# CSC485A/586A/SENG480

# Assignment 2 Part 2

G11 - Junnan Lu, Bill Xiong, Colum McClay, Sahibdeep Sran

## Abstract

Cruise control is a standard example of a resource control issue. Ultimately, we want to control the speed of the engine. To do this, we utilize the throttle and control the throttle position in order to influence the gear ratio, the current speed of the car, and other factors that are at play. The actuator which commands the throttle is a cable mechanism which opens and closes a valve, allowing different amounts of air flow into the cylinder.

The PID controller is a self-adaptive, autonomous system that feigns intelligence. In addition to human control, the throttle position can be determined by an electric motor using the PID controller and the calculations made in the previous round.

## Instructions for Matlab

### Tutorial

The steps outlined below will demonstrate the MATLAB modelling procedure

1. Define variables

    a. Set the transfer function `s = tf('s')`
    b. Define a plant function, here $G(S) = \frac{40}{2s^3+10s^2+82s+10}$ was used
    c. In matlab, `G = 40 / (2s^3 + 10s^2 + 82s + 10);`
    d. Define a variable `Ku = 1`
    e. Create feedback `H = feedback(Ku*G,1);`

2. Use Ziegler-Nichols method to find Ku
    a. Plot the graph `step(H)`
    b. Notice how the oscillations will have different pitch.
    c. Redo the steps above but change `Ku` appropriately so that the graph is constantly oscillation with steady frequency and pitch.
    d. Find the period of oscillations, and save it into a variable `Tu`.

3. Determine $K_p$, $K_i$ and $K_d$

Create new variables, and set values for classical PID:

```
Kp = 0.33*Ku
Ki = 0.5*Tu
Kd = 0.33*Ku
```

4. Enter pid values

```
C = pid(Kp,Ki,Kd);
```

and plot `step(C)`

## Code

You can find the code for MatLab on https://github.com/bxio/UVicSAS_A2/

## Results of Matlab Experiment

The following figures display some of the results when attempting to find the correct Ku value for the Ziegler Nichols method. We incremented Ku by 1 until we found the correct value, which is displayed in Figure 6.

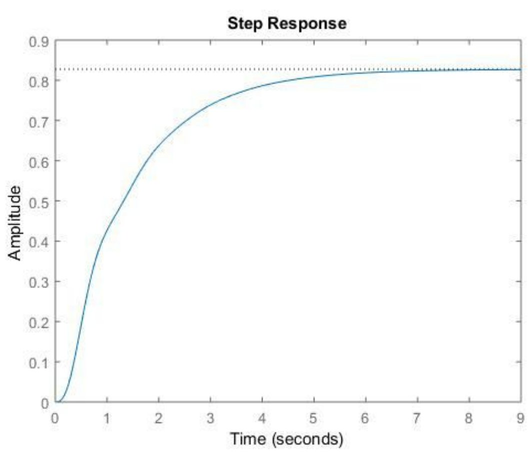


***Figure 1**:* When $K_u$=1

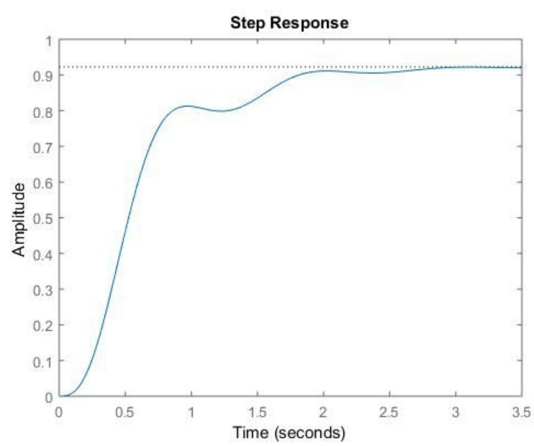


***Figure 2:*** When $K_u$ = 3

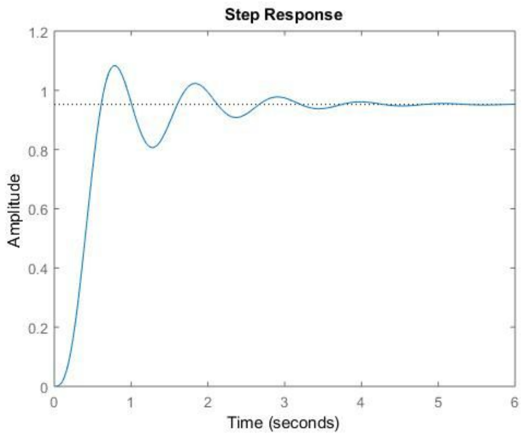


***Figure 3:*** $K_u = 5$

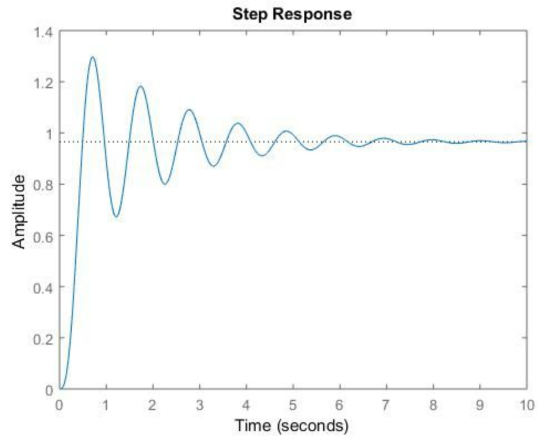


***Figure 4:*** $K_u = 7$

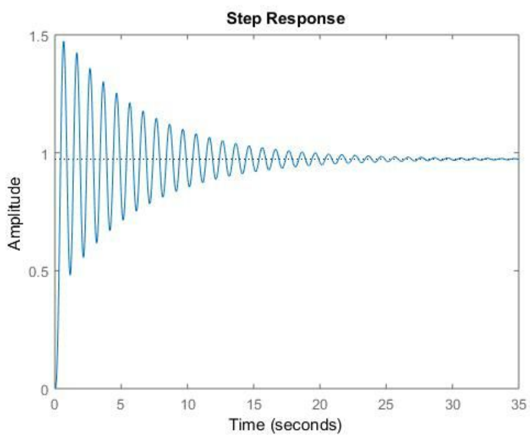


***Figure 5:*** $K_u = 9$

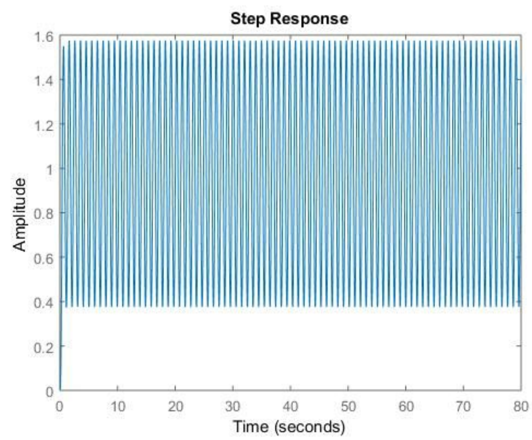


***Figure 6:*** $K_u = 10$

Larger versions of these graphs can also be found in our github repository.

## PID Parameters

In our findings, when $K_u = 10$ and $T_u = 1$ second, the system reach the sustained oscillation (point of instability). Thus, applying Ziegler-Nichols method, (the classic PID), the Proportional Gain, $K_p$, Integral Gain, $K_i$, and the Derivative Gain, $K_d$ can formulated as follows:

$T_u = 1$ second,
$K = 10$,
$K_p = 0.33 * K_u = 3.3$,
$T_i = 0.5 * T_u = 0.5$,
$T_d = 0.33 * T_u = 0.33$,
Because, the PID = $K_p + K_i / s + K_d*s = K_p + K_p / (T_i*s)+K_p*T_d*s$, thus,
$K_i = K_p/T_i = 3.3/0.5 = 6.6$,
$K_d = K_p*T_d = 3.3*0.33=1.089$

The PID control function is C=3.3 + 6.6/s+1.089*s, the plan function is

$$G(S) = \frac{40}{2s^3+10s^2+82s+10}.$$

Now we replace the variables, close the feedback loop and obtained the close loop feedback function $$\frac{\theta i}{\theta o} = \frac{21.78\,s^2 + 66\,s + 132}{s^4+5s^3+62.78s^2+71s+132}.$$

Then, the step response is as in Figure 7.

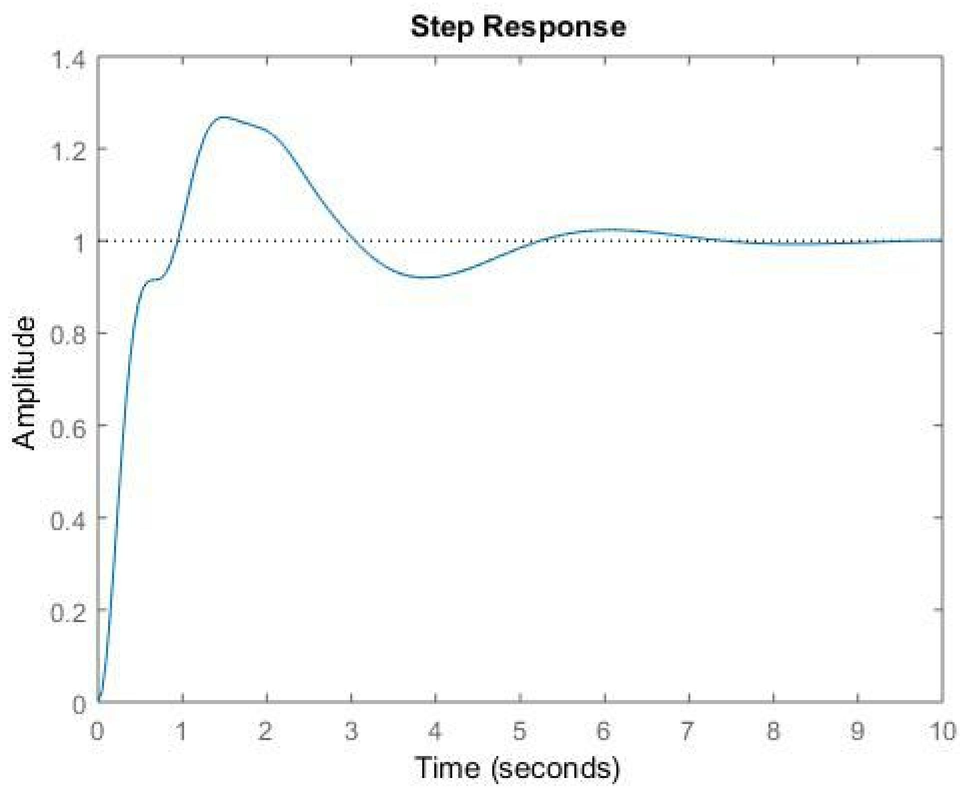


***Figure 7:*** Displays the amount of time it takes to efficiently regulate the system. The rising time is 2 seconds and the settling time is 7 seconds.

# References

Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, Compilers: Principles, Techniques, and Tools, second edition. Reading, MA: Addison-Wesley, 2006.

Honerkamp, J. "PID Systems Tutorial." *PID Systems Tutorial*. University of Freiburg, 19 July 2002. Web. 16 June 2015.

# Group Members

SEng480-Jiashu-Xiong-V00737042
CSC485a-Colum-McClay-V00745851
CSC586a-Junnan-Lu-V00217112
CSc485A-Sahibdeep-Sran-V00486531