Today
- What we hope you will learn
- What you should already know
- What is feedback control
- Thermal Example

Learn:

Given a robot, car, oven, drone, etc
- Decide on actuators & sensors
- Extract a useful model
- Use the model to design a controller
- Implement and assess performance

Need insight to redesign.

Videos Flipping, Floating, Flying

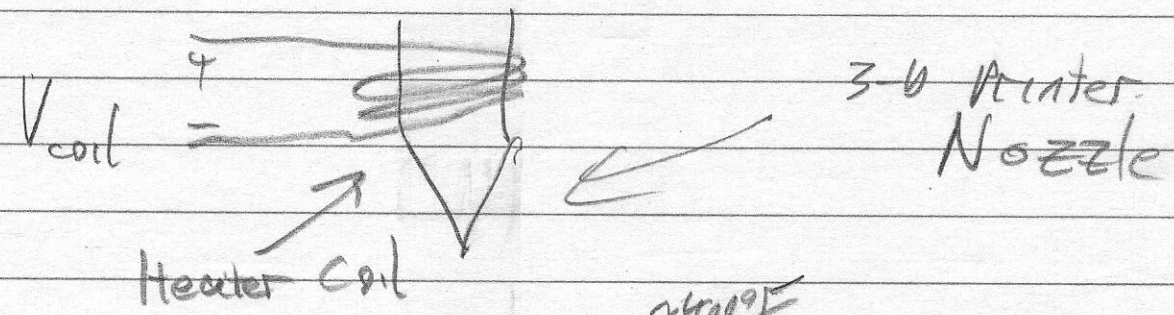
Already Know
- Linear Alg (18.06, 18.C06)
- Some physics (8.01 at least 8.01+8.02)

Logistics:

url: introcontrol.mit.edu ← Accts by 2/3 AM

grading:
- No exams, prelabs, labs, (infinite retries)
- Prelabs due before part II Labs (See website calender)

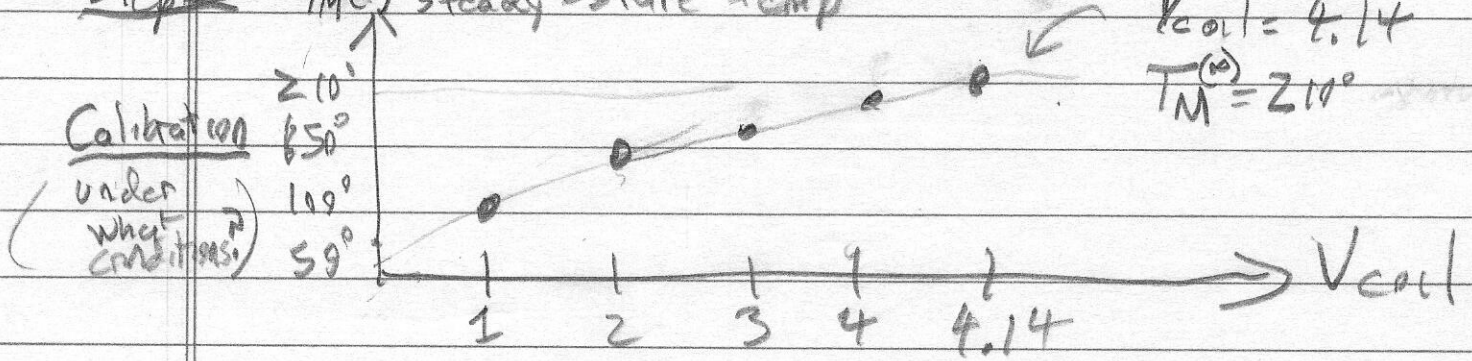
Thermal Example



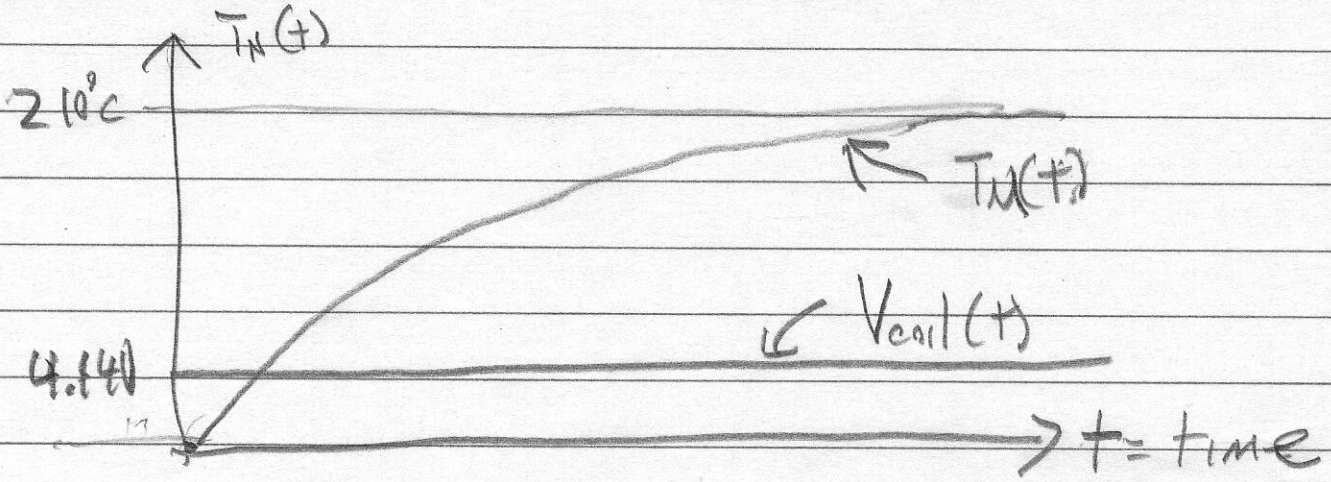
Want nozzle at 210°C ≈ 410°F

Approach 1 & Read From Table

Step 1 $T_M(t)$ steady-state temp



Step 2 Set $V_{coil} = 4.14$ Volts and wait

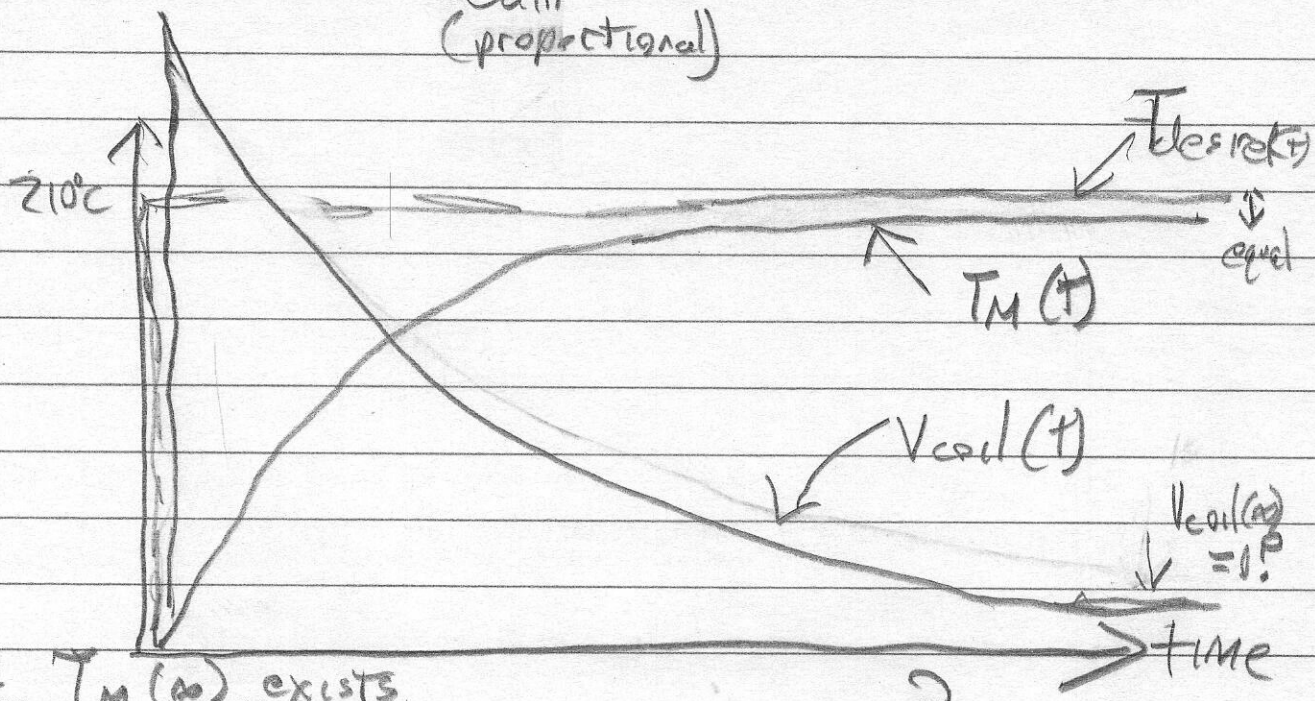


Problems 1) slow
2) Sensitive to disturbances
Open a window, etc

Approach 2

$$\text{Set } V_{coil}(t) = K_p \left(T_d(t) - T_M(t) \right)$$

$V_{coil}(t)$: time; K_p: Gain (proportional); $T_d(t)$: desired; $T_M(t)$: measured



Why?

If $T_M(\infty)$ exists

Will $T_{desired}(\infty) = T_M(\infty)$?

No Model for dynamic relation between T_M & V_{coil}

$$T_{desired}(\infty) - T_M(\infty) = \frac{V_{coil}(\infty)}{K_p}$$

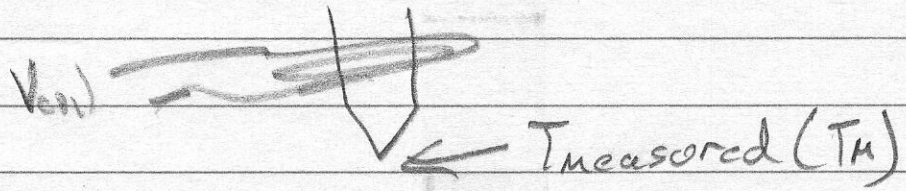
$$\simeq \frac{4.14V}{K_p}$$

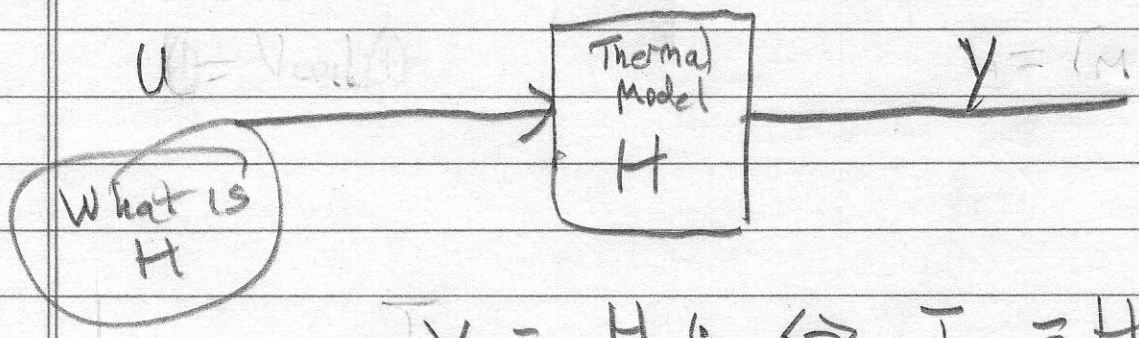
1) Faster Response? How Fast?

2) Less sensitive to disturbances

$K_p \uparrow$ Sensitivity $\downarrow$

Block Diagram

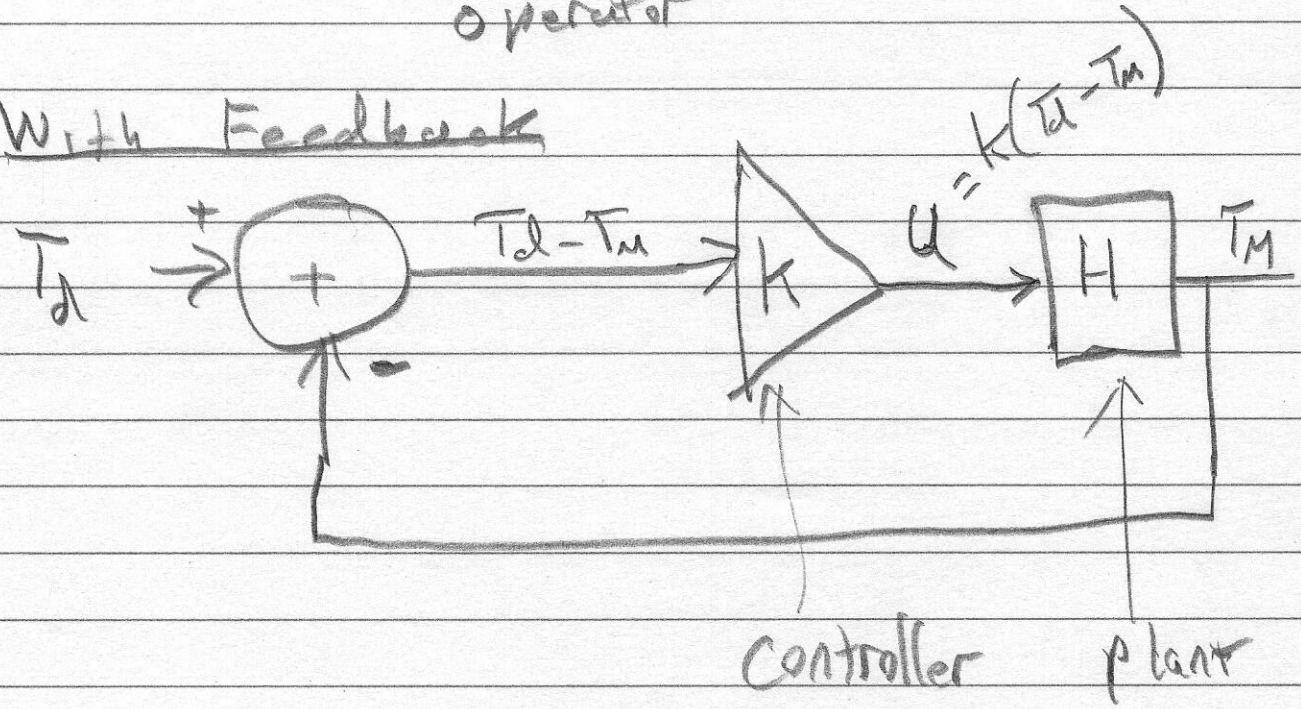




$Y = HU \Leftrightarrow T_M = HV_{coil}$

↑ operator

With Feedback



Black's Formula

$$u = K(T_d - T_M)$$

$$T_M = Hu = H(K(T_d - T_M))$$

Justify ⇕ Clarify this just Before Spring Break!

If we pretend K & H are composible distributable operators → K

If $H(\alpha u_1 + \beta u_2) = \alpha H u_1 + \beta H u_2$

$\Rightarrow H(K(T_d - T_M)) = HKT_d - HKT_M$

$$\Rightarrow T_M = HKT_d - HKT_M$$

or

$$(1 + HK)T_M = HKT_d$$

Suppose further that $(1+HK)\cdot\frac{1}{(1+HK)} = 1$

$$\Rightarrow T_M = \frac{HK}{1+HK} T_d$$

And assuming a whole lot more

Ideally $\frac{HK}{1+HK} \simeq 1$ so that $T_M = T_d$

So $|HK| >> 1$?