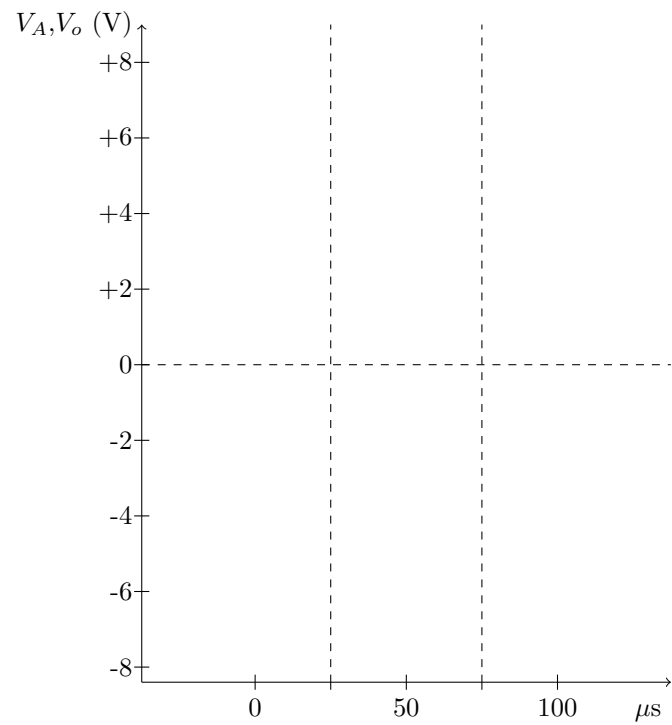
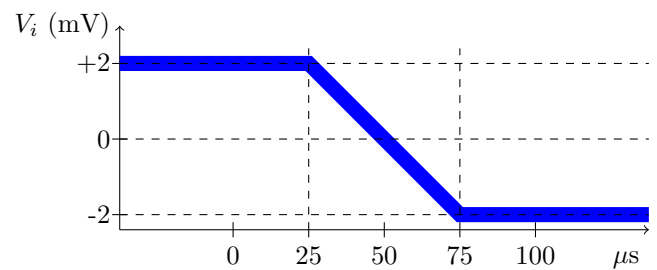
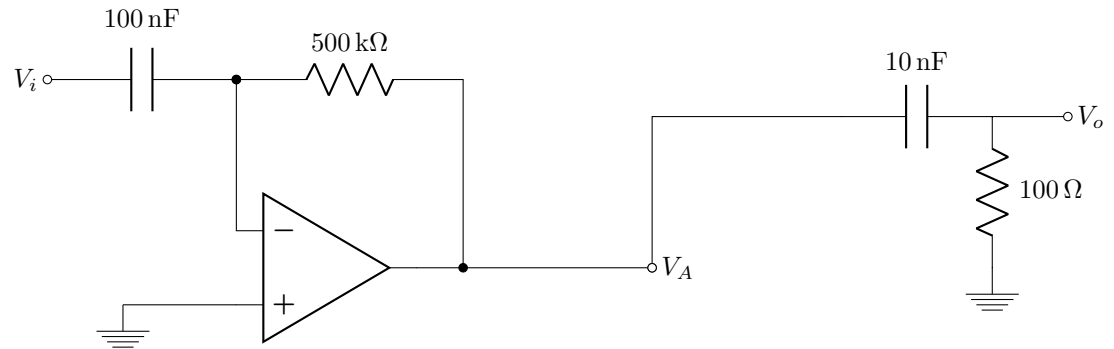


Instructions:

- This quiz lasts 30 minutes. Answer all questions (on both sides of the sheet)
- You may have a 8.5" × 11" sheet of notes and a non-network-connected calculator

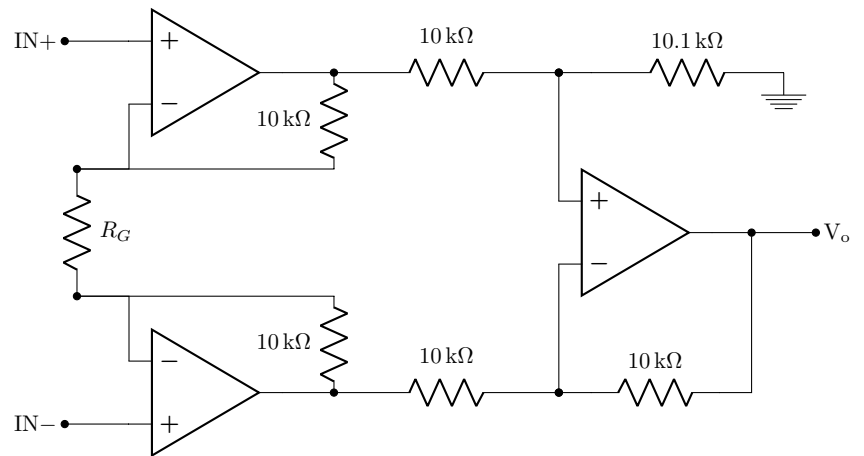
Q1a: Op amps are ideal, with power supply,  $V_{EE} = -15\text{ V}$  and  $V_{CC} = 15\text{ V}$ . At  $t = 0$  there is no change on capacitors.

- (5 marks) When  $V_i$  is as shown below, **sketch the output**,  $V_A$ , on the lower graph. Indicate voltage levels.
- (5 marks) **Sketch the output**,  $V_o$ , on the same graph. Indicate voltage levels (to within 1% accuracy) and calculate any time-constants.



Q2a: Consider the following instrumentation amplifier:

- (a) (5 marks) Initially all resistors except  $R_G$  are  $10\text{ k}\Omega$ . Calculate  $R_G$  so that the differential gain ( $A_d$ ) is 100.  
(b) (5 marks) Calculate the common-mode gain ( $A_{cm}$ ) when the resistor values are as shown.

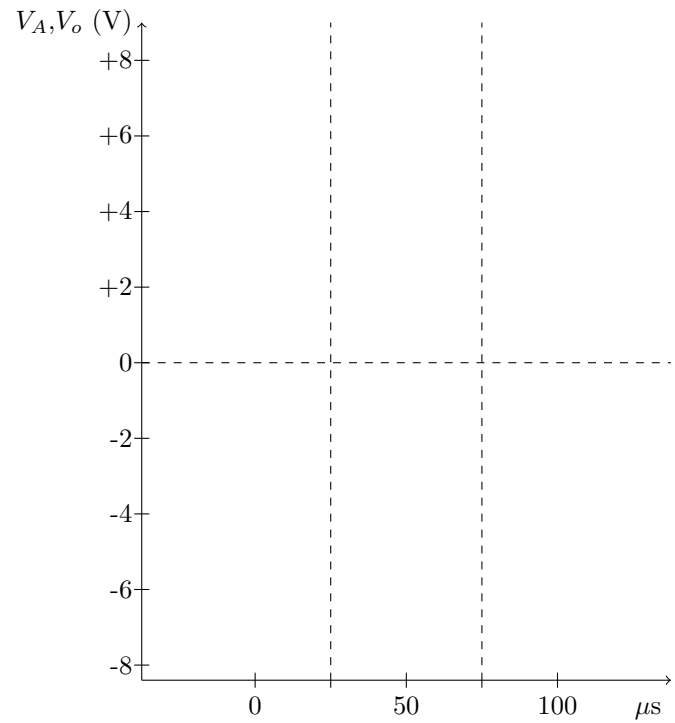
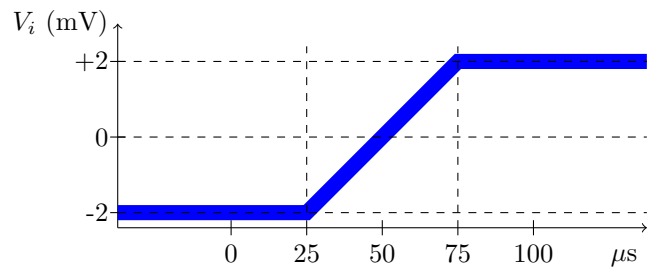
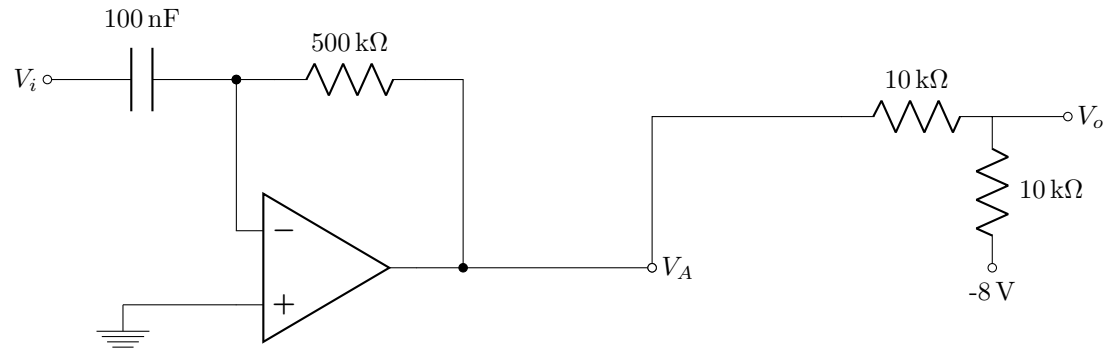


## Instructions:

- This quiz lasts 30 minutes. Answer all questions (on both sides of the sheet)
- You may have a 8.5" × 11" sheet of notes and a non-network-connected calculator

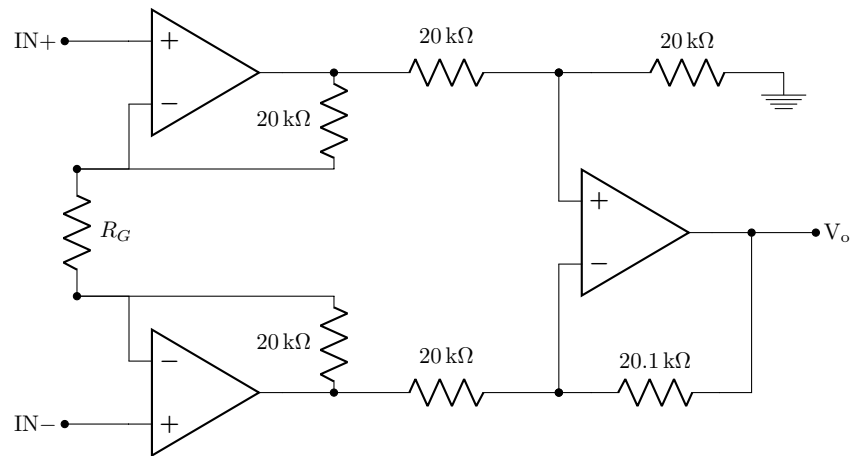
Q1b: Op amps are ideal, with power supply,  $V_{EE} = -15\text{ V}$  and  $V_{CC} = 15\text{ V}$ . At  $t = 0$  there is no change on capacitors.

- (5 marks) When  $V_i$  is as shown below, **sketch the output**,  $V_A$ , on the lower graph. Indicate voltage levels.
- (5 marks) **Sketch the output**,  $V_o$ , on the same graph. Indicate voltage levels (to within 1% accuracy) and calculate any time-constants.



Q2b: (10 marks) Consider the following instrumentation amplifier:

- Initially all resistors except  $R_G$  are  $20\text{ k}\Omega$ . Calculate  $R_G$  so that the differential gain ( $A_d$ ) is 200.
- Calculate the common-mode gain ( $A_{cm}$ ) when the resistor values are as shown.

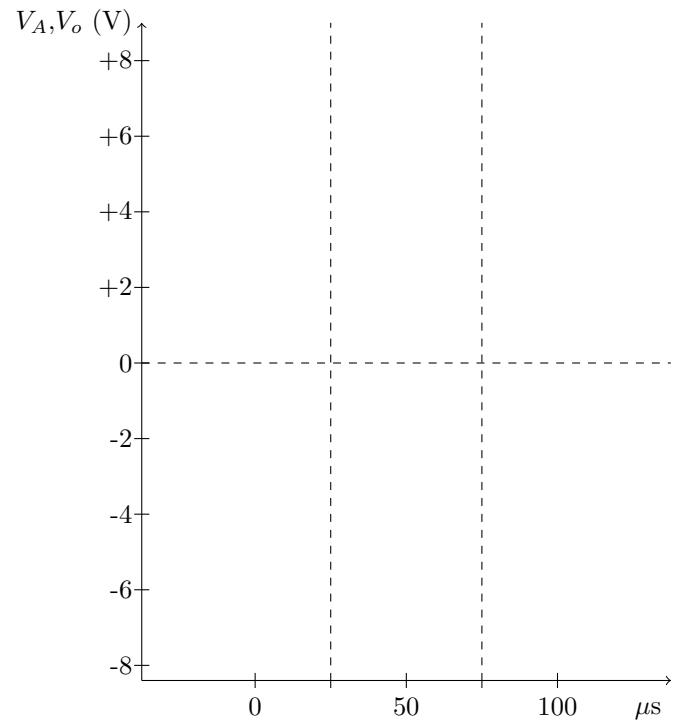
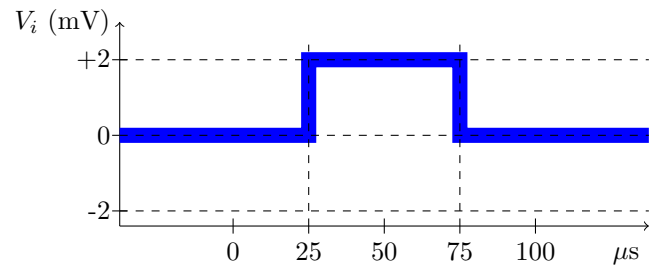
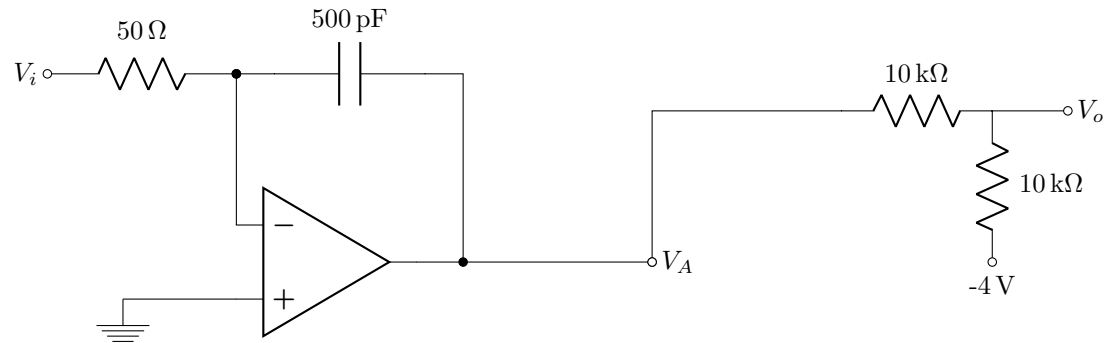


## Instructions:

- This quiz lasts 30 minutes. Answer all questions (on both sides of the sheet)
- You may have a 8.5" × 11" sheet of notes and a non-network-connected calculator

Q1c: Op amps are ideal, with power supply,  $V_{EE} = -15\text{ V}$  and  $V_{CC} = 15\text{ V}$ . At  $t = 0$  there is no change on capacitors.

1. (5 marks) When  $V_i$  is as shown below, **sketch the output**,  $V_A$ , on the lower graph. Indicate voltage levels.
2. (5 marks) **Sketch the output**,  $V_o$ , on the same graph. Indicate voltage levels (to within 1% accuracy) and calculate any time-constants.



Q2c: (10 marks) Consider the following instrumentation amplifier:

- Initially all resistors except  $R_G$  are  $5\text{ k}\Omega$ . Calculate  $R_G$  so that the differential gain ( $A_d$ ) is 100.
- Calculate the common-mode gain ( $A_{cm}$ ) when the resistor values are as shown.

