Write your name at the top right corner of every page (including this cover page and any extra pages).

Copy everything you want counted towards your grade onto the pages that I provided. Use the extra pages I provide if necessary.

Write with a pen that cannot be erased!

No books and none of your own calculators are allowed! Use the calculators that we provide.

Write down all the steps that lead to your result. If we cannot see how you arrived at the result, no points will be awarded.

Clearly identify all variables that you may introduce in the circuit diagrams.

Read all the problems before you start so that you can begin with those that seem easiest to you.

The last problem is for the 6610 students only. Should students from 3610 attempt to solve the problem, points they gain may be used to proportionally replace the lowest scoring problem in their main section. In other words: Should a 3610 student get 100% on the last problem but e.g. a lowest score of only 50% on the first problem, the complete score for that student will be calculated with 100% of the points for the first problem replacing the actually achieved 50% of points on the respective first problem.
Students from 3610 are not required to do the last problem!

Problem 1 (9 pts):

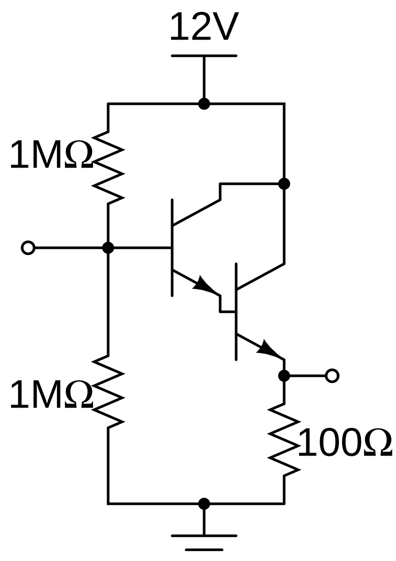
Draw the straight line approximation Bode plot (magnitude and phase) for the following transfer function:

$$H = \frac{s+5}{(s+10)(s+100)}$$

(continuation of problem 1)

Problem 2 (9 pts):

The circuit below is shows a so-called Darlington transistor. It is made of two transistors typically on a single piece of silicon. Find the base current into the first transistor's base and the current through the 100Ω resistor if both transistors have $\beta = 100$.



(continuation of problem 2)

Problem 3 (7 pts):

Disregarding the inverted active region, there are three operation regimes for the BJT: active, saturated, and cut-off. In the table below you will find characteristics of BJT operation as they correspond to the large signal model we discussed. Please mark the correct correspondence between characteristic and operating regime by placing a cross in the right column for each of the characteristics. Only one cross per characteristic please:

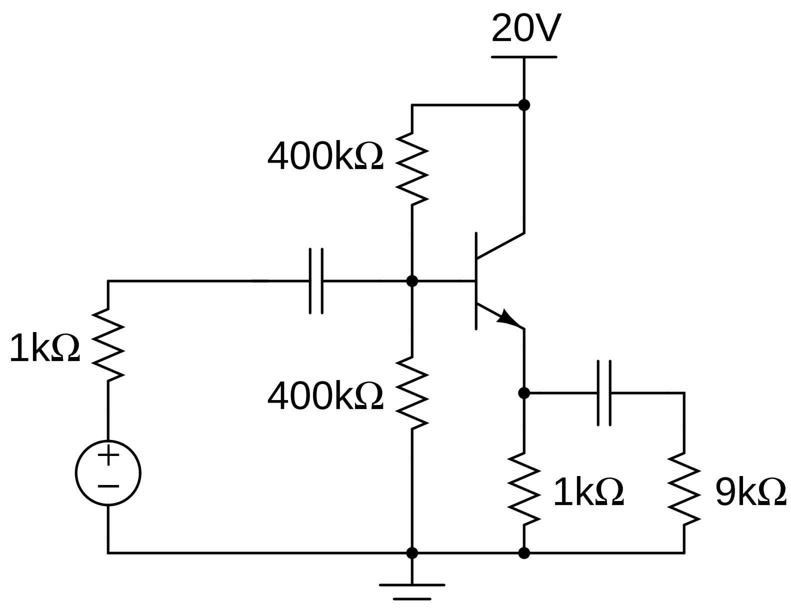
	active	saturated (ON)	cut-off (OFF)
$i_C = \beta i_B$			
$v_{BE} < 0.5$V			
$v_{CE} \approx 0.2V$			
$v_{BE} \approx 0.7$V			
$i_C = i_B = i_E = 0$			
$v_{BE} \approx 0.8V$			
$\beta i_B \geq i_C$			

Problem 4 (6 pts):

Draw the two small signal equivalent circuits for a npn-transistor; the one involving r_π and the one involving r_e. Draw the r_π circuit also for the pnp transistor. Remember that a dependent source needs to be labelled as to what it depends on and how it depends on it. In all diagrams: Please label your three terminals (B,C,E) and the resistors with the right subscript (π,e)!

Problem 5 (9 pts):

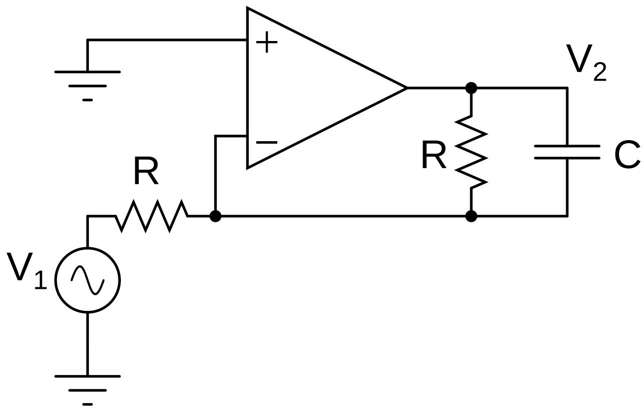
For the circuit shown below: Draw the ac-equivalent circuit with the small signal BJT equivalent circuit replacing the BJT (use the r_e version). Given that I_{CQ}=3.09 mA, what is r_e ($V_T = 26$ mV)? Given that $h_{fe} = 100$, what is $A_v = \frac{v_e}{v_b}$



(continuation of problem 5)

Problem 6 (6610 only; 9 pts):

For the op-amp circuit below sketch the amplitude response $\frac{V_2}{V_1}$ by means of its high and low frequency asymptotes and calculating values of the amplitude at $\omega = \frac{1}{RC}$ as well as for frequencies one decade below and above that point.



(continuation of problem 6)