MANIPAL
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**DEPARTMENT OF SCIENCES, III SEMESTER M.Sc (PHYSICS)**
**END SEMESTER EXAMINATION, JANUARY 2021**

SUBJECT: EXPERIMENTAL METHODS IN PHYSICS [PHY-5105]
**(REVISED CREDIT SYSTEM-2017)**

Time: 3 Hours Date: 02-01-2021 MAX. MARKS: 50

Note: (i) Answer **ALL** questions

(ii) Draw diagrams, and write equations wherever necessary

1.

a) With a necessary diagram, explain the working principle of a rotary pump. What are its drawbacks? Explain the gas ballasting procedure. **[5]**

b) Explain the working principle of a cold cathode ionization gauge. Mention the range of pressures that can be measured by this gauge and explain. **[5]**

2.

By the method of least square, find the constants $\boldsymbol{a}$ and $\boldsymbol{b}$ such that it fits a curve of the form $\boldsymbol{y = ae^{bx}}$ to the following data: **[5]**

| $x$ | 1 | 3 | 5 | 7 | 9 |
|---|---|---|---|---|---|
| $y$ | 2.50 | 6.70 | 18.3 | 49.6 | 135.0 |

b) To measure the quantity $q = x^2y - xy^2$ , a scientist measures $x$ and $y$ as follows: $x = 3.0 \pm 0.1$ and $y = 2.0 \pm 0.1$. Calculate $q$ and its uncertainty, assuming the errors are random and independent. **[2]**

c) A moving coil ammeter has a fixed shunt of 0.01 ohm. With a coil resistance of 750 ohm and a voltage drop of 400 mV across it, the full scale deflection is obtained. Calculate (a) the current through the shunt and (b) the resistance of meter to give full scale deflection if the shunted current is 50 A. **[3]**

3.

a) Four arms of a particular bridge are arranged as follows: The arm AD is a coil of unknown impedance Z, arm DC is a non-inductive resistance of 1 kΩ, arm CB is a non-inductive resistance of 800 Ω in series with a standard capacitor of 2 μF. Arm BA is a non-inductive resistance of 16.5 kΩ. The supply frequency is 50 Hz. Calculate the value of L and R of a coil when the bridge is balanced. **[5]**

b) Mentioning the basic assumptions made, derive the four-point probe equation for an isotropic semi-infinite 3D homogenous bulk material. **[5]**

4.

a) Explain (a) interaction volume and (b) the working principle of a scanning electron microscope. **[5]**

b) Briefly explain the working principle of x-ray photoelectron spectroscopy. What are its advantages over energy dispersive x-ray analysis for elemental quantification? **[5]**

5.

a) The results of an X-ray diffraction experiment using x-rays with $\lambda = 0.7107$ Å (a radiation obtained from molybdenum (Mo) target) show diffracted peaks at the following $2\theta$ angles: $20.20^o$ $28.72^o$, $35.36^o$, $41.07^o$, $46.19^o$, $50.90^o$, $55.28^o$, $59.42^o$. Determine the crystal structure, the indices of the plane producing each peak, and the lattice parameter of the material. **[5]**

b) Mention the working principle of a SQUID. Mention its few applications. **[5]**

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