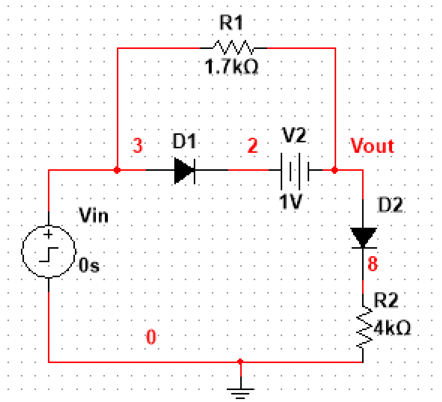
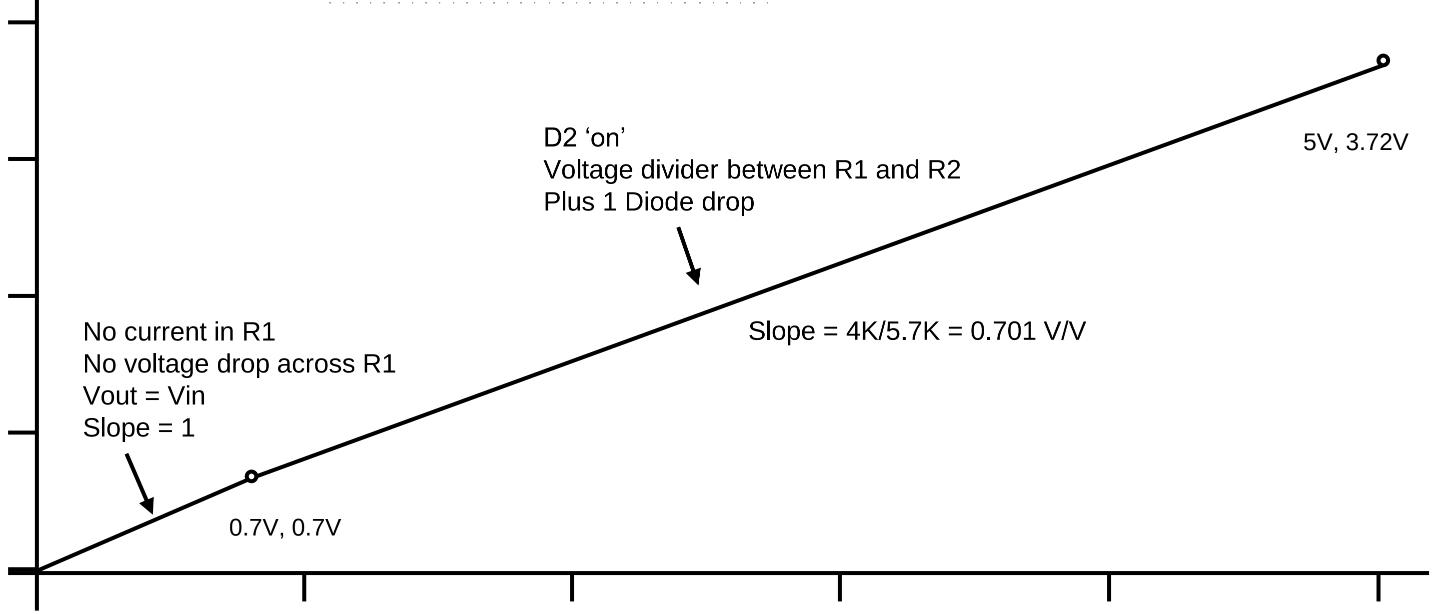
ELE 4142 HW2 Name________________

1 – Sketch out the transfer characteristic of this circuit Vout vs Vin for Vin ranging from 0V to 5V. Assume V_{Don} = 0.7V. Be sure to identify notable voltages and slopes. 20pts





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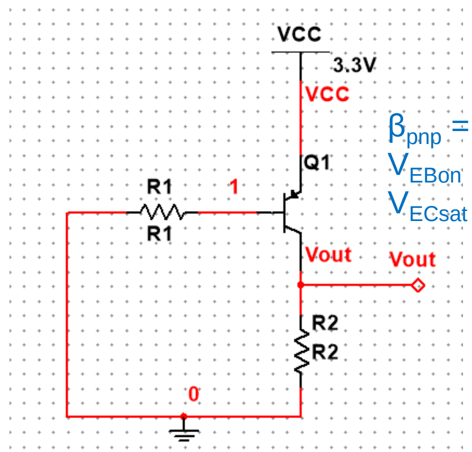
2 – Select values for R1 and R2 in the circuit below. The output voltage should be 1.6V with a < 10% error to loads greater than 15KΩ 20pts



$\beta_{pnp} = 100$
$V_{EBon} = 0.75V$
$V_{ECsat} = 0.25V$

10% error forces R2 || Rload to be between 0.9R2 and 1.1R2
With Rload >= 15K Ω, R2 must be < .111Rload = 1.66KΩ

Choose 1KΩ

$I_C = 1.6V/1K\Omega = 1.6mA$
$I_B = 16uA$
$V_{R1} = 3.3V - 0.75V = 2.55V$
$R1 = V_{R1}/I_B = 159{,}375\Omega$

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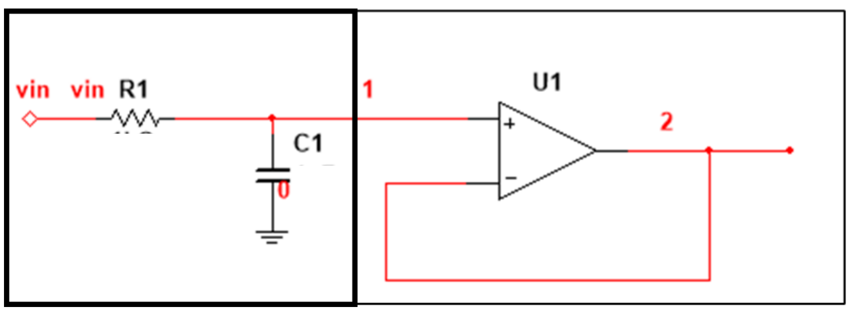
3 – Design a first order active low pass filter with a cutoff frequency of 30KHz and Zin > 20KΩ, use industry standard common components (listed on the website) 30pts

Passive Filter

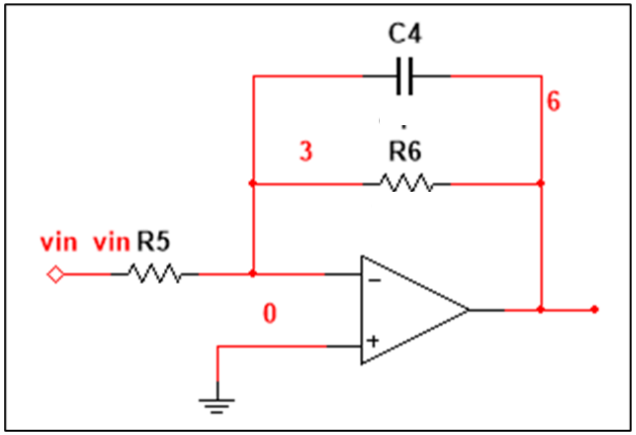


$$f_C = \frac{1}{2\pi RC}$$

$$A = 1$$

$$A_v = \frac{A}{\sqrt{1 + \left(\frac{f}{f_C}\right)^2}}$$

R > 20KΩ → 24KΩ
→ C = 221pF
→ 220pF



$$f_C = \frac{1}{2\pi R_F C}$$

$$A = -\frac{R_F}{R_I}$$

$$A_v = \frac{A}{\sqrt{1 + \left(\frac{f}{f_C}\right)^2}}$$

INVERTING

A = 1
$R_F = R_I$ > 20KΩ → 24KΩ
→ C = 221pF
→ 220pF

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4 – Provide the LSB size for each of the following: 30pts

10bit ADC with Vref = 2.5V

$2.5V / 2^{10}$steps = 2.5V/1024 steps = 2.441mV/step

$2.5V / (2^{10} – 1)$steps = 2.5V/1023 steps = 2.444mV/step

12bit DAC with Vdd = 3.3V

$3.3V / 2^{12}$steps = 3.3V/4096 steps = 805.7uV/step

$3.3V / (2^{12} – 1)$steps = 3.3V/4095 steps = 805.8uV/step

Provide the expected output value (hex) for the 10bit ADC above with Vin = 1.8V

1.8V / 2.441mV/step = 737.40 steps → 737 steps = 10 1110 0001 = 0x2E1

1.8V / 2.444mV/step = 736.49 steps → 736 steps = 10 1110 0000 = 0x2E0

Provide the expected output value (V) for the 12bit DAC above with the input set to 0x7A3

0x7A3 = 0111 1010 0011 = 1955 steps → 1955 steps * 805.7uV/step = 1.575V

0x7A3 = 0111 1010 0011 = 1955 steps → 1955 steps * 805.8uV/step = 1.575V

Briefly describe what Quantization Error is:

e.g for the 10 bit ADC, any input value within a +/- LSB/2 gives the same output so the best we can measure a value is the +/- LSB/2, this is the quantization error