

Principles of Electronics Design (521431A)
Exam 12/19/2006

1. a) Use operational amplifiers to design a circuit that sums two input signals. The phase of the output signal should be same as the phase of the input signal. (Total gain is positive.) You have no more than two operational amplifiers. Mark all components using individual symbols. (2p)
b) Find the output voltage of your design in terms of the input voltages. (Use the same symbols as in part a.) (2p)
c) Choose component values so that the gain from the first input to the output is 5 and from the second input is 10. The input impedance of both inputs should not be lower than 5 k Ω . (2p)
2. The common-emitter BJT amplifier is shown in Fig. 1. The BJT's $\beta=100$.
 - a) Redraw the circuit using equivalent models for DC and small AC signal cases. (2p)
 - b) Calculate the input and the output impedance. (1p)
 - c) Calculate the gain from the input to the output (u_o/u_i). (1p)
 - d) Sketch the signals in points x and y in the same figure. Pay attention to the correct phase of the signals. (What is the sign of the signal.) The amplitude of the AC input signal is 10 mV and frequency is 1 kHz. (1p)
 - e) What is the small modification that increases the gain of the circuit but would not change the DC operation point? (1p)

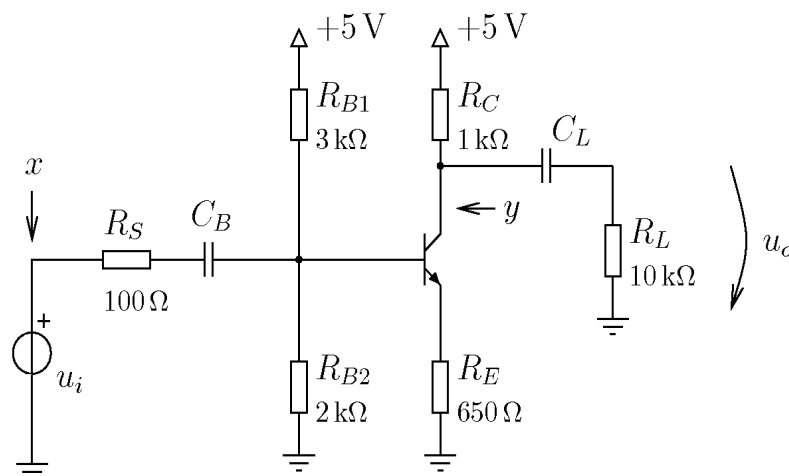


Figure 1. Circuit of problem 2.

3. AD and DA converters. Choose one AD and one DA converter topology, draw their block diagrams and explain their principles of operation. What does quantization mean and how does it relate to the signal-to-noise ratio at the output of a converter? How does the S/H circuit operate and why is it needed? (6p)

4. The structure and use of the MOS transistor. Explain briefly the operating principle of the MOS transistor. What does the operating regions of the MOS transistor mean (i.e. triode and saturation regions)? How do you select the operating region, if you are using a MOS transistor in an amplifier application? How do you select the operating region of a MOS transistor used as a switch? How would you realize the Boolean function $Y = \overline{AB}$ and a current mirror with MOS transistors? (6p)