Model Simplifications and Uncertainities

The models used for control design are often simplified and contain a variety of inaccuracies including uncertain parameters, unmodeled dynamics, nonlinear effects, and implementation effects. It is common to design the controller with the simplified model and then check performance on a more accurate model.

Contents

DC MOTOR Full model (includes faster dynamics)

```
G_full = tf(1.23e-3, [3e-10 1.6e-6 1.505e-6])
```

```
G_full =

               0.00123
  ---------------------------------
  3e-10 s^2 + 1.6e-06 s + 1.505e-06

Continuous-time transfer function.
```

DC MOTOR Simplified model (dominant pole)

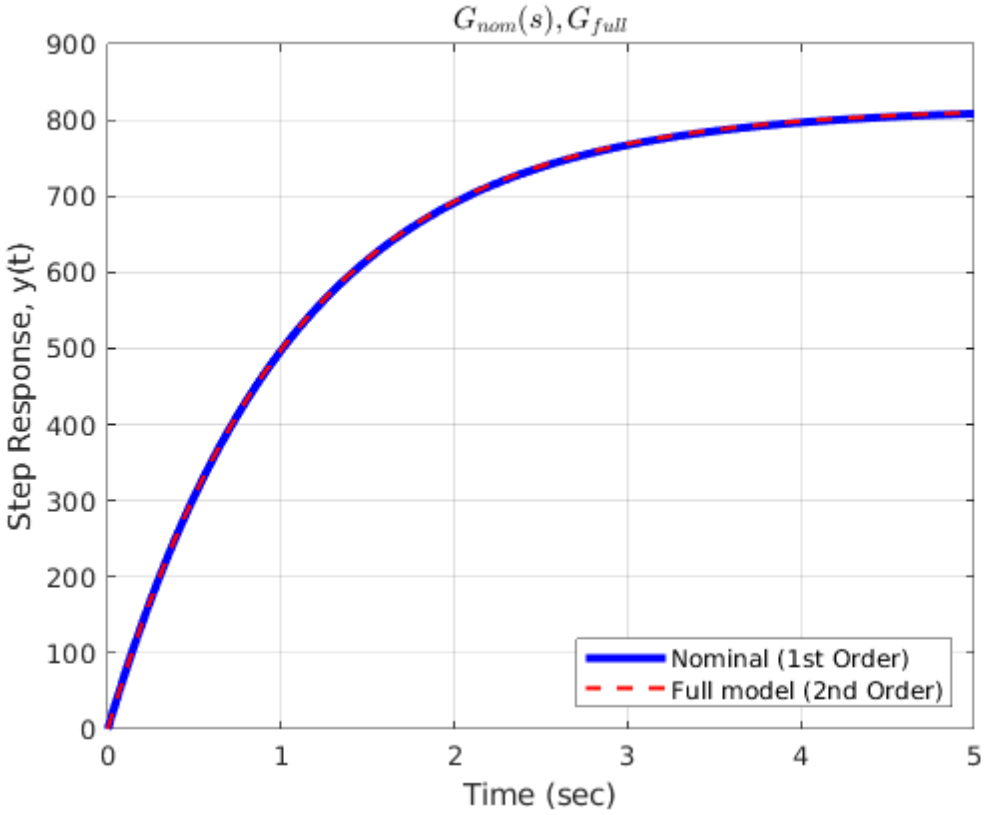
```
a0 = 0.94; % 1/sec
b0 = 766.8; % rad/sec^2V
G_nom = tf(b0, [1 a0])
```

```
G_nom =

   766.8
  --------
  s + 0.94

Continuous-time transfer function.
```

Unmodeled Dynamics

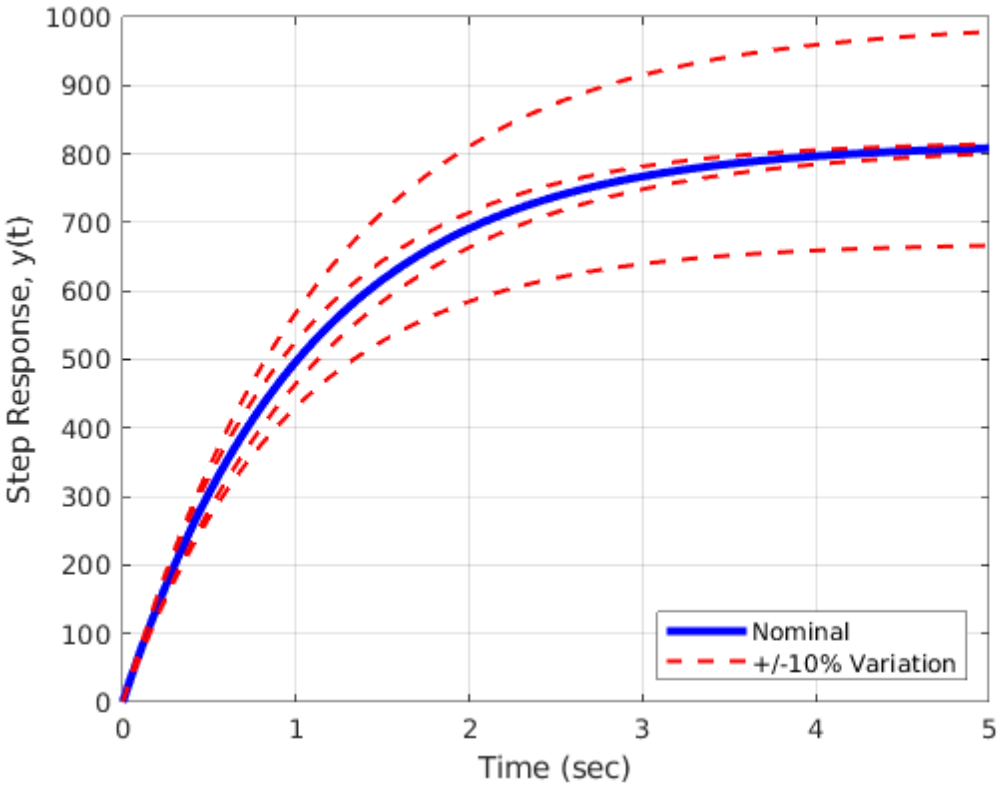
```
Tf = 5;
[y_full, t] = step(G_full, Tf);
[y_nom, t] = step(G_nom, Tf);
figure(1)
plot(t, y_nom, 'b', 'LineWidth',3);
hold on;
plot(t, y_full, 'r--', 'LineWidth',1.5);
legend('Nominal (1st Order)', 'Full model (2nd Order)', 'Location','southeast');
```

```
xlabel('Time (sec)')
ylabel('Step Response, y(t)')
title('$G_{nom}(s) ,  G_{full}$', 'interpreter', 'latex');
grid on;
hold off;
```



Uncertain Parameters

```
figure(2)

[y_nom, t] = step(G_nom, Tf);
plot(t, y_nom, 'b', 'LineWidth',3);
hold on;

a = [0.85 0.85 1.03 1.03];
b = [690.1 843.5 690.1 843.5];

for i = 1:length(a)
    G = tf(b(i),[ 1 a(i)]);
    [ydummy, t] = step(G, Tf);
    plot(t, ydummy, 'r--', 'LineWidth',1.5);
    hold on;
end

hold off;
legend('Nominal', '+/-10% Variation', 'Location','southeast');
xlabel('Time (sec)')
ylabel('Step Response, y(t)')
% title('$G_{nom}(s) ,  G_{full}$', 'interpreter', 'latex');
grid on;
```



Published with MATLAB® R2024a