Summary of Covered Topics

Important concepts:

- Impedance
- Amplification
- Frequency/Fourier Analysis
- Feedback

Important electronics components and equipment:

- Resistors, capacitors, inductors.
- Special components: tranformers, photodiodes, thermistors, and Peltier coolers.
- Diodes, BJTs, and FETs.
- Op-amps and comparators.
- Multimeters, oscilloscopes, and function generators.
- Breadboards, prototyping boards, and soldering irons.
- Circuit simulation and layout software.

Final Exam

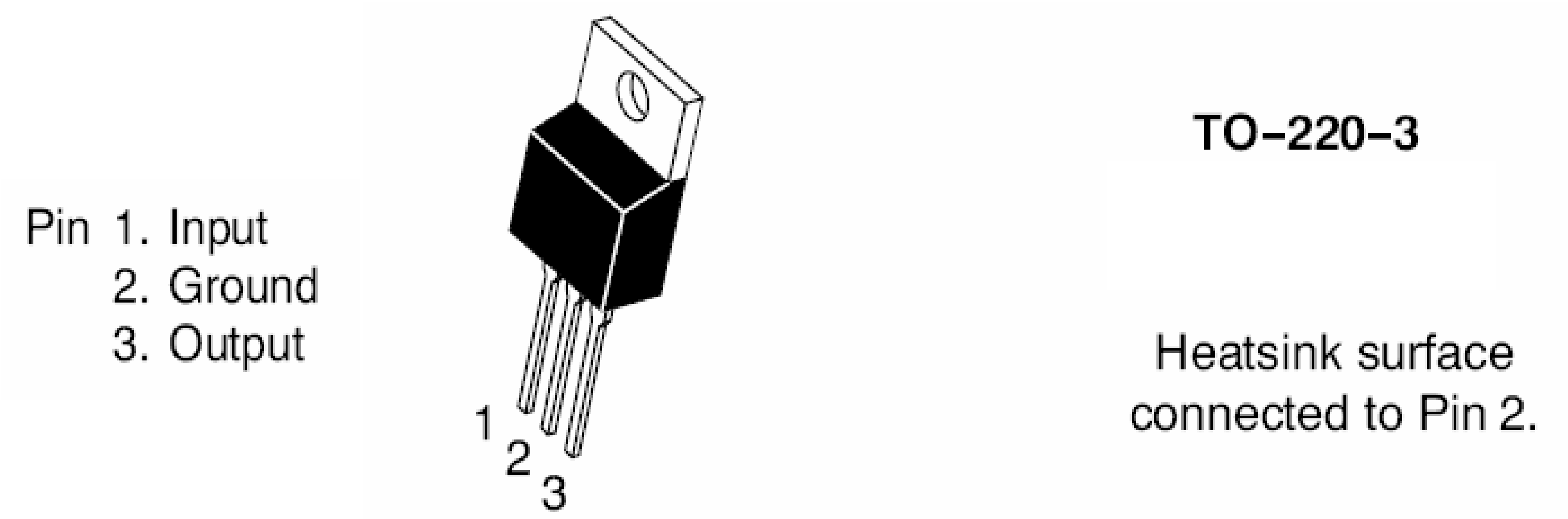
- Tuesday, April 29, 2008: Small Hall 238, 1:30pm-4:30pm.
- 3 hours long.
- It will cover all the topics covered in the class and lab.
- You can expect some variations on the quiz and design exercise materials.
- Some questions will be on pratical lab knowledge.
- Some problems will involve combining knowledge from different chapters.

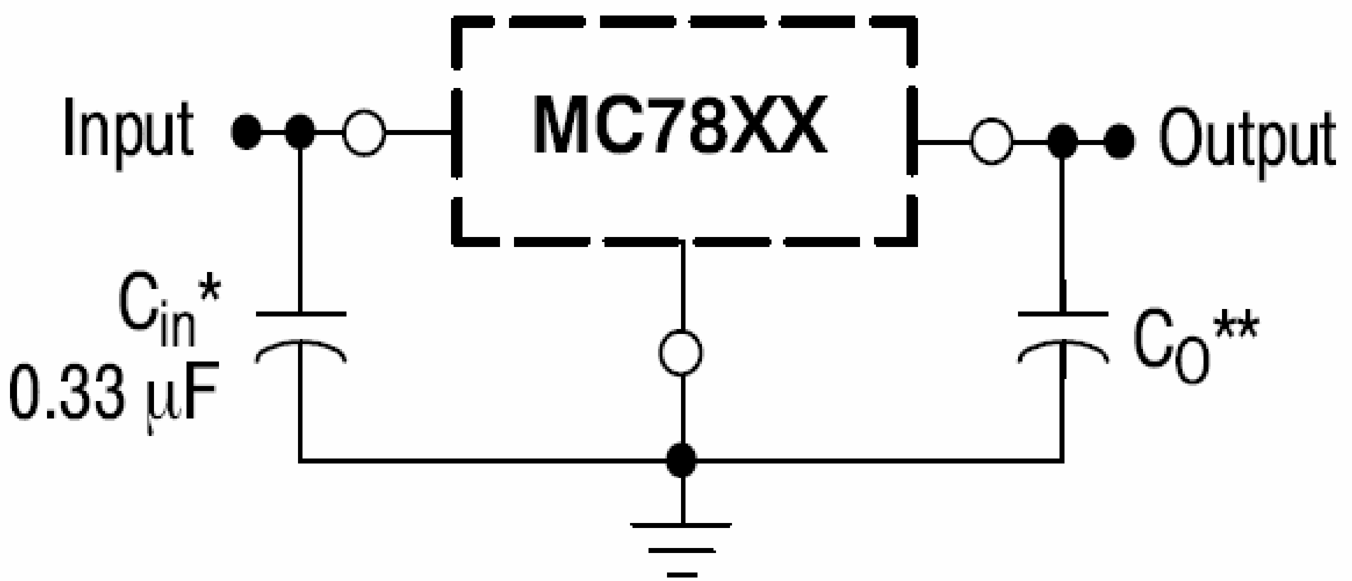
Physics 351: Electronics II
What to expect?

- Mostly **DIGITAL** electronics
  - → Logic gates.
  - → Operations.
  - → ADCs, DACs, and opto-couplers.
  - → Counters, registers, and digital memory.
- A fair bit on **FPGA**s
  - → C-like programming.
  - → Complex digital circuits.
- A little bit on **microprocessors**
  - → C programming.
- ***Digital Signal Processing (DSP)*** … or how to make an analog circuit with digital concepts.

Voltage Regulators (I)

Voltage regulators produce a constant output voltage despite variations in the input.





Voltage Regulators (II)

MC7800, MC7800A, MC7800AE, NCV7800

ELECTRICAL CHARACTERISTICS (V_{in} = 10 V, I_O = 500 mA, $T_J = T_{low}$ to 125°C (Note 1), unless otherwise noted)

Characteristic	Symbol	MC7805B, NCV7805			MC7805C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = 25°C)	V_O	4.8	5.0	5.2	4.8	5.0	5.2	Vdc
Output Voltage (5.0 mA ≤ I_O ≤ 1.0 A, P_D ≤ 15 W) 7.0 Vdc ≤ V_{in} ≤ 20 Vdc 8.0 Vdc ≤ V_{in} ≤ 20 Vdc	V_O	 – 4.75	 – 5.0	 – 5.25	 4.75 –	 5.0 –	 5.25 –	Vdc
Line Regulation (Note 4) 7.5 Vdc ≤ V_{in} ≤ 20 Vdc, 1.0 A 8.0 Vdc ≤ V_{in} ≤ 12 Vdc	Reg_{line}	 – –	5.0 1.3	100 50	– –	0.5 0.8	20 10	mV
Load Regulation (Note 4) 5.0 mA ≤ I_O ≤ 1.0 A 5.0 mA ≤ I_O ≤ 1.5 A (T_A = 25°C)	Reg_{load}	 – –	 1.3 0.15	 100 50	 – –	 1.3 1.3	 25 25	mV
Quiescent Current	I_B	–	3.2	8.0	–	3.2	6.5	mA
Quiescent Current Change 7.0 Vdc ≤ V_{in} ≤ 25 Vdc 5.0 mA ≤ I_O ≤ 1.0 A (T_A = 25°C)	ΔI_B	 – –	 – –	 – 0.5	 – –	 0.3 0.08	 1.0 0.8	mA
Ripple Rejection 8.0 Vdc ≤ V_{in} ≤ 18 Vdc, f = 120 Hz	RR	–	68	–	62	83	–	dB
Dropout Voltage (I_O = 1.0 A, T_J = 25°C)	$V_I - V_O$	–	2.0	–	–	2.0	–	Vdc
Output Noise Voltage (T_A = 25°C) 10 Hz ≤ f ≤ 100 kHz	V_n	–	10	–	–	10	–	µV/V_O
Output Resistance f = 1.0 kHz	r_O	–	0.9	–	–	0.9	–	mΩ
Short Circuit Current Limit (T_A = 25°C) V_{in} = 35 Vdc	I_{SC}	–	0.2	–	–	0.6	–	A
Peak Output Current (T_J = 25°C)	I_{max}	–	2.2	–	–	2.2	–	A
Average Temperature Coefficient of Output Voltage	TCV_O	–	-0.3	–	–	-0.3	–	mV/°C

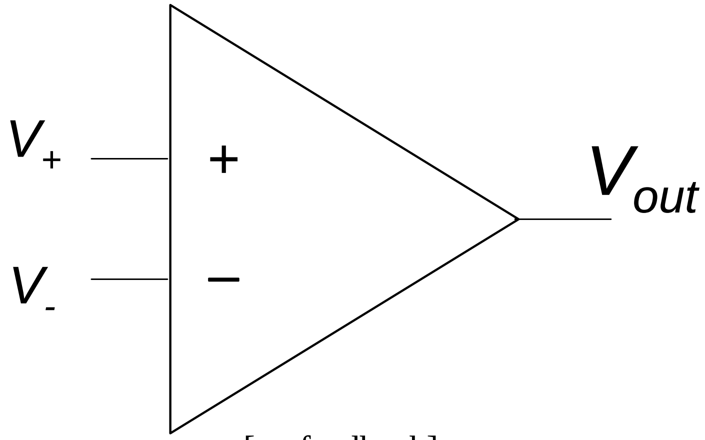
1. T_{low} = 0°C for MC78XXC, MC78XXAC,
   = −40°C for NCV78XX, MC78XXB, MC78XXAB, and MC78XXAEB
2. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

Comparators

Comparators are specialty op-amps designed to be used with positive feedback or no feedback.

Comparators are two-state devices which output either a high signal or a low signal depending on whether an input voltage is above or below a reference voltage.

A comparator is like an **IF** statement in computer programming.



[no feedback]

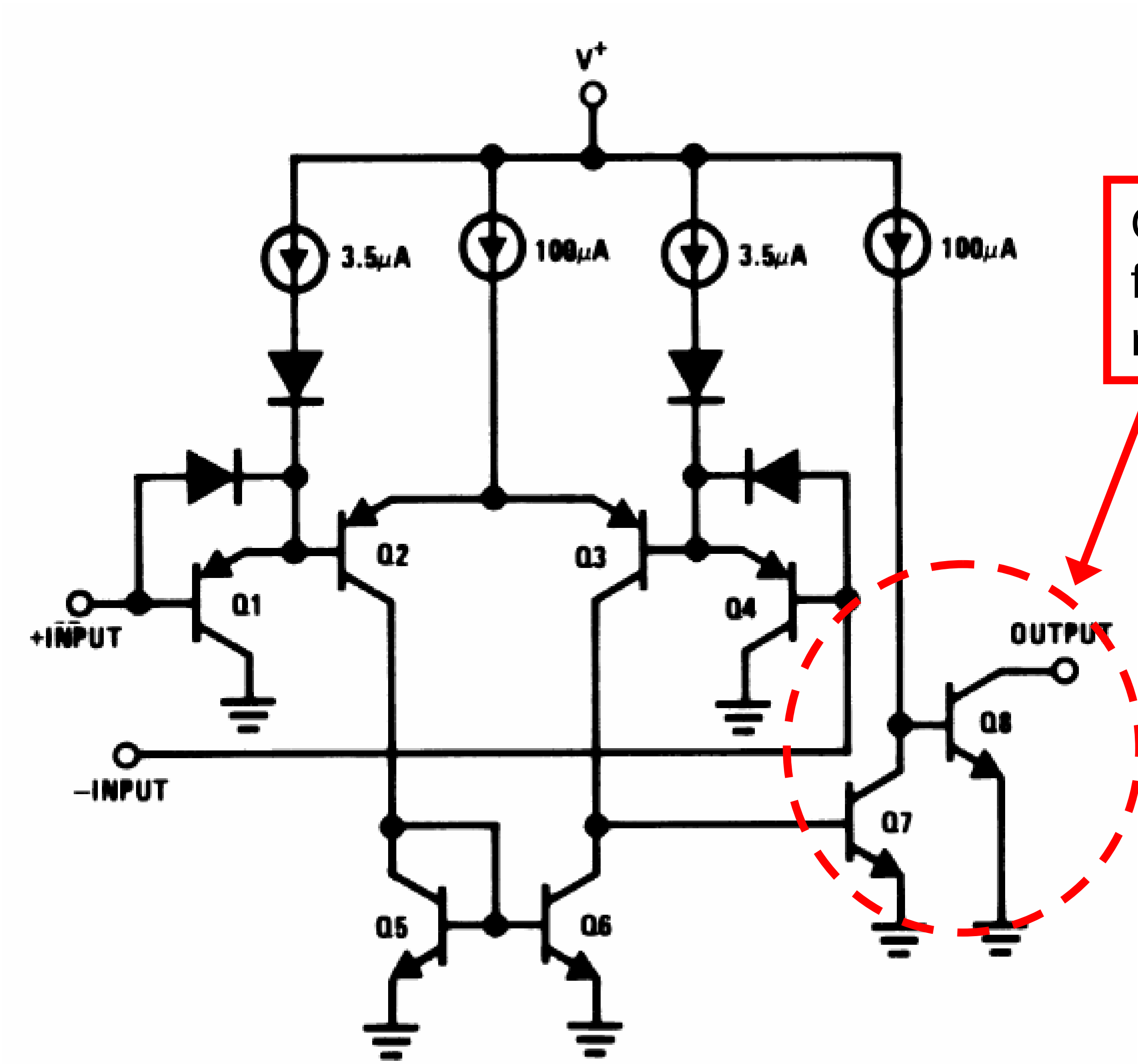
Op-amp equation: $V_{out} = Gain \times (V_+ - V_-)$

Since $Gain \sim 10^5$-10^6,

If $V_+ > V_-$, then $V_{out} = + V_{supply}$ (HIGH)

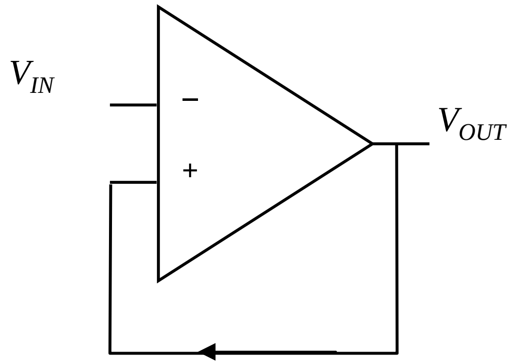
If $V_+ < V_-$, then $V_{out} = - V_{supply}$ (LOW)

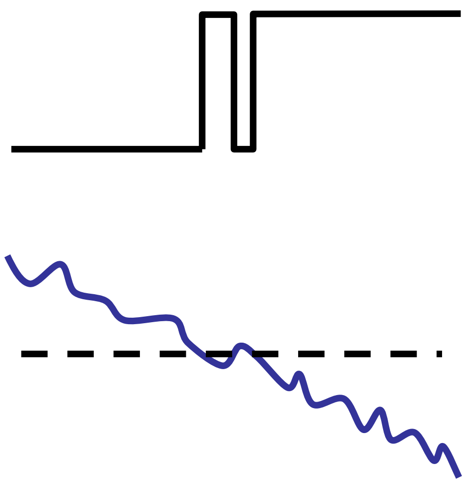
The LM2903 comparator



Output is configured for use with a pull-up resistor

Positive Feedback



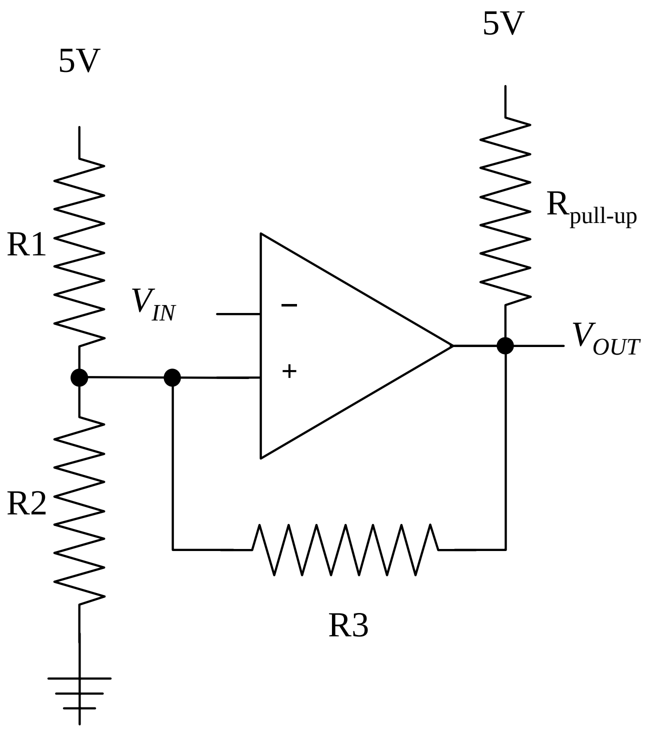


Noisy signal leads to
“false” triggering

The merits of positive feedback:

- Speed-up the choice of HIGH output or LOW output.
- Introduce **hysteresis** into comparator behavior
  (i.e. circuit output depends not just on the input, but on its history).

Schmitt Trigger



Hysteresis suppresses "false" triggering due to noise.