

Answer any eight (8) questions. Questions are equally weighted. Answer in the script books provided.

Question 1.

(1) Define:

- (a) **accuracy;**
- (b) **precision;**
- (c) **error;**
- (d) **mistake.**

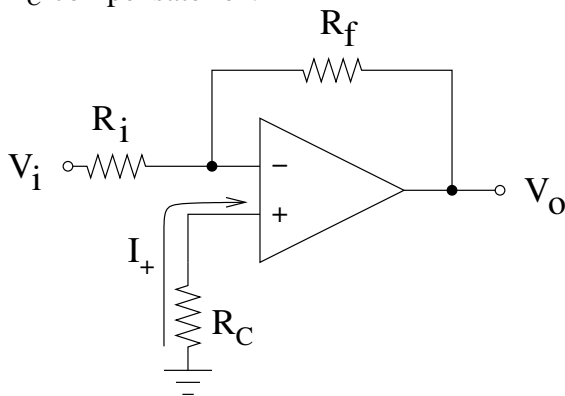
(2) Name one (1) kind of **reading error**, and briefly describe what causes it.

Question 2.

(1) Draw a simple **inverting amplifier** circuit.

(2) Derive the expression for the **voltage gain** of that inverting amplifier. (Assume ideal components.)

(3) In the following circuit involving a real op-amp, what does the **compensation resistor** R_C compensate for?



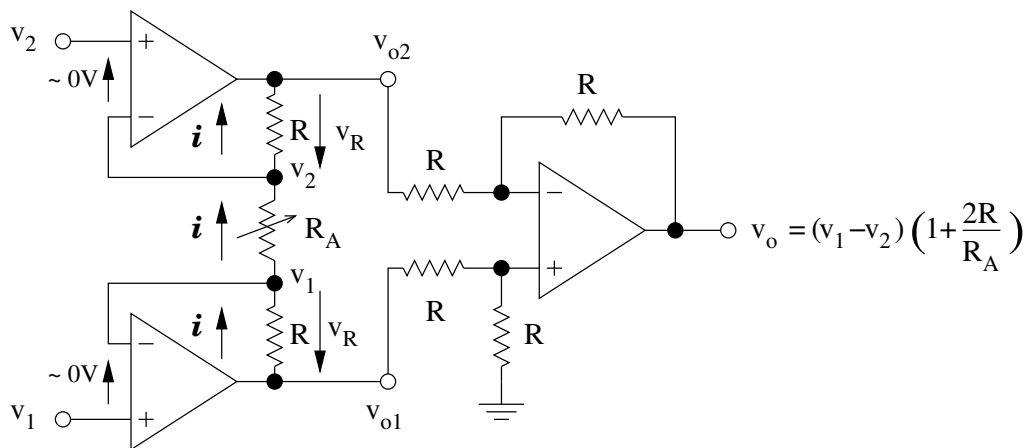
(4) What is the formula for R_C ?

(5) Given that $R_i = 2\text{k}\Omega$ and $R_f = 3\text{k}\Omega$, calculate R_C .

Question 3.

In the following instrumentation amplifier, assume that the input impedances of the op-amps are much higher than the values of the resistances R_A and R .

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- (1) Derive the formula for the **gain** of the instrumentation amplifier, by first determining the formula for $v_{o1} - v_{o2}$.
- (2) If $R_A = 2 \text{ k}\Omega$, and $R = 4 \text{ k}\Omega$, what is the value of the gain?

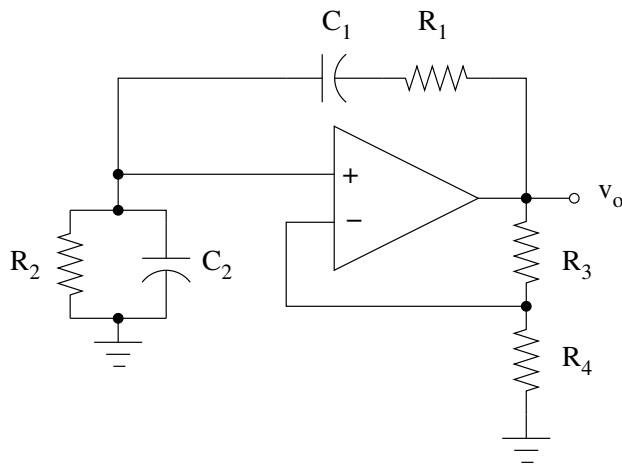
Question 4.

- (1) How many *clock cycles* does it take for a 64-bit **ramp ADC** to perform a **full scale conversion**?
- (2) Given a 1 GHz clock, how many *years* will that conversion take?
- (3) Using the same clock, how long will it take a 64-bit **successive approximation ADC** to do the same conversion?
- (4) Again using the clock, how long would a 64-bit **flash ADC** would take?
- (5) Estimate the **linear dimensions** of a 64-bit flash ADC given present-day IC technology.

Question 5.

- (1) Define:
 - (a) **tuned circuit**.
 - (b) **oscillator**.
- (2) Quote the formula for **closed loop gain** in an amplifier feedback circuit. [Hint: the variables are: a , A and F .]
- (3) State what each **variable** in that formula represents.
- (4) Name the **class** of oscillator depicted below.

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Question 6.

- (1) Name the four (4) components of the **vertical deflection system** in a cathode-ray oscilloscope.
- (2) Name the three (3) components of an oscilloscope's **horizontal deflection system**.
- (3) Using a diagram, describe the purpose of the **trigger** circuit.

Question 7.

- (1) Describe:
 - (a) **twisted pair**;
 - (b) **shielded wire**.
- (2) List one (1) *disadvantage* of a **crocodile clip**.
- (3) Name two (2) *undesirable* effects that may occur if the **ground-wire of a probe** is *not* used.

Question 8.

- (1) What is **harmonic distortion**?
- (2) What is **crosstalk**?
- (3) Define:
 - (a) **pulse width**;
 - (b) **overshoot**.
- (4) Draw a *block diagram* of a **computer-controlled automatic test equipment (ATE)** setup.

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Question 9.

- (1) Define **thermal noise**.
- (2) At a temperature of 18 Celsius, a 1 M Ω resistor with an *effective noise bandwidth* of 10 MHz generates how much **thermal power**? [Hint: $P = 4kT\Delta f$, Boltzmann's constant equals 1.38×10^{-23} W/Hz/K, and $0^\circ\text{C} = 273$ K.]
- (3) Name two (2) counter-measures against magnetically coupled interference.

Question 10.

- (1) In an AC power cord:
 - (a) why is there both a **neutral** and a **ground** wire?
 - (b) how do their purposes differ?
- (2) What is a **ground loop**?
- (3) When is **single-point grounding** *not* feasible?
- (4) How would you *eliminate* the effect of **common-mode voltage** in the *absence* of single-point grounding?

Question 11.

- (1) Define the **signal-to-noise ratio** (S/N).
- (2) An **electric shield** has a cylindrical opening with radius 1 cm and sleeve length 8 cm. Calculate the **attenuation** of an interference waveform of wavelength 60 cm that enters the opening. Attenuation is given by the formula:

$$54.5 \left(\frac{L}{\lambda_c} \right) \sqrt{1 - \left(\frac{\lambda_c}{\lambda} \right)^2} \quad \text{where } \lambda_c = \pi r$$