1) Determine the Thevenin equivalent for R1/R2 and the Q-point (Vce, Ic). Assume $\beta = 100$

Vb = Vth	Rb = Rth	Vce	Ic
4.50 V	**93.75k**	**3.89V**	**4.05mA**
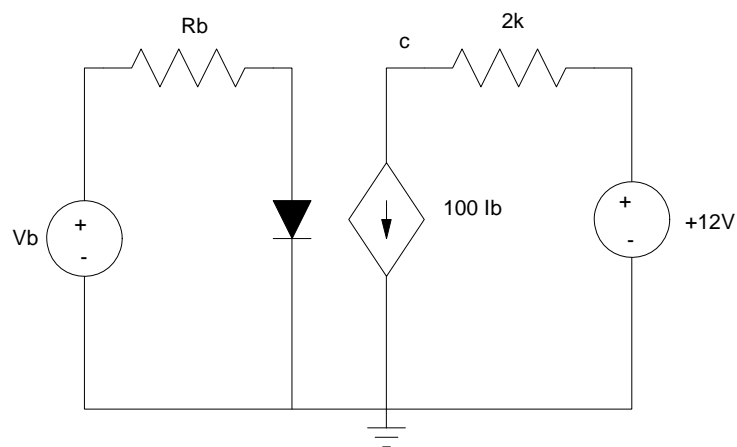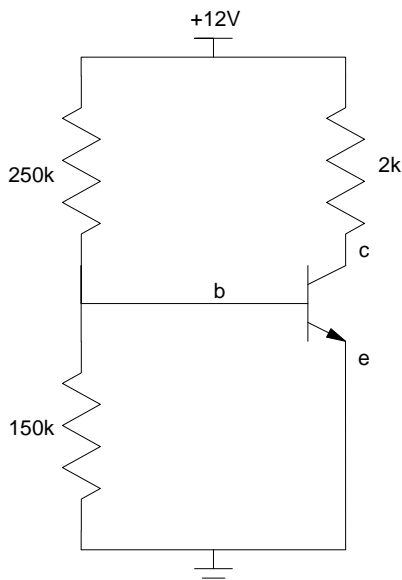
$$V_b = \left(\frac{150k}{150k+250k} \right) 12V = 4.5V$$

$$R_b = 150k || 250k = 93.75k$$

$$I_b = \left(\frac{4.5V - 0.7V}{93.75k} \right) = 40.5 \mu A$$
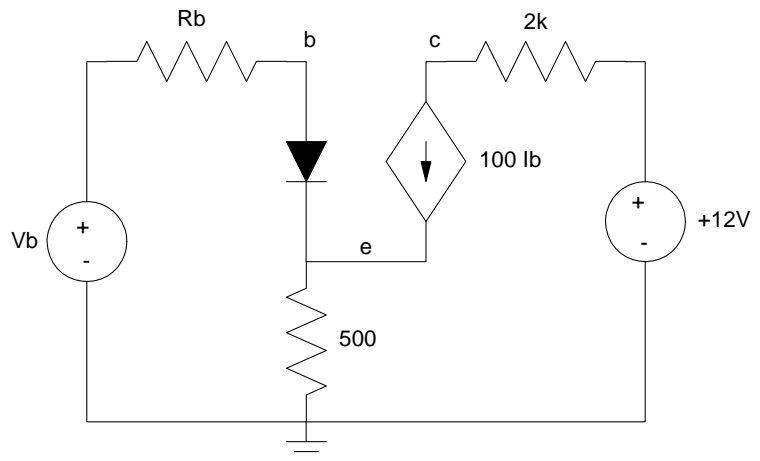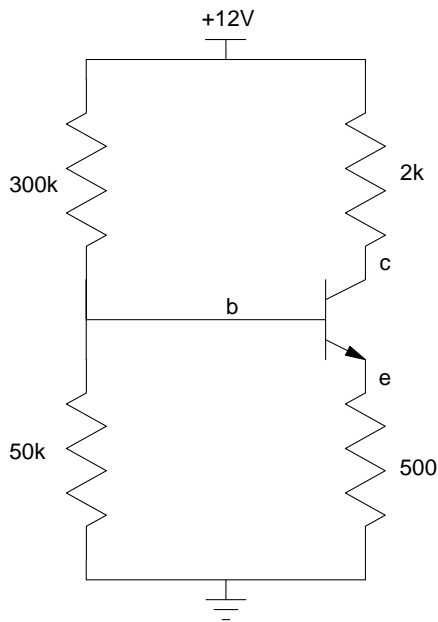
$$I_c = 100 I_b = 4.05mA$$

$$V_c = 12 - 2000 \cdot I_c = 3.89V$$

$$V_e = 0$$

$$V_{ce} = V_c - V_e = 3.89V$$

2) Determine the Thevenin equivalent for R1/R2 and the Q-point (Vce, Ic). Assume $\beta = 100$

Vb = Vth	Rb = Rth	Vce	Ic
1.714V	**42.86k**	**9.278V**	**1.086mA**

$$V_b = \left(\frac{50k}{50k+300k}\right) 12V = 1.714V$$

$$R_b = 50k||300k = 42.86k$$

$$I_b = \left(\frac{1.714V - 0.7V}{42.86k + 101 \cdot 500}\right) = 10.86\mu A$$

$$I_c = 100 I_b = 1.086mA$$

$$V_c = 12 - 2000 \cdot I_c = 9.827V$$
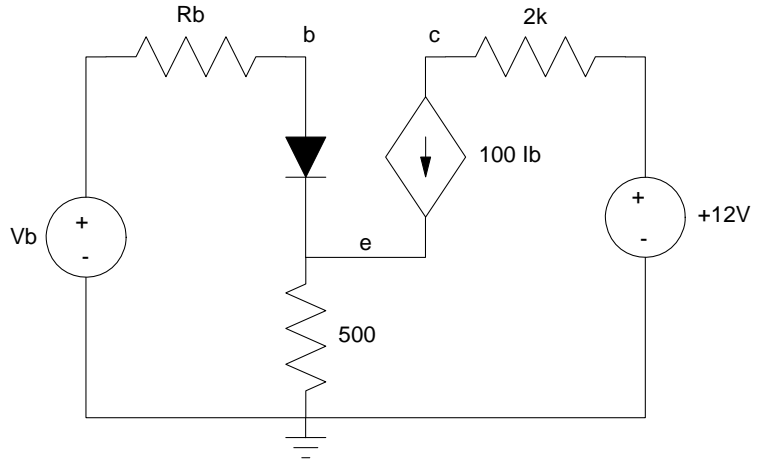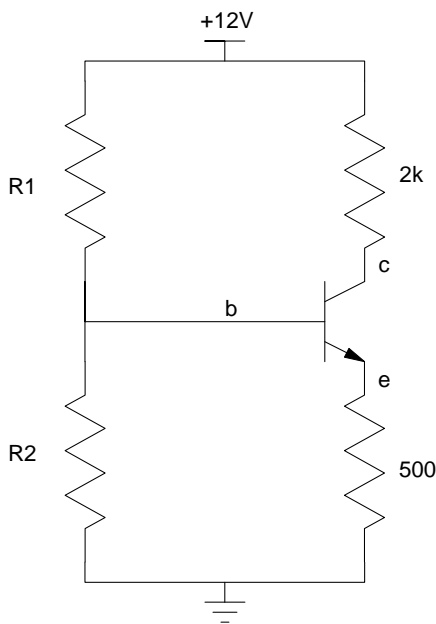$$V_e = (I_b + I_c)500 = 0.548V$$

$$V_{ce} = V_c - V_e = 9.278V$$

3) Design a circuit so that the Q-point is

- Stabilized for variations in β (meaning $(1 + \beta)R_e \gg R_b$)
- Vce = 6.0V

Assume $\beta = 100$

R1	R2	Vb	Rb
29.57k	**6.018k**	**2.029V**	**5k**
			anything $\ll 50.5k$ Vb, R1, R2 depend upon what you pick for Rb

$$(1 + \beta)R_e \gg R_b$$

$$R_b \ll 50.5k$$

Let Rb = 5k

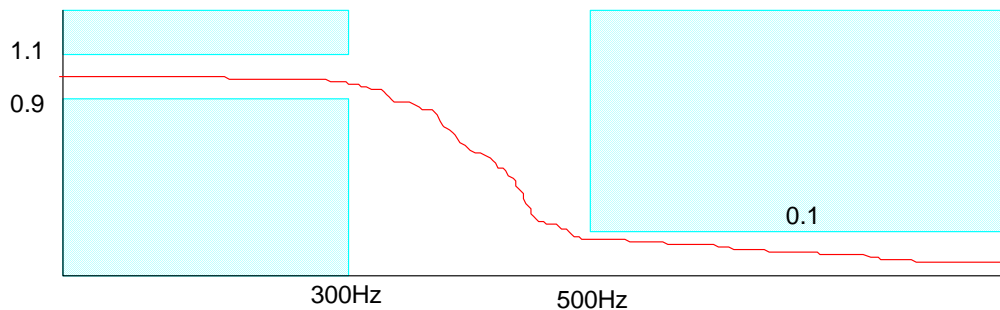$$I_c = \left(\frac{12V-6V}{2k+1.01\cdot500}\right) = 2.395mA$$

$$I_b = I_c/100 = 23.95\mu A$$

$$V_b = R_b I_b + 0.7 + (I_b + I_c)500 = 2.029V$$

$$\left(\frac{R_2}{R_1+R_2}\right)12V = 2.029V \qquad R_1||R_2 = 5k$$

4) Filter Requirements: A low pass filter is to have a gain:
- In-between 1.1 and 0.9 over the range of 0 .. 300Hz, and
- Less than 0.1 for frequencies between 500Hz and 2000 Hz.

a) Determine N, the number of poles this filter must have to meet these requirements, and

b) Give the transfer function for a Nth-order Butterworth filter with
- A DC gain of 1.000 and
- A corner frequency of 300Hz

N # of poles	G(s)
5	$\left(\dfrac{(600\pi)^5}{(s+600\pi)\left(s+600\pi\angle\pm36^0\right)(s+600\pi\angle\pm72^0)} \right)$

Number of Poles

$$\left(\frac{300}{500}\right)^N = 0.1$$

$$N = 4.5076$$

round up to N = 5

Angle between poles = $\dfrac{180^0}{N} = 36^0$

300Hz = 600π rad/sec

5) Assume you have a 3rd-order Butterworth filter with a corner frequency of 1 rad/sec (0.16Hz). Find y(t) if x(t) has a 1 rad/sec and 2 rad/sec component:

$$Y = \left(\frac{1}{(s+1)(s^2+s+1)}\right)X = \left(\frac{1}{s^3+2s^2+2s+1}\right)X$$

$$x(t) = 3\sin(t) + 4\sin(2t)$$

$$\boxed{y = 2.121\sin(t - 135^0) + 0.496\sin(2t + 150^0)}$$

x(t) = 3 sin(t)

$$s = j$$

$$\left(\frac{1}{s^3+2s^2+2s+1}\right)_{s=j} = 0.707\angle -135^0$$

$$y = (0.707\angle -135^0)\cdot 3\sin(t)$$

$$y = 2.121\sin(t - 135^0)$$

x(t) = 4 sin(2t)

$$s = j2$$

$$\left(\frac{1}{s^3+2s^2+2s+1}\right)_{s=j2} = 0.124\angle 150^0$$

$$y = (0.124\angle 150^0)\cdot 4\sin(2t)$$

$$y = 0.496\sin(2t + 150^0)$$

Inheritance Tax Trivia!!! In your opinion, should there be an inheritance tax (a.k.a. death tax)? Why or why not?

Pro Inheritance Tax (4 votes):

(Libertarian argument: Ron Paul): The government's job is to assure a level playing field so that everyone has a chance to succeed. Allowing money to accumulate within a family for generations creates an aristocracy - a system where your place is determined by your birthright, not your abilities. That's not what America stands for. The inheritance tax is one tool to prevent too much wealth from accumulating in a few families, preventing the rise of an aristocracy.

(Philanthropy Argument: Bill Gates & Andrew Carnegie): The greatest sin a person can commit is to die rich. Before you die, do some good with the money you earned. Start a school. Cure a disease. Build a library. If you can't think of anything, then give it to the government and they'll find something to do with it. (The inheritance tax is completely voluntary: it you don't want to pay it, don't die rich.)

(Capitalism Argument: Robert Reich): Too much wealth inequality is harmful to the economy. At present, the wealthiest 85 people in the U.S. have more assets than the poorest 150 million. That's greater wealth inequality than at any time in the past, more than even Apartheid South Africa had in its hay day, more than Victorian England had with its aristocracy. For an economy that's based upon consumerism, that just doesn't work: 85 people just don't buy as much as 150 million people. For a viable economy, you have to have a middle class. To have a viable middle class, you have to limit the wealth that accumulates into the hands of just a few people. The inheritance tax prevents too much wealth from accumulating over generations.

Anti-Inheritance Tax (21 votes):

Fairness: The money was already taxed once. It shouldn't be taxed again.

Humanity: The family already lost a loved one. It's unkind to pile a tax on top of the hardship they're facing.

Fairness (take 2): It doesn't make sense to penalize someone for dying: it's something everyone does.