Nama : Aphrodity Nirmala Putri

NIM : 23/511906/PA/21852

```python
import numpy as np
import matplotlib.pyplot as plt
import scipy as sci
import sympy as sp
import control as ct
```

NOMOR 1

```python
p_poly = np.array ([1, -3, 2, -1])
q_polly = np.array ([1, -1])

r_polly = np.convolve(p_poly, q_polly)
print("r = ", r_polly)
```

```
r =  [ 1 -4  5 -3  1]
```

```python
p_roots = np.roots(p_poly)
q_roots = np.roots(q_polly)
# r_roots = np.roots(r_polly)

print("p roots = ", p_roots)
print("q roots = ", q_roots)
# print("r roots = ", r_roots)
```

```
p roots =  [2.32471796+0.j          0.33764102+0.56227951j 0.33764102-
0.56227951j]
q roots =  [1.]
```

NOMOR 2

1. a.

```python
s = sp.symbols('s')
g_polly = (s**2+ 6*s +2)/((s+1)**3)
h_polly = (s**2 + 4*s + 5) / (s**3 + 6*s**2 + 11*s + 6)
print ("g polly = ", g_polly)
print ("h polly = ", h_polly)

g = sp.apart(g_polly)
h = sp.apart(h_polly)
print ("g partial = ", g)
print ("h partial = ", h)
```

```
g polly =   (s**2 + 6*s + 2)/(s + 1)**3
h polly =   (s**2 + 4*s + 5)/(s**3 + 6*s**2 + 11*s + 6)
g partial =   1/(s + 1) + 4/(s + 1)**2 - 3/(s + 1)**3
h partial =   1/(s + 3) - 1/(s + 2) + 1/(s + 1)
```

1. b.

```
g_tf = ct.TransferFunction([1, 6, 2], [1, 3, 3, 1])
h_tf = ct.TransferFunction([1, 4, 5], [1, 6, 11, 6])

print ("g tf = ", g_tf)
print ("h tf = ", h_tf)

g tf =   <TransferFunction>: sys[0]
Inputs (1): ['u[0]']
Outputs (1): ['y[0]']


     s^2 + 6 s + 2
  ---------------------
  s^3 + 3 s^2 + 3 s + 1

h tf =   <TransferFunction>: sys[1]
Inputs (1): ['u[0]']
Outputs (1): ['y[0]']


     s^2 + 4 s + 5
  ----------------------
  s^3 + 6 s^2 + 11 s + 6


zg = ct.zeros(g_tf)
pg = ct.poles(g_tf)
print ("g zeros = ", zg)
print ("g poles = ", pg)

zh = ct.zeros(h_tf)
ph = ct.poles(h_tf)
print ("h zeros = ", zh)
print ("h poles = ", ph)

g zeros =   [-5.64575131+0.j -0.35424869+0.j]
g poles =   [-0.99999243+0.00000000e+00j -1.00000378+6.55502679e-06j
 -1.00000378-6.55502679e-06j]
h zeros =   [-2.+1.j -2.-1.j]
h poles =   [-3.+0.j -2.+0.j -1.+0.j]
```

1. c.

```
s1 = h_tf
print ("s1 = ", s1)
h_con = (s1**2 + 4*s1 + 5)/(s1**3 + 6*s1**2 + 11*s1 + 6)
print ("h kontinyu = ", h_con)

s1 =   <TransferFunction>: sys[1]
Inputs (1): ['u[0]']
```

Outputs (1): ['y[0]']


```
    s^2 + 4 s + 5
---------------------
s^3 + 6 s^2 + 11 s + 6
```

h kontinyu = <TransferFunction>: sys[25]
Inputs (1): ['u[0]']
Outputs (1): ['y[0]']


```
 5 s^27 + 274 s^26 + 7184 s^25 + 1.2e+05 s^24 + 1.433e+06 s^23 +
1.304e+07 s^22 + 9.396e+07 s^21 + 5.502e+08 s^20 + 2.667e+09 s^19 +
1.084e+10 s^18 + 3.733e+10 s^17 + 1.096e+11 s^16 + 2.756e+11 s^15 +
5.955e+11 s^14 + 1.108e+12 s^13 + 1.772e+12 s^12 + 2.437e+12 s^11 +
2.871e+12 s^10 + 2.882e+12 s^9 + 2.449e+12 s^8 + 1.745e+12 s^7 +
1.029e+12 s^6 + 4.923e+11 s^5 + 1.865e+11 s^4 + 5.376e+10 s^3 +
1.108e+10 s^2 + 1.452e+09 s + 9.098e+07
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
----------------------------------------------------------------------
------------------
6 s^27 + 335 s^26 + 8948 s^25 + 1.522e+05 s^24 + 1.853e+06 s^23 +
1.717e+07 s^22 + 1.261e+08 s^21 + 7.524e+08 s^20 + 3.717e+09 s^19 +
1.541e+10 s^18 + 5.411e+10 s^17 + 1.621e+11 s^16 + 4.161e+11 s^15 +
9.186e+11 s^14 + 1.746e+12 s^13 + 2.857e+12 s^12 + 4.019e+12 s^11 +
4.846e+12 s^10 + 4.984e+12 s^9 + 4.342e+12 s^8 + 3.173e+12 s^7 +
1.919e+12 s^6 + 9.433e+11 s^5 + 3.671e+11 s^4 + 1.088e+11 s^3 +
2.306e+10 s^2 + 3.111e+09 s + 2.007e+08
```

```
s2 = ct.zpk(zh, ph, 1)
print ("s2 = ", s2)
h_zpk = (s2**2 + 4*s2 + 5)/(s2**3 + 6*s2**2 + 11*s2 + 6)
print ("h zpk = ", h_zpk)
```

s2 = <TransferFunction>: sys[26]
Inputs (1): ['u[0]']
Outputs (1): ['y[0]']


```
    s^2 + 4 s + 5
---------------------
s^3 + 6 s^2 + 11 s + 6
```

h zpk = <TransferFunction>: sys[50]
Inputs (1): ['u[0]']

```
Outputs (1): ['y[0]']


 5 s^27 + 274 s^26 + 7184 s^25 + 1.2e+05 s^24 + 1.433e+06 s^23 +
1.304e+07 s^22 + 9.396e+07 s^21 + 5.502e+08 s^20 + 2.667e+09 s^19 +
1.084e+10 s^18 + 3.733e+10 s^17 + 1.096e+11 s^16 + 2.756e+11 s^15 +
5.955e+11 s^14 + 1.108e+12 s^13 + 1.772e+12 s^12 + 2.437e+12 s^11 +
2.871e+12 s^10 + 2.882e+12 s^9 + 2.449e+12 s^8 + 1.745e+12 s^7 +
1.029e+12 s^6 + 4.923e+11 s^5 + 1.865e+11 s^4 + 5.376e+10 s^3 +
1.108e+10 s^2 + 1.452e+09 s + 9.098e+07
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------
6 s^27 + 335 s^26 + 8948 s^25 + 1.522e+05 s^24 + 1.853e+06 s^23 +
1.717e+07 s^22 + 1.261e+08 s^21 + 7.524e+08 s^20 + 3.717e+09 s^19 +
1.541e+10 s^18 + 5.411e+10 s^17 + 1.621e+11 s^16 + 4.161e+11 s^15 +
9.186e+11 s^14 + 1.746e+12 s^13 + 2.857e+12 s^12 + 4.019e+12 s^11 +
4.846e+12 s^10 + 4.984e+12 s^9 + 4.342e+12 s^8 + 3.173e+12 s^7 +
1.919e+12 s^6 + 9.433e+11 s^5 + 3.671e+11 s^4 + 1.088e+11 s^3 +
2.306e+10 s^2 + 3.111e+09 s + 2.007e+08
```