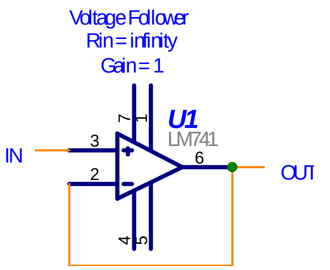
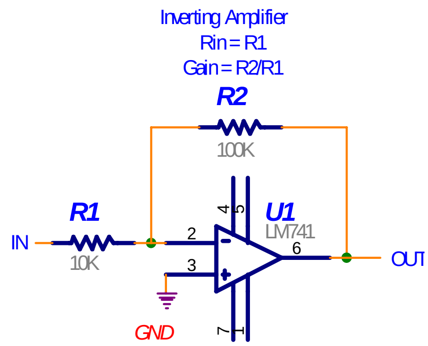
Early study guide for PHYS 483/683 Final (more to come):

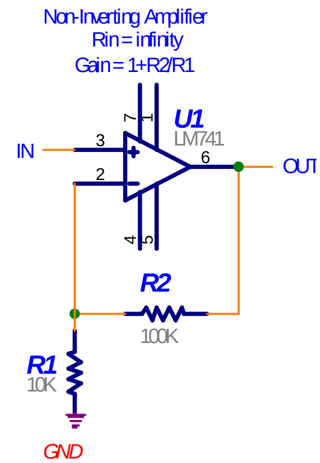
Op-amps:

Know the two rules that are valid for the circuits we'll be dealing with:
1. No current flows into the input pins (i.e. infinite input impedance)
2. The output voltage will adjust to try and bring the - input to the same voltage as the + input

Know the following circuits:

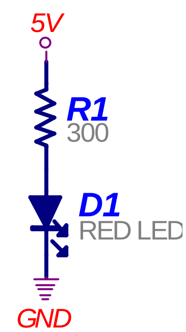






Op-amp datasheets: know what the following terms mean:
Input Offset Voltage, Bandwidth (or gain bandwidth product, GBW), and Slew Rate

Know how to add filters to the op-amp circuits to control the frequency response (i.e. the cut-off frequency is $= 1/(2\pi RC)$). You should be able to make amplifiers in which the gain rolls off at high frequencies, low frequencies, or both (i.e. design an amplifier that has a gain of 100 in the pass band but the gain decreases when at lower or higher frequencies).



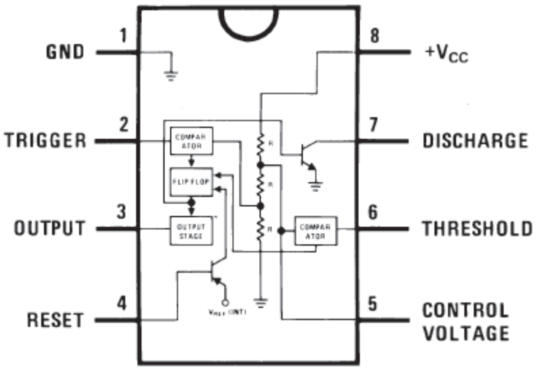
LEDs:
The intensity of light that a LED produces is directly proportional to the current. Usually the current is set with a resistor. Ex: At 10mA a red LED drops about 2V. With a 5V supply, this leaves 3V across the resistor. Therefore if R = 300Ω I will be 10mA (3V/10mA = 300Ω).

Photodiodes:
Know what dark current is and that reverse biasing the diode decreases its capacitance, which allows it to respond faster. Know how to amplify a photodiode signal using op-amps (i.e. a current to voltage converter). Know that the current from a photodiode is directly proportional to the light intensity.

Digital Logic:
Be able to implement a truth table using logic gates. Be able to fill out the truth table for a given logic circuit.

Digital Integrated Circuits:
If given the equation for frequency (555) and pulse duration (74HC123) be able to configure the 555 to oscillate at a specific frequency and the 74HC123 to provide a specific pulse width or delay. Know how the 74HC74 flip-flop works (i.e. what the preset and clear lines do and what happens to the output when the input gets clocked). The pin-outs will also be given (as shown below). Make sure to tie all unused inputs hi or low as needed.

Dual-In-Line, Small Outline
and Molded Mini Small Outline Packages



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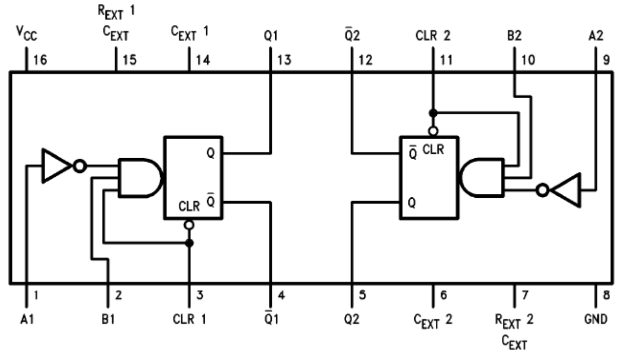
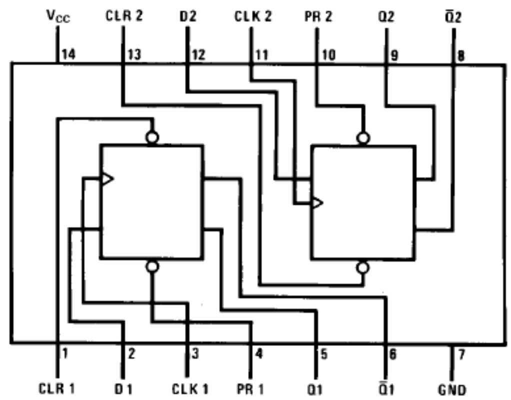
Top View

Dual-In-Line Package



Dual-In-Line Package



EMI & Shielding:

Know what the skin effect is and what skin depth is. If I tell you the skin depth of Aluminum at some frequency you should be able to calculate the skin depth at any other frequency (i.e. skin depth gets smaller as frequency increases, proportional to the square root of frequency). Know how to calculate the attenuation (effectiveness of a shield) of a signal at a specific frequency (i.e. if shield is one skin depth thick then signal is 1/e times weaker after passing through the shield. 20log(1/e) = 8.7db attenuation per skin depth.

Know how a given size hole will effect the shielding. If the hole is 1/20 of interfering λ then the interfering signal will be attenuated by a factor of 10 (20db). If the hole is 10 times smaller the attenuation will be 10 times larger.

Know why these general rules are a good idea:
Always minimize the loop areas (think about where the return current is flowing).
Minimize rise time (i.e. use the slowest parts possible)
Power cables/traces can conduct noise (use filtering and decoupling caps as needed)

Transmission Lines:

Know the amplitude and sign of a reflected signal. If the terminating resistor is larger than the cable impedance the reflected wave will be positive. If the terminating resistor is smaller than the cable impedance the reflected wave will be negative. If I give you a situation where a pulse is going down a cable and reflects off of something and I tell you the propagation speed in the cable you should be able to draw the voltage on the cable at a specific time (i.e. what's it look like 20ns after the pulse leaves the generator).

Know the Reflection Coefficient = $(Z_L - Z_0)/(Z_L + Z_0)$ where Z_L is the impedance of the terminating resistor or the cable to which the pulse will hit and Z_0 is the impedance of the cable the pulse is in. This tells you the amplitude of the reflected wave (note: the amplitude of the reflected wave won't be the same as the incident wave unless the terminating impedance is 0 or ∞.