ME2801 HW4: Textbook Exercise Solutions in MATLAB

Nise 5.1

- See Textbook solutions for by-hand solution. Note that the MATLAB command `minreal` simplifies the transfer function expression.

In MATLAB you need to name each transfer function block:

```
G1 = tf(1,[1 0 0])
```

```
G1 =

    1
   ---
   s^2

Continuous-time transfer function.
Model Properties
```

```
G2 = tf(50,[1 1])
```

```
G2 =

    50
   -----
   s + 1

Continuous-time transfer function.
Model Properties
```

```
G3 = tf(2,[1 0])
```

```
G3 =

   2
   -
   s

Continuous-time transfer function.
Model Properties
```

```
G4 = tf([1 0],1)
```

```
G4 =

   s

Continuous-time transfer function.
Model Properties
```

```
G5 = 2
```

```
G5 =
2
```

We can combine G2 and G3 using the feedback form. The equivalent TF is

```
Ge1 = feedback(G2, G3)
```

```
Ge1 =

      50 s
  -------------
  s^2 + s + 100

Continuous-time transfer function.
Model Properties
```

We can combine G4 and G4 using parallel form, noticing that the summation includes a negative sign. The equivalent TF is

```
Ge2 = G4 - G5
```

```
Ge2 =

  s - 2

Continuous-time transfer function.
Model Properties
```

And we then have everything in the forward path in series form - the entire open-loop TF as

```
Gol = G1 * Ge1 * Ge2
```

```
Gol =

    50 s^2 - 100 s
  -------------------
  s^4 + s^3 + 100 s^2

Continuous-time transfer function.
Model Properties
```

Finally close the outer loop to get the entire closed-loop transfer function

```
T = feedback(Gol, 1)
```

```
T =

        50 s^2 - 100 s
  ---------------------------
  s^4 + s^3 + 150 s^2 - 100 s

Continuous-time transfer function.
Model Properties
```

Notice there is both a pole and a zero at zero, which cancel each other out. The `minreal()` function simplifies the reprsentation by cancelling pole/zero pairs.

```
T2 = minreal(T)
```

```
T2 =

        50 s - 100
  -----------------------
  s^3 + s^2 + 150 s - 100
```

```
Continuous-time transfer function.
Model Properties
```

Nise 5.11

a) See Textbook solutions for by-hand solution.

b) Using MATLAB, use the `feedback()` and `stepinfo()` commands to accomplish the same result.

Open-loop transfer function.

```
G = tf(225, [1 15 0])
```

```
G =

     225
  ----------
  s^2 + 15 s

Continuous-time transfer function.
Model Properties
```

Closed-loop transfer function.

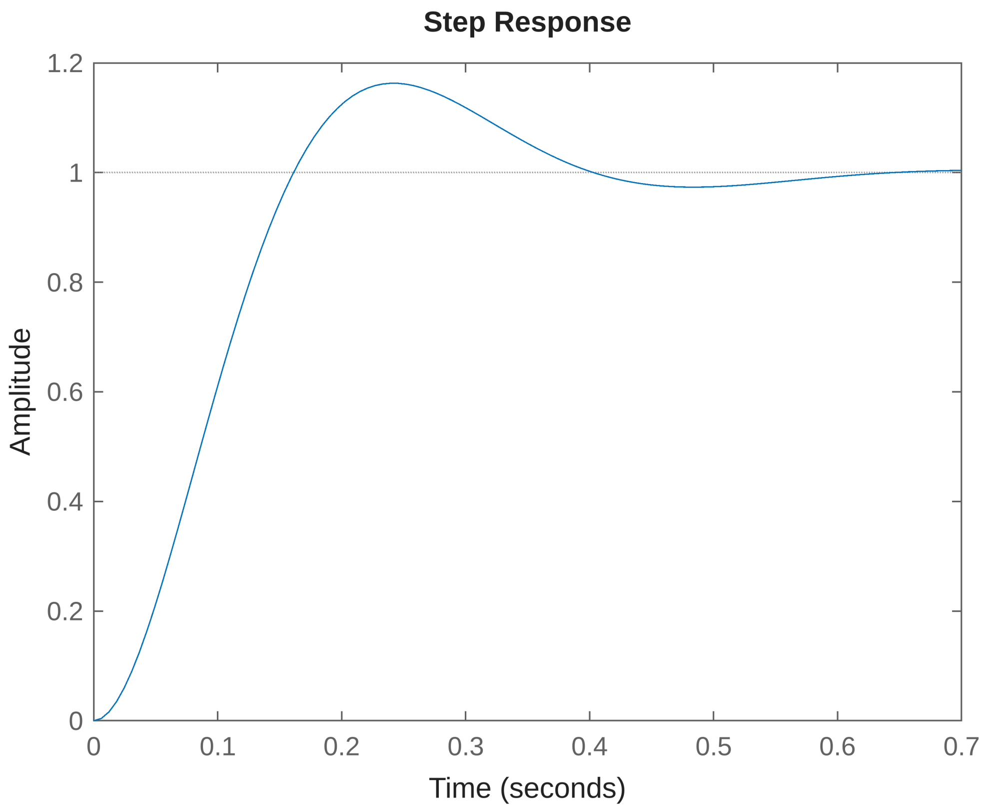
```
Ge = feedback(G,1)
```

```
Ge =

        225
  ----------------
  s^2 + 15 s + 225

Continuous-time transfer function.
Model Properties
```

Plot closed-loop step response and calculate the performance metrics.

```
step(Ge)
```

```
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software
OpenGL. For more information, click here.
```




```
stepinfo(Ge)
```

```
ans = struct with fields:
        RiseTime: 0.1093
    TransientTime: 0.5384
     SettlingTime: 0.5384
      SettlingMin: 0.9315
      SettlingMax: 1.1629
        Overshoot: 16.2929
       Undershoot: 0
             Peak: 1.1629
         PeakTime: 0.2395
```

Nise 5.14

See Textbook solutions