ECE 320 - Final pt 1: Name _____

Semiconductors and Diodes. October 26, 2018

Semiconductors

1a) What is meant by a p-type semiconductor?

1b) For metals, the resistance increases as temperature increases. For semiconductors, the resistance decreases as temperature increases. Why?

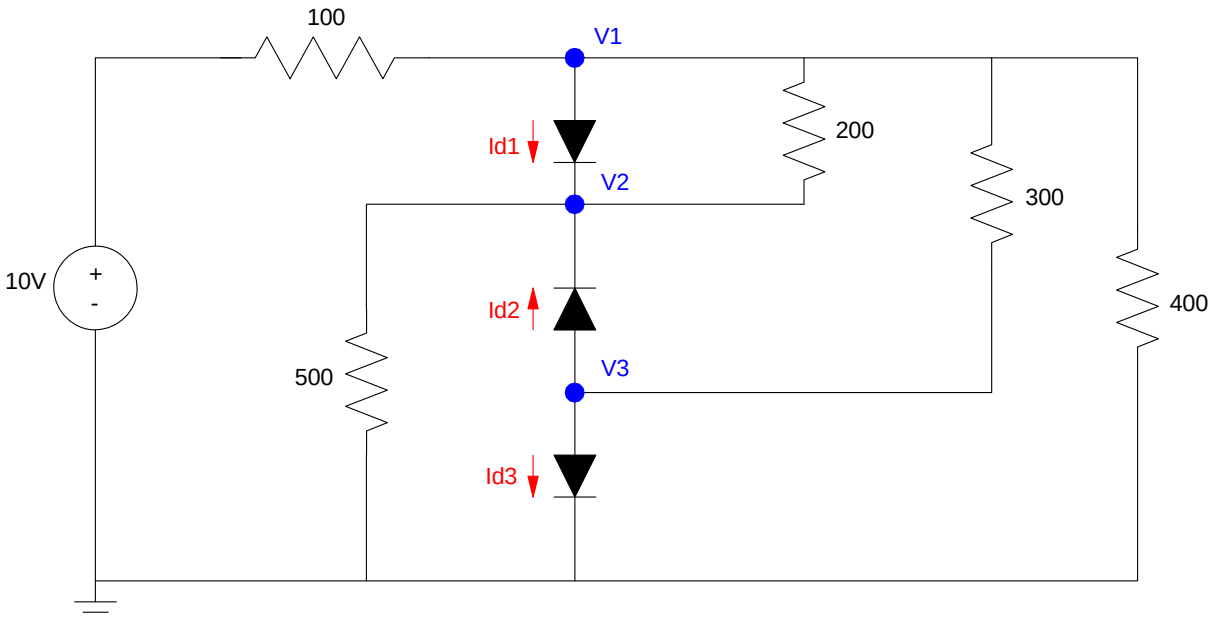
1c) Why can current flow p to n in a pn junction but not n to p?

Diodes: Nonlinear Model

2) Assume the VI characteristics for a diode are

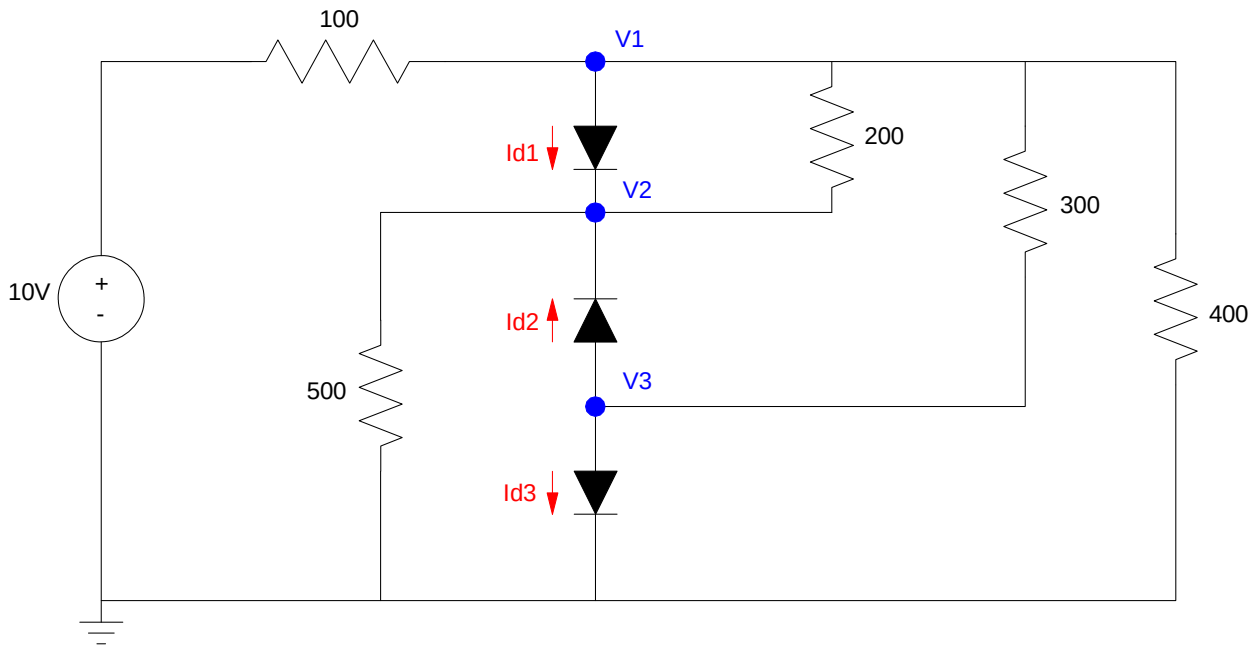
$$V_d = 0.052 \ln\left(\frac{I_d}{10^{-8}} + 1\right) \qquad I_d = 10^{-8}\left(\exp\left(\frac{V_d}{0.052}\right) - 1\right)$$

Write 6 equations for 6 unknowns (V1, V2, V3, Id1, Id2, Id3}



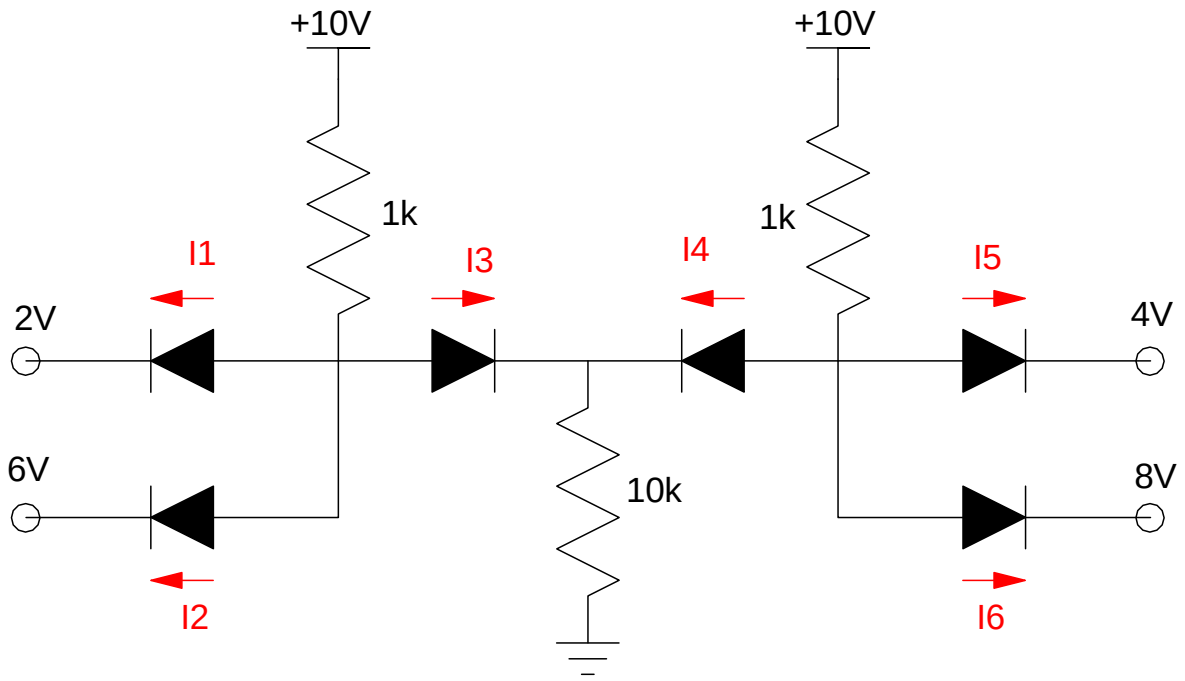
3) Assume ideal silicon diodes (Vf = 0.7V). Determine the currents for the following diode circuit

V1	V2	V3	Id1	Id2	Id3



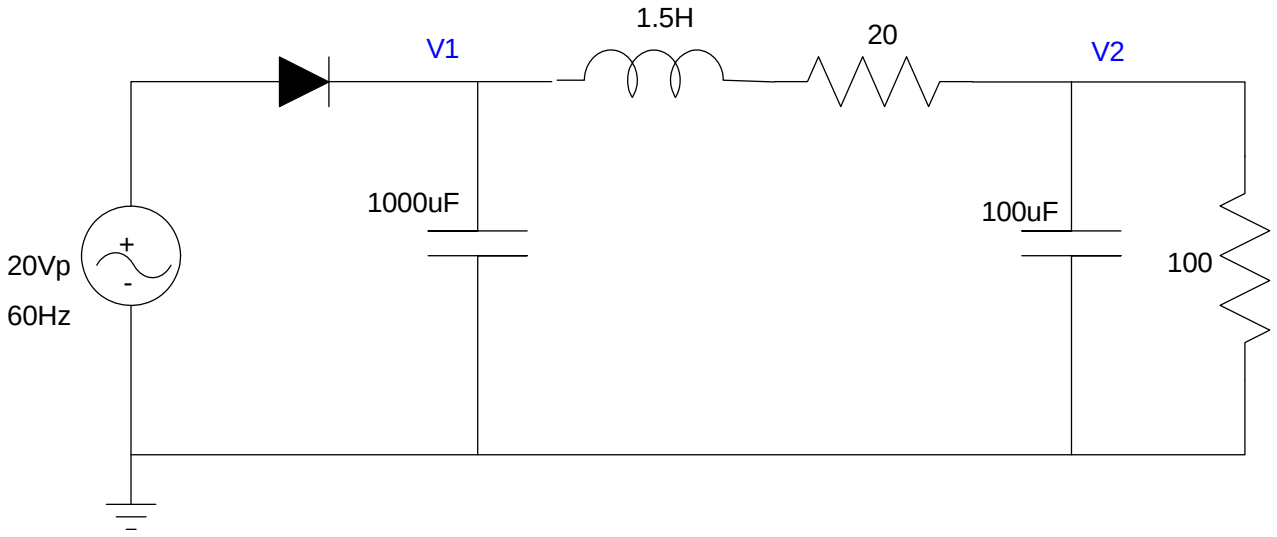
4) Determine the currents through the following min/max circuit. Assume ideal silicon diodes.

I1	I2	I3	I4	I5	I6



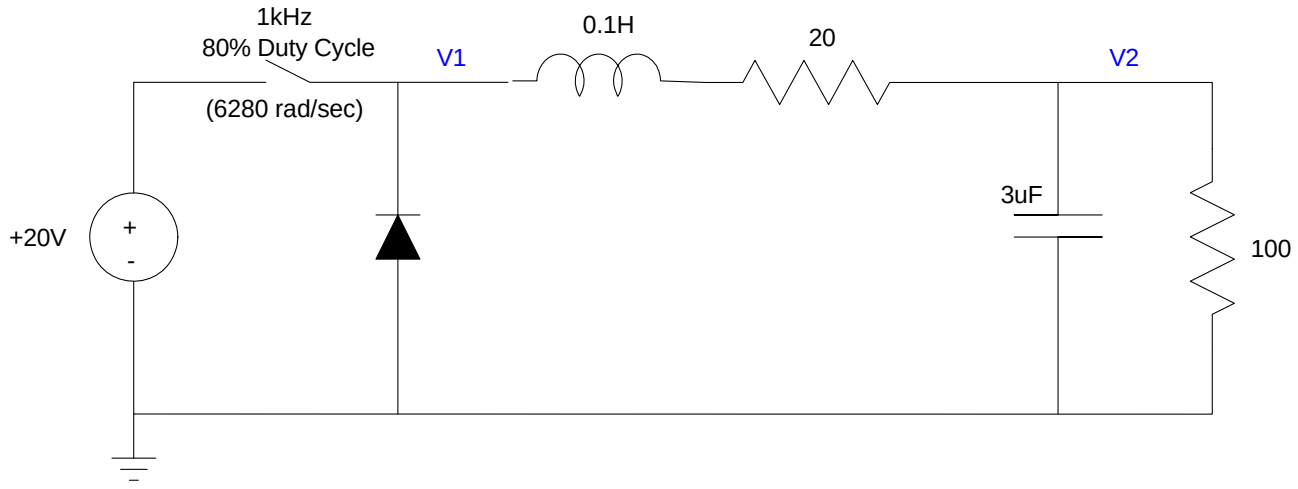
5) For the following AC to DC converter, determine the AC and DC voltages at V1 and V2

V1		V2	
DC (mean(V1))	AC (V1pp)	DC (mean(V2))	AC (V2pp)



6) For the following DC to DC converter, determine the AC and DC voltages at V1 and V2

V1		V2	
DC (mean(V1))	AC (V1pp)	DC (mean(V2))	AC (V2pp)

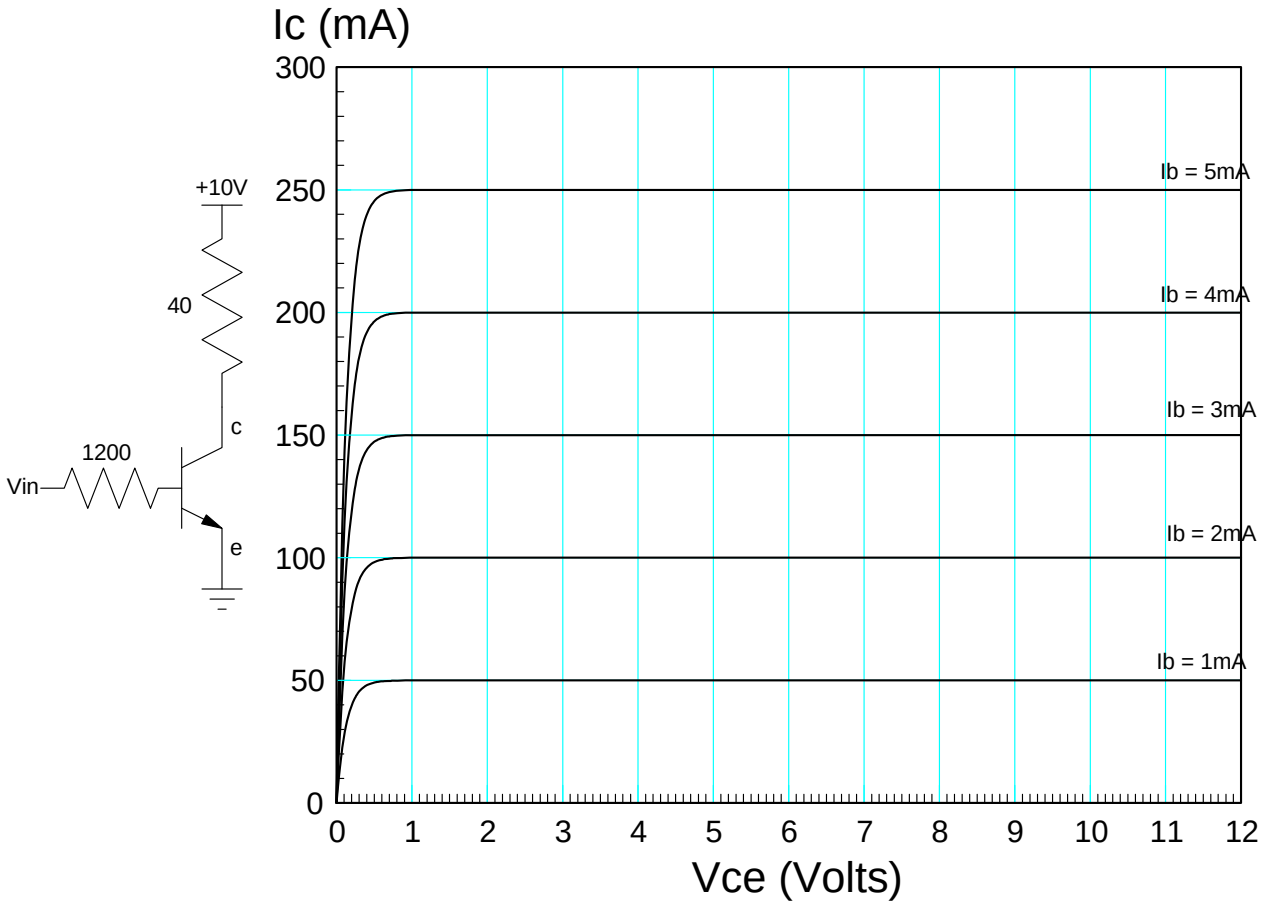


ECE 320 - Final pt 2: Name _____

Transistors and Op-Amps. October 29, 2018

1) Transistor Theory. The VI characteristics for an NPN transistor are shown below. Draw the load-line for the circuit below and determine the Q-point (Vce, Ic) for Vin = 0V, 5V, and 10V.

Load Line	(a) Q-Point for Vin = 0	(b) Q-Point for Vin = 5V	(c) Q-Point for Vin = 10V
show on graph	show on graph	show on graph	show on graph



2) Transistor Switch: An NPN transistor is to turn on and of a 5W LED with a 0V / 5V input:

Input: 0V / 5V DC source capable of driving up to 20mA

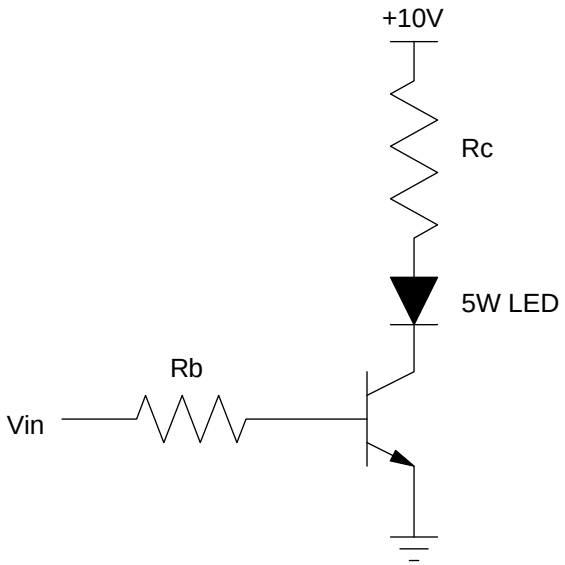
Output: 5W white LED

Relationship:

- Vin = 0V: Id = 0mA
- Vin = 5V: Id = 1.5A

Determine the resistors for the following circuit. Assume an ideal silicon transistor with $\beta = 100$

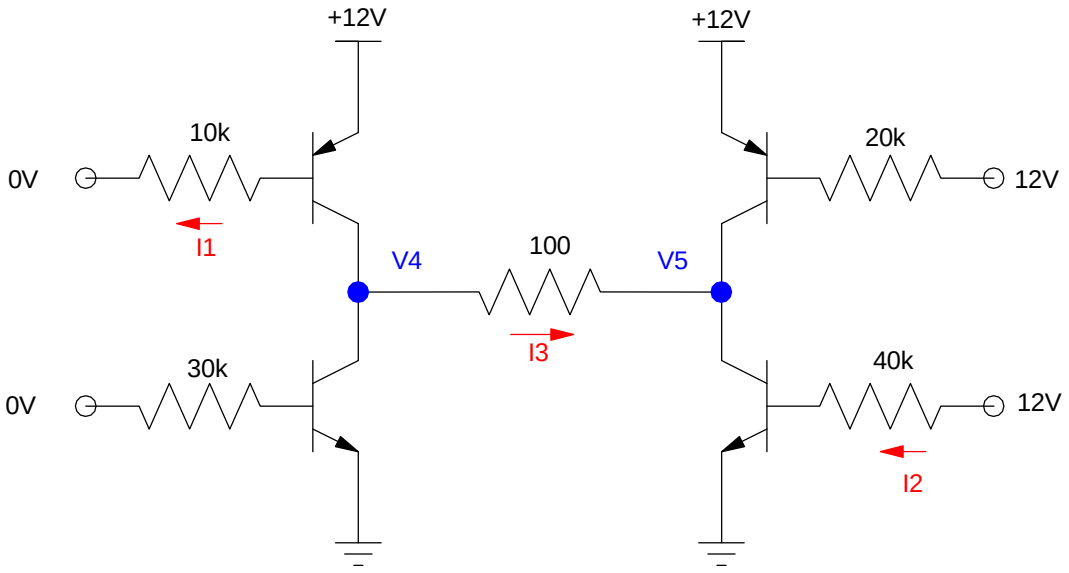
min value of Rb	max value of Rb	Rc



3) H-bridge. Determine the voltages and currents for the following H-bridge. Assume all transistors have

- $|V_{be}| = 0.7V$
- $\beta = 100$
- $\min(|V_{ce}|) = 0.2V$

I1	I2	I3	V4	V5



4) Schmitt Trigger. Design a circuit to turn on an off a DC servo motor based upon temperature:

- The motor turns on when T > 30C (303K)
- The motor turns off when T < 25C (298K)

Assume a thermistor with the characteristics of

$$R = 1000 \cdot \exp\left(\frac{3905}{T} - \frac{3905}{298}\right)\ \Omega$$

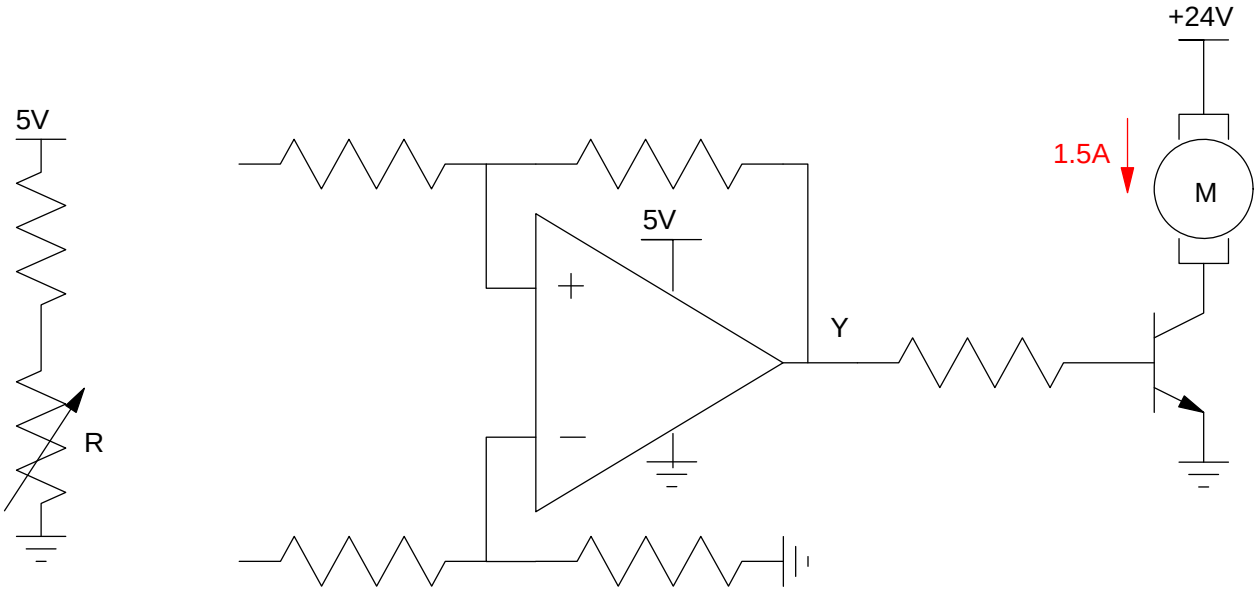
where T is the temperature in degrees Kelvin. Assume

Transistor:

- Vbe = 0.7V
- Vce(sat) = 0.2V
- β = 100

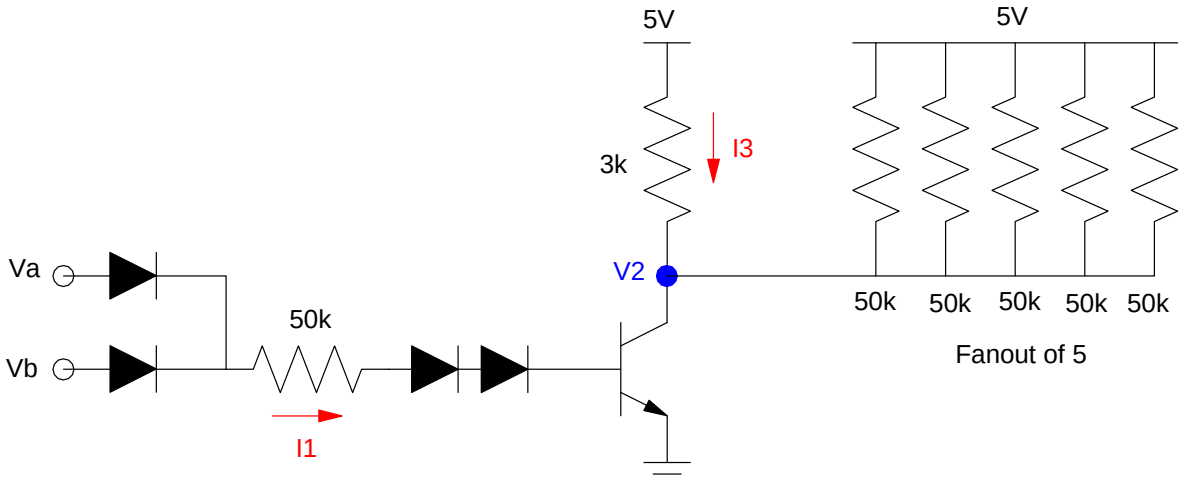
Op-Amp

- rail to rail (output goes 0V to 5V)
- max output = 20mA



5) DTL OR Gate: A DTl NOR gate is connected to five other gates (modeled as five 50k resistors at the output). Determine the logic levels for this gate

Logic Level 0 Range of Va and Vb that result in the transistor being off	**Logic Level 1** Range of Va and Vb that result in the transistor begin saturated.
0 < V < _____	**_____ < V < 5V**



6) Fourier Transforms: A 20% duty cycle, 20Vp, 100Hz square wave drives a circuit. Determine the DC and AC terms (1st harmonic) for this waveform.

DC: $X_0 = \frac{1}{T}\int_0^T x(t) \cdot dt$ AC: $X_1 = \frac{2}{T}\int_0^T x(t) \cdot e^{-j\omega_0 t} \cdot dt$

$$\omega_0 = \frac{2\pi}{T}$$

DC Term Xo (Volts)	AC Term (100Hz component) 2|X1| (Vpp)