Date :

Register Number:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – I SEMESTER
SEMESTER EXAMINATION : OCTOBER 2021
(Examination conducted in January-March 2022)
PH7420/PH7421- 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)

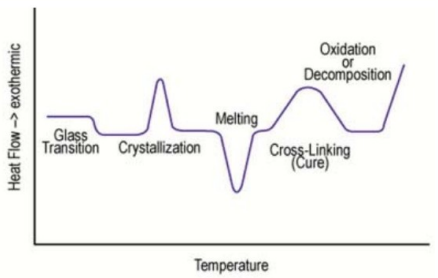
1. a)With a neat diagram, explain the working of a Bourdon tube as pressure gauge. Why is the instrument filled with glycerin before sealing it?

   b) Why do Resistance Temperature Detectors have positive temperature coefficient of resistance whereas most of the thermistors made up of semi-conducting material have negative temperature coefficient of resistance? (7+3)

2. a) Explain the principle and working of hot-wire anemometers as velocity transducers? Compare their performance with hot-film anemometers.
   b) Why is the response of displacement capacitive transducer measured in terms of fractional change in impedance rather than fractional change in displacement?
   c) Using the given relation for fractional change in resistance, explain why gauge factor ranges between 2-4 for metal foil strain gauges whereas it is almost 100 times greater for semiconductor strain gauges. (Here, ρ is resistivity and L is length of the resistive sample). (6+2+2)

$$\frac{dR}{R} = \frac{d\rho}{\rho} + (1 + 2\mu)\frac{dL}{L}$$

3. What is a Differential Scanning Calorimeter (DSC)? How is it different from Thermo Gravimetric Analyser (TGA)? The typical DSC profile curve of a sample is as shown in the figure. Using it, explain the thermodynamics of phase transitions taking place in this amorphous sample as it is heated.



4. a) Explain why resistances of the order of few hundred MΩ or GΩ cannot be measured using multimeter. Which method is used for accurate measurement of the value of these high resistances?
   b) Explain the principle and working of Vibration Sample Magnetometer (VSM) along with relevant theory. (2+8)

5. a) With a neat circuit diagram and input-output waveform, explain the working of Schmitt trigger circuit if sinusoidal voltage is given as input to this circuit.

b) Draw a circuit that can act as light sensor using LDR (Light Dependent Resistor) and op-amp. (7+3)

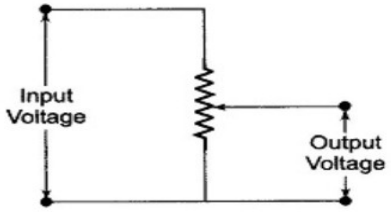
6. Explain the working of 4-bit successive approximation Analog to Digital converter (ADC) with a diagram. Mention one advantage and one disadvantage of it over flash ADC. (8+2)

7. a) Explain what is spin polarized current and how can it be used to create spin valves for use in Giant Magneto-Resistive (GMR) sensors.
   b) For what type of applications, is laser heating preferred over resistance heating in the diamond anvil cell?
   c) What are the advantages of an instrumentation amplifier over a normal differential amplifier? (6+2+2)

Part-B

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

8. A potentiometer used as a displacement transducer has a total resistance of 18.5 kΩ and a total length of 25 cm. It is connected to an input voltage of 10V. For a given displacement, the wiper is at 14cm from the bottom of the resistor. If the voltage is measured using a voltmeter that has an internal resistance of 45 kΩ, then find the measured output voltage. Also, calculate the output voltage reading for the case of an ideal voltmeter and the % error in actual measurement.



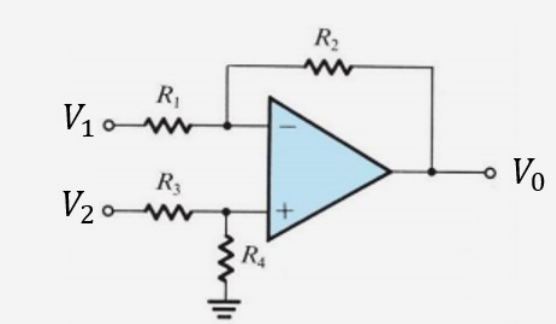
9. A tachometer has sensitivity of 5V/1000rpm (revolutions per minute) and is connected to a 6 bit ADC which has an input voltage range from 0 to 10 V.
   a) Calculate the maximum angular velocity that can be measured using it.
   b) Find the resolution of the tachometer (in volts). (2.5+2.5)

10. An iron-constantan thermocouple is used as a temperature sensor in a furnace. If the cold junction is maintained at 0°C and the voltmeter measures an output voltage of 45.17 mV, then determine the temperature of the furnace. If the Seebeck coefficient of iron and constantan with respect to Platinum are 19 μV/°C and -35 μV/°C respectively, then find the output voltage at 800°C. Compare the calculated voltage with the voltage from the table at that temperature. Can you give reason for the observed discrepancy?

°C	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
					Thermoelectric Voltage in mV						
750	42.281	42.344	42.408	42.472	42.536	42.599	42.663	42.727	42.791	42.855	42.919
760	42.919	42.983	43.047	43.111	43.175	43.239	43.303	43.367	43.431	43.495	43.559
770	43.559	43.624	43.688	43.752	43.817	43.881	43.945	44.010	44.074	44.139	44.203
780	44.203	44.267	44.332	44.396	44.461	44.525	44.590	44.655	44.719	44.784	44.848
790	44.848	44.913	44.977	45.042	45.107	45.171	45.236	45.301	45.365	45.430	45.494
800	45.494	45.559	45.624	45.688	45.753	45.818	45.882	45.947	46.011	46.076	46.141
810	46.141	46.205	46.270	46.334	46.399	46.464	46.528	46.593	46.657	46.722	46.786
820	46.786	46.851	46.915	46.980	47.044	47.109	47.173	47.238	47.302	47.367	47.431
830	47.431	47.495	47.560	47.624	47.688	47.753	47.817	47.881	47.946	48.010	48.074
840	48.074	48.138	48.202	48.267	48.331	48.395	48.459	48.523	48.587	48.651	48.715
850	48.715	48.779	48.843	48.907	48.971	49.034	49.098	49.162	49.226	49.290	49.353
860	49.353	49.417	49.481	49.544	49.608	49.672	49.735	49.799	49.862	49.926	49.989
870	49.989	50.052	50.116	50.179	50.243	50.306	50.369	50.432	50.495	50.559	50.622
880	50.622	50.685	50.748	50.811	50.874	50.937	51.000	51.063	51.126	51.188	51.251
890	51.251	51.314	51.377	51.439	51.502	51.565	51.627	51.690	51.752	51.815	51.877

11. The steady state temperatures at the ends of a copper rod of length 25 cm and area of cross-section 1.0 cm^2 are 125°C and 0°C respectively. Calculate the rate of heat flow and the temperature at a distance of 10 cm from the hot end. Given that coefficient of thermal conductivity (K) for copper is 0.92 cal/(sec-m-°C).

12. In the circuit shown below, find the output voltage V_o if both the input voltages V_1 and V_2 are 5V. Given that $R_1=R_3=R_4= 1\ k\Omega$ and $R_2=2\ k\Omega$.



13. An RTD operating in linear range gives an output of 8 mV for around 50°C rise in temperature. If it is desired to produce an output voltage for every 1°C rise in temperature, then what is the required resolution of DAC (Digital to Analog Converter) i.e how many bits DAC is required?