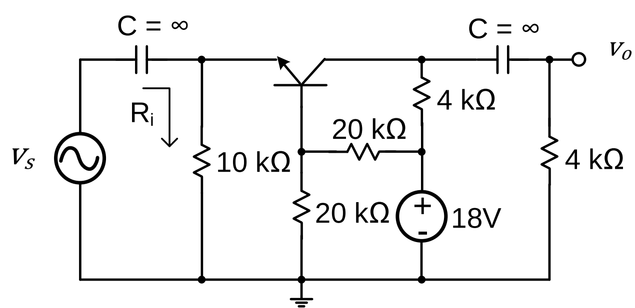
EECE 2412 – Homework 7 – Fall 2018

Due: Wednesday, November 7, 2018

1) Problem 4.49 on page 284 in the textbook (Allan R. Hambley, Electronics, 2nd edition, Prentice Hall, 1999).

2) Problem 4.58 on page 285 of the textbook.

3) Consider the amplifier shown below.
   a) Find the small-signal voltage gain (an equation and the value) $A_{vs} = v_o / v_s$ for the circuit below using the hybrid-π transistor model (with r_π and g_m). Assume $\beta = 250$, $V_T = 26mV$, $r_{ce} = \infty$, $V_{BE} = 0.7V$ if the transistor is in active mode, and ($V_{BE} = 0.7$ V, $V_{CE} = 0.2V$) if the transistor is in saturation mode. Note: You have to perform DC analysis and AC analysis to solve this problem.
   b) Find an equation for the input resistance (R_{in}) that is seen directly at the terminal of the source v_s, using the hybrid-π transistor model (with r_π and g_m). Calculate the value of R_{in} with the given component values.



4) Set up the circuit from Problem 3) in PSPICE using the Q2N2222 BJT model and C = 50µF.
   a. Run a DC simulation to verify that the BJT is operating in active mode. Inspect the DC operating point information of the BJT (as in homework 6), and record the transconductance parameter (GM). Compare the AC voltage gain with that in problem 3), and explain the cause(s) of the difference(s) if there are any significant deviations. Submit a print-out of the schematic in which the DC voltages and currents are displayed. Also print the DC operating point information of the BJT.
   b. Run an AC simulation from 1Hz to 100MHz using a logarithmic sweep with 20 points per decade. Plot the AC voltage gain (v_o/v_s) in dB-scale vs. frequency. Label the midband frequency gain (in dB) and the 3-dB frequencies (low corner frequency and high corner frequency) in the plot before printing it out for submission. What is the midband voltage gain as a ratio (not in dB)?
   c. Set up a transient simulation with a sinusoidal input at 1kHz that has a 2mV amplitude. Use a 10µs max. time step and a simulation time of 5ms. Plot the input and output signals vs. time, and mark the peak amplitudes in the plots. What is the gain based on the transient simulation? Does it agree with the AC gain in part b)?
   d. Increase the input signal amplitude to 150mV and repeat the transient simulation. Plot the output signal. Can you notice the distortion? Which condition is not satisfied? (What causes the distortion)?
   e. Add another capacitor (C = 50µF) in the schematic of the circuit, connecting it between the base of the BJT and ground. Repeat the AC simulation with the same range as in part b, and compare your new voltage gain with the analytical expectation based on the equation in problem 3). Label

the midband frequency gain (in dB) and the 3-dB frequencies (low corner frequency and high corner frequency) in the plot before printing it out for submission. What is the midband voltage gain as a ratio (not in dB)? Repeat the transient simulation as in part c) with the added capacitor, and submit a plot of the output voltage vs. time in which the peak amplitude is labeled. What is the gain based on the transient simulation?