Question 1.

(a) (1) What is the **metric prefix** for ten to the power of **fifteen**? (2) What is its **name**?

(b) Define (1) **precision** and (2) **resolution**.

(c) A **Wheatstone** bridge has $R_1 = 600\,\Omega$, $R_2 = 100\,\Omega$, R_3 as the *variable* resistance, and R_X as the *unknown* resistance. R_3 varies from $300\,\Omega$ to $3\,\mathrm{k}\Omega$.

(1) *Draw* the bridge.

(2) *Calculate* the range of values of the *unknown* resistance that the bridge can measure.

Question 2.

(a) *Name* the kind of **AC bridge** suitable for measuring **low-Q** inductors.

(b) (1) *Draw* a simple **non-inverting** amplifier's circuit. (2) *Derive* the expression for its voltage **gain**.

(c) For each of the following properties, in your **script-book** *write* "**yes**" or "**no**" as to whether a **real** op-amp has that property.

(1) infinite open loop gain.

(2) non-zero output impedance.

(3) infinite bandwidth.

(4) infinite output impedance.

(5) non-zero noise generation.

(d) *Draw* the circuit for an **op-amp integrator**.

Question 3.

(a) When making measurements of a patient's heart during **cardiac surgery**, is it better to *ground* the *sensor*, or not? Justify your answer.

(b) A simple op-amp **comparator** has a 1 kΩ **feedback** resistor and a 1kΩ resistor between its **positive** input and ground. Its minimum and maximum **output** voltages are 0 V and 5 V.

(1) *Draw* the comparator.

(2) *Calculate* its minimum and maximum **input** voltages.

Question 4.

(a) What is the *unit* of **voltage drift**?

(b) *Describe* the **Peltier** effect.

(c) *State* the **sampling theorem**.

Question 5.

(a) In a **CRO**, what is the *purpose* of the **graticule lines**?

(b) **Semiconductor temperature transducers** contain two identical transistors for which the difference in their base-emitter voltages depends on temperature.

(1) *Write the formula* for that difference voltage ΔV_{be} in terms of temperature T, Boltzmann's constant k, the electron charge q, and the two transistors' emitter currents I_1 and I_2.

(2) *Calculate* the value of ΔV_{be} at a temperature of 300 K, if the emitter currents are 2 mA and 6 mA.

Question 6.

(a) *Draw* a **five**-bit **synchronous** counter.

(b) What **advantage** does a *synchronous* counter have over a *ripple* counter?

(c) *Sketch* the distorted waveform that results from feeding a *square* wave to a **band** pass filter.

Question 7.

(a) If a **DAC** has a *minimum* voltage of 0 volts, a *maximum* voltage of 10.20 volts, and a *resolution* of 40 millivolts, then how many **bits** does it have?

(b) What is one potential *disadvantage* of a **flash ADC**?

(c) *Draw* the *diagram* from the lecture notes for a **ramp ADC**.

Question 8.

(a) *Define* the **common mode rejection ratio** of a differential amplifier.

(b) A **fluid pressure** transducer with a sensitivity of 2 μV/V/mmHg is excited by a +10 V dc source. Calculate the *output voltage* if a pressure of 50 mmHg is applied.

(c) *Draw* the block diagram for an **RF signal generator**.

Question 9.

(a) *Draw* the block diagram for a **spectrum analyser**.

(b) Why is the interior of a **microwave oven** enclosed in a *metal-wire mesh*?

(c) *List* two (2) indoor sources of **capacitive** interference.

Question 10.

(a) The **GPIB** standard defines four (4) classes of device or instrument.

(1) Name the classes.

(2) Give an example for each class.

(b) In measurements on untuned amplifiers, what is **slew rate**?

(c) *Draw* the circuit diagram for a **Wien** oscillator.