

Principles of Electronics Design 521431A

Exam 04/08/2008

1. You are provided with an ideal op amp and resistors. Design a circuit that
 - (a) amplifies the input signal u_i to provide an output $u_{\text{out}} = -11 \cdot u_{\text{in}}$, (1p)
 - (b) amplifies the input signal u_i to provide an output $u_{\text{out}} = 6 \cdot u_{\text{in}}$, (1p)
 - (c) sums the input signals u_{i1} and u_{i2} to provide an output $u_{\text{out}} = -5 \cdot (u_{i1} + u_{i2})$, (1p)
 - (d) subtracts the input signals u_{i1} and u_{i2} to provide an output $u_{\text{out}} = 10 \cdot (u_{i2} - u_{i1})$. (1p)
 - (e) What is the input resistance of the circuit a) ? (1p)
 - (f) What is the input resistance of the circuit b)? (1p)

2. The following problems are related on Figure 1:
 - (a) Find the emitter current at operation point. (1p)
 - (b) Draw a small-signal equivalent model of the circuit and mark nodes A and B on the model. (1p)
 - (c) Use a test voltage (u_A) at node A to find the input resistance of the amplifier. (1p)
 - (d) Use a test voltage (u_B) at node B to find the output resistance of the amplifier. (1p)
 - (e) Find the gain from A to B (u_B/u_A). (1p)
 - (f) Find the overall gain u_B/u_{src} . (1p)

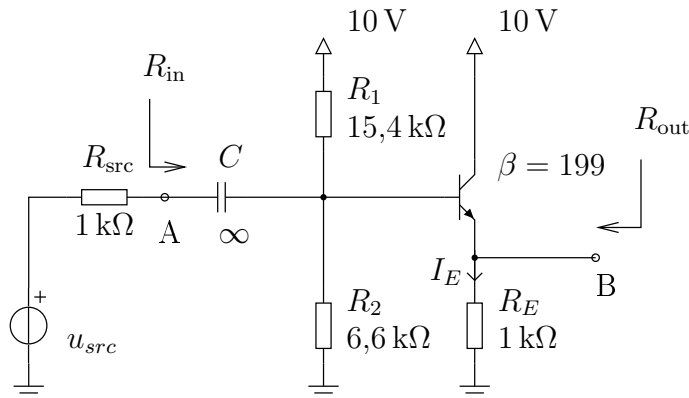


Figure 1: Figure for question 2.

3. (a) Draw the typical I_D - V_{DS} -curves of a NMOS-fet, name the different operation regions and describe, in which regions the transistor operates as a switch or an amplifier, for example. (2p)
- (b) Draw the small signal models of a NMOS-fet (2 pc.) (2p)
- (c) What does mean the "channel length modulation" and how is it included in the small signal model? (2p)
4. (a) Describe the structure of a CMOS inverter and draw the characteristic curve of it (V_{in} - V_{out}) and the operation in different regions. (2p)
- (b) What is the purpose of the schematic in Fig. 2 and what are the typical applications? (2p)
- (c) What does mean the "quantization noise" of a A/D-converter and how much is the rms-value of it? (2p)

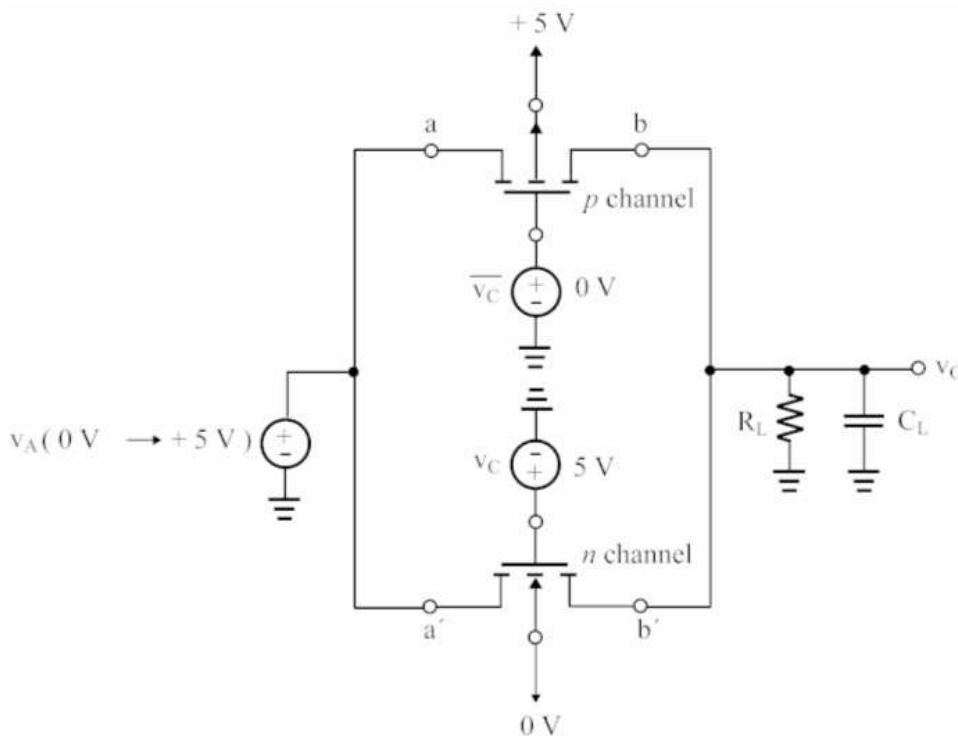


Figure 2: Figure for question 4 b).