Register Number:
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**ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27**
**M.Sc. PHYSICS - I SEMESTER**
**SEMESTER EXAMINATION: OCTOBER 2019**
**PH7418-EXPERIMENTAL PHYSICS-I**

**Time- 2 1/2 hrs** **Max Marks-70**

**This paper contains 2 parts and 3 printed pages.**

**Part-A**

**Answer any 5 questions. Each question carries 10 marks. (5X10=50)**

1. With a neat diagram, explain in detail how a diamond anvil cell is used for measuring very high pressures (assuming that a thermocouple is used to measure temperature).

2. a) Two thermistors have the same base resistance of 500Ω but they have different Temperature Coefficients of Resistance. Can they be used interchangeably? Explain.
   b) Why is Platinum a preferred material to make resistance temperature detectors?
   c) What do you understand by the terms resolution, precision and accuracy of an instrument. Are they related? Explain.
   d) What material properties should one consider while choosing the material for making a thermocouple? (2+2+2+4)

3. In order to determine the thermal conductivity 'K' of a good conductor , a bar of uniform cross-section 'A' is heated from one end until steady state is reached. Under steady state, the temperature gradients across two cross-sections L and M at distance $x$ and $x+\delta x$ respectively from the hot end are given as $-(\frac{d\theta}{dx})_L$ and $-(\frac{d\theta}{dx})_M$ . Obtain the relation for thermal conductivity 'K' as a function of the density 'ρ' and specific heat 'c' of the material. Also explain the experimental procedure used to determine the conductivity. (4+6)

4. Draw a circuit diagram and explain what modification should be made to normal inverting op-amp circuit to make it a logarithmic amplifier. Show that the output voltage is proportional to the log of the input voltage. Explain one application of the logarithmic amplifier. (4+4+2)

5. Design and show how analog input of 5.2 V is converted into digital output using Successive approximation Analog to Digital Converter.

6. a) Explain how magnetoresistive effect is produced in Anisotropic Magnetoresistive (AMR) devices.
   b) Explain the use of Hall effect sensor as fuel level indicator in the vehicles.(6+4)

7. a) A 4-bit asynchronous counter consists of flip-flops each of which have a clock to output propagation delay time of 2 ns. How long does it take the counter to recycle from 1111 to 0000 after the triggering edge of the clock pulse? What will be the delay time if we use synchronous counter instead?
   b) Draw and explain the working of a 3-bit positive edge triggered asynchronous Down counter. (2+8)

## Part-B

Answer any **4** questions. Each question carries **5** marks. **(4X5=20)**

8. a) A slide wire potentiometer with a length of 100 mm is fabricated by winding a wire having a diameter of 0.10 mm around a cylindrical insulated core. Determine the resolution limit of this potentiometer.
   b) A strain gauge having a resistance of 200Ω and gauge factor 2.0 is connected in one of the arms of a Wheatstone bridge. All other resistances in the bridge are also 200Ω . The bridge is excited by a DC source of 30 V. Calculate the strain that the gauge undergoes if the output voltage produced is 4 V. (2+3)

9. A piezoelectric transducer is a voltage source of 10 V with an internal impedance of 10 MΩ. It is connected to a digital oscilloscope with an input impedance of 10 MΩ (i) directly and (ii) using a high impedance buffer amplifier. What voltage will be measured by the oscilloscope in the two cases? Draw circuit diagrams for the two cases and explain.

10. Thermoelectric sensitivities for different materials in contact with Platinum are given in the table below:

| **Material** | **Senstivity (μV/ °C)** |
|---|---|
| Nickel | -15 |
| Constantan | -35 |
| Alumel | -13.6 |
| Aluminium | +3.5 |
| Iron | +18.5 |
| Chromel | +25.8 |
| Copper | +6.5 |

    Determine the sensitivity of the Chromel-Alumel thermocouple and the output voltage at the meter of the thermocouple if $T_1$ is 320 °C and $T_2$ is 50 °C. Compare it with the output voltage of Iron-Constantan thermocouple. Which one is better?

11. The input voltage of an op-amp differentiator is a positive going ramp which starts at t=0 and varies from -5V to +5V in 5μs and then it changes to negative going ramp from+5V to -5V in next 5μs. Determine the output voltage of the differentiator. The values of feedback resistor and capacitor are 2.2kΩ and 0.0005μF respectively. The values of input resistor and capacitor are 100Ω and 0.011μF. Draw the input and output waveforms.

12. Giant Magnetoresistive (GMR) sensors are used in Wheatstone bridge configuration and additional permalloy structures are plated to act as flux concentrators. For a 10% change in the resistance of the active resistors, how can we obtain an output equal to 5% of the voltage applied to the bridge?

13. Three plates of thermal conductivities $K_1$ , $K_2$ and $K_3$ and of thickness $d_1$ , $d_2$ and $d_3$ respectively are placed in contact in the order 1,2,3. Prove that after steady state is reached, the combination behaves as a single plate of conductivity $K$ given by $\frac{d_1+d_2+d_3}{K}=\frac{d_1}{K_1}+\frac{d_2}{K_2}+\frac{d_3}{K_3}$ .