler-Nichols method results in poor initial results making additional optimizations necessary but all calculations are first hand mathematical operations performed by the user which gives a better control/customizability for the user.

	Peak Amplitude	Overshoot	Rise time [s]	Settling time
Root-Locus	1,05	8,25%	5,53	19,5
Ziegler-Nichols	1,15	16,49%	1,63	7,98
Matlab functions	4,31	4,31%	7,6	21,18