EE1101: Circuits and Network Analysis

Assignment - 02[1]

Handed out: 16 - Aug - 2024 **Due : 26 - Aug - 2024 (before 5 PM)**

Instructions :

1. Please upload your assignment solutions to the course page on the Canvas platform. Only solutions submitted through this page will be reviewed. For specific guidelines, refer to the instructions provided on the course page.
2. Submissions received after the deadline will attract negative marking.
3. It is suggested that you attempt all the problems. However, it is sufficient to submit solutions for problems that total 10 points.
4. Ensure that your submissions are named in the following format: RollNo-Assignment-02.pdf.

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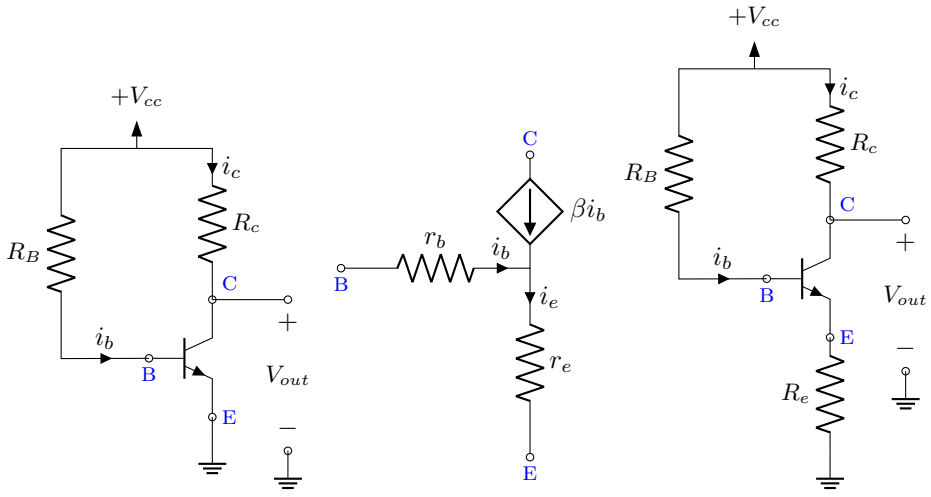
1. (4 points) Consider the BJT circuit shown in Fig. 1(a). Using the equivalent circuit shown in Fig. 1(b), derive an expression for i_b, i_c and V_{out}.



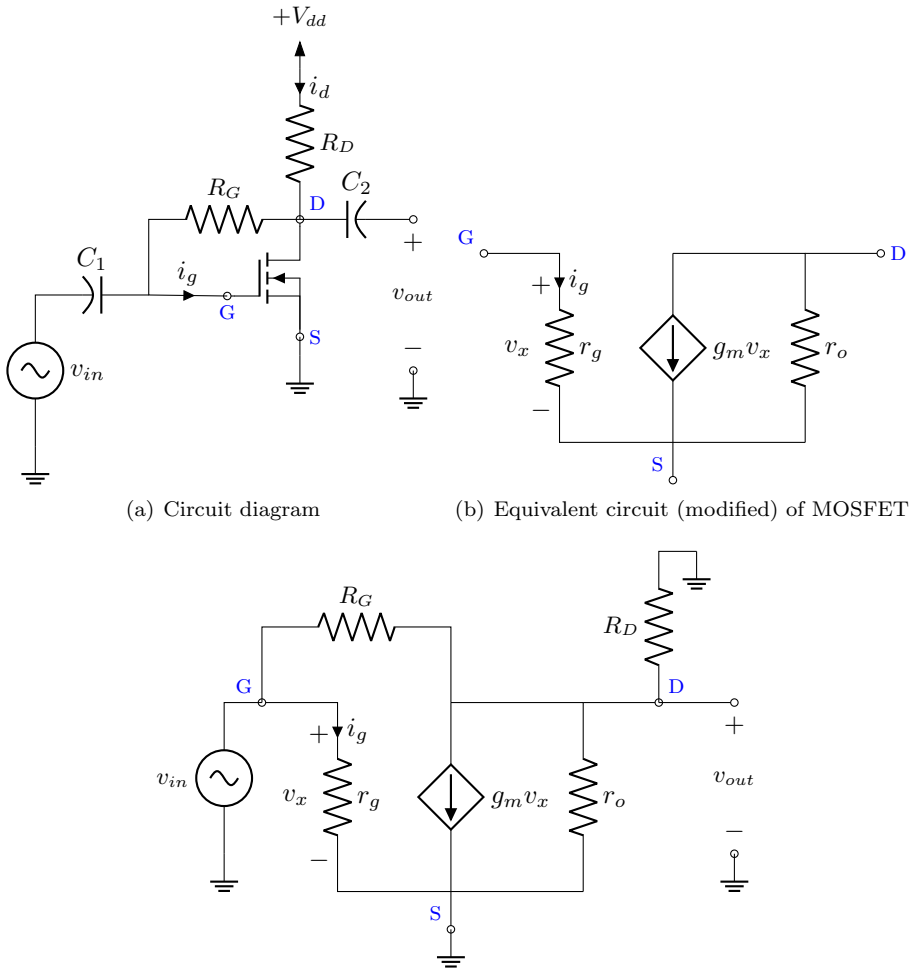
(a) Circuit 1 (b) Equivalent circuit (slightly modified) of BJT (c) Circuit 2

Fig. 1: Circuits with BJT (Questions 1 and 2)

2. (4 points) Consider the BJT circuit shown in Fig. 1(c). Using the equivalent circuit shown in Fig. 1(b), derive an expression for i_b, i_c and V_{out}.

[1]Some of the circuits in this assignment are commonly known as DC biasing circuits. For the purposes of this course, you only need to solve these circuits by applying the equivalent circuits for semiconductor devices. More detailed information will be covered in future courses. You will find some of the problems in this assignment and similar ones in standard textbooks on electronic devices and circuits. Try solving these problems using the equivalent circuits and the relevant approximations.

3. (4 points) The MOSFET circuit shown in Fig. 2(a) is the common source amplifier with a feedback resistor. The small signal equivalent circuit shown in Fig. 2(b). The small signal equivalent circuit of the common source amplifier (wherein the MOSFET is replaced by its small signal equivalent circuit, capacitors are shorted and so are the DC supplies) is shown in Fig. 2(c)[2]. For the circuit shown in Fig. 2(c), derive an expression for v_{out} considering $r_g \to \infty$.



(a) Circuit diagram

(b) Equivalent circuit (modified) of MOSFET

(c) Circuit for small signal analysis

Fig. 2: MOSFET-based Amplifier (Question 3)

4. (4 points) The MOSFET circuit shown in Fig. 3(a) is the common source amplifier. The small signal equivalent circuit shown in Fig. 3(b). The small signal equivalent circuit of the common source amplifier (wherein the MOSFET is replaced by its small signal equivalent circuit, capacitors are shorted and so are the DC supplies) is shown in Fig. 3(c)[3]. For the circuit shown in Fig. 3(c), derive an expression for v_{out} considering $r_g \to \infty$.

5. (8 points) Consider the Op-Amp circuit (slightly hypothetical in nature) shown in Fig. 4(b). Using the equivalent circuit shown in Fig. 4(a), derive

[2]For the purpose of analysis, it might better to redraw the circuit identifying nodes at the same potential
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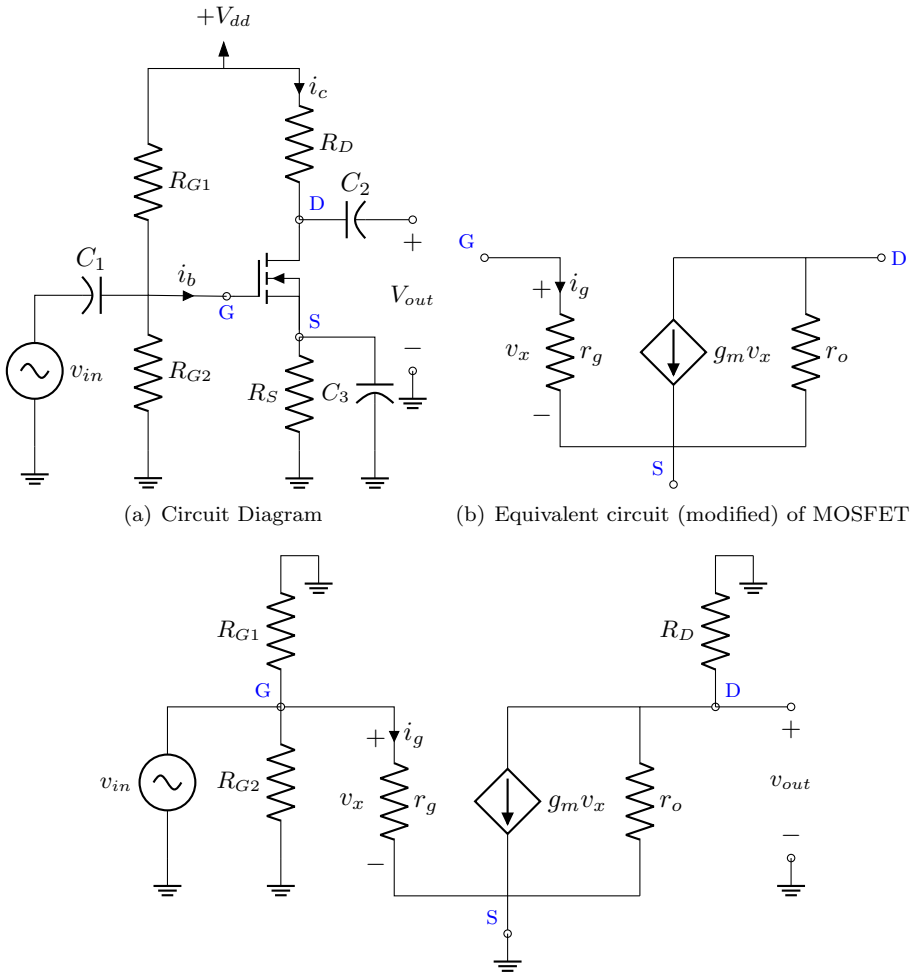
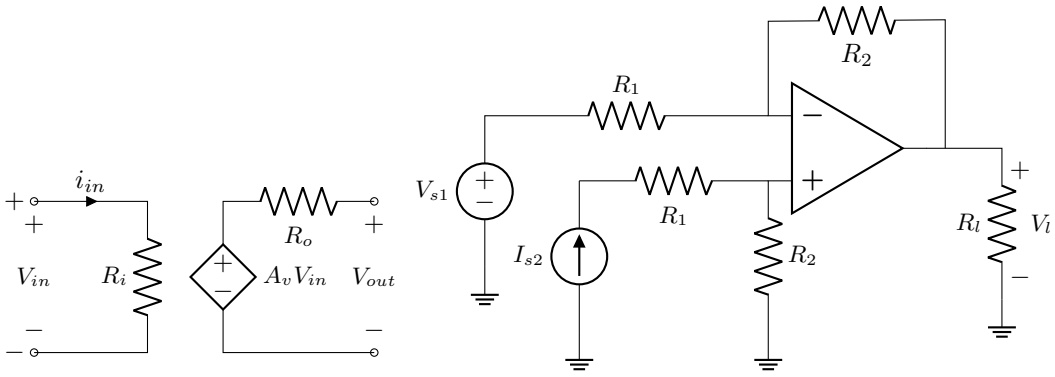


(a) Circuit Diagram (b) Equivalent circuit (modified) of MOSFET

(c) Circuit for small signal analysis

Fig. 3: MOSFET-based Amplifier (Question 4)



(a) Equivalent circuit of an op-amp (b) op-amp circuit for analysis

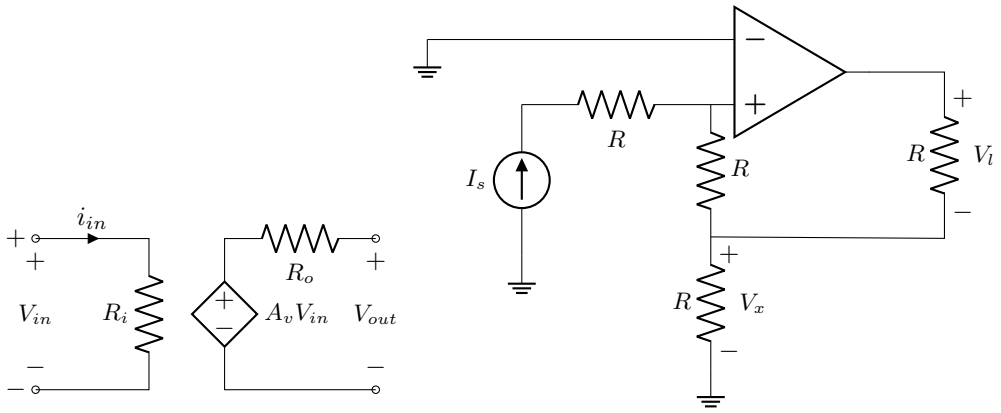
Fig. 4: Circuits with operational amplifier (Question 5)

(a) (4 points) an expression for V_{out}, without assuming the Op-Amp is ideal.

(b) (4 points) an expression for V_{out} assuming the Op-Amp is ideal (i.e., gain $A_v \to \infty$, input resistance $R_i \to \infty$

and output resistance $R_o \to 0$).

6. (8 points) Consider the Op-Amp circuit (slightly hypothetical in nature) shown in Fig. 5(b). Using the equivalent circuit shown in Fig. 5(a), derive



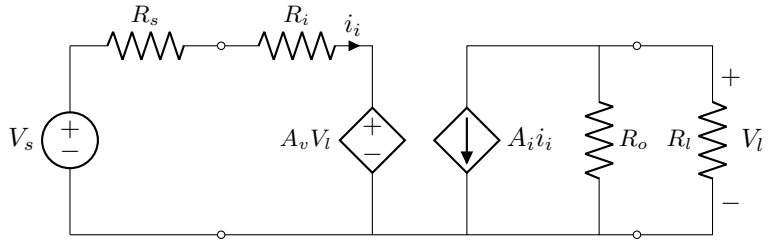
(a) Equivalent circuit of an op-amp (b) op-amp circuit for analysis

Fig. 5: Circuits with operational amplifier (Question 6)

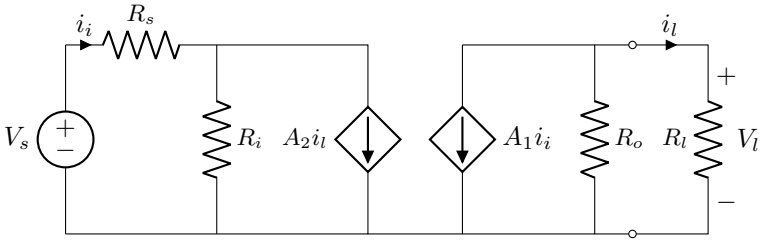
(a) (4 points) an expression for V_{out}/V_x, without assuming the Op-Amp is ideal.

(b) (4 points) an expression for V_{out}/V_x assuming the Op-Amp is ideal (i.e., gain $A_v \to \infty$, input resistance $R_i \to \infty$ and output resistance $R_o \to 0$).

7. (8 points) For the circuits shown in Fig. 6, derive an expression for voltage V_l.



(a) circuit 1



(b) circuit 2

Fig. 6: Circuits for Question 7