PH 308 End Semester Examination of 90 min. duration (6 x 10 marks)

READ INSTRUCTIONS CAREFULLY: Provide answers for all SIX questions in the RESPONSE SHEET provided with file name yourrollno.docx. Answer with required numerical precision as indicated (say, ###.###) in the mentioned unit(s). Write only the numerical value (the unit itself need not be written). Use ONLY the data and values of constants given in each problem. Use standard values for all other constants not provided. UPLOAD ALL RESPONSES WITHIN 90 minutes (i.e., 12:30 h) as a yourrollno.docx file in format provided in the MS FORMS link provided in the email.

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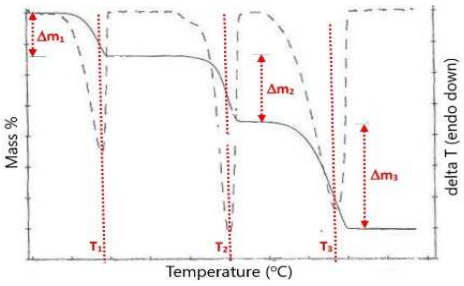
1. Strain gauges R1 and R2 are bonded on the bottom and strain gauges R3 and R4 are bonded to the top of a cantilever at half way point along its length. The cantilever is subjected to a downward force of 0.5 N. The length, width, thickness, Young's modulus and Poisson ratio of the cantilever are 24 cm, 6 cm, 2 mm, 6×10^{10} Pa and 0.3, respectively. Unstrained resistance and gauge factor of the strain gauges are 100 Ω and 2.0, respectively.). **Find the values of the resistances of the four strain gauges.**
   (a) R1 = ###.### Ω (b) R2 = ###.### Ω (c) R3 = ###.### Ω (d) R4 = ###.### Ω

2. A variable reluctance displacement sensor has a core consisting of a steel rod of diameter 12 mm bent in the form of a semi-circle of diameter 60 mm. A coil of 500 turns is wound on the core. The armature is a steel plate of length 65 mm, width of 10 mm and thickness of 3 mm. If the permeability of free space is $4\pi \times 10^{-7}$ Hm^{-1}, and the relative permeability of steel and air are 100 and 1, respectively, **the inductance of the sensor for (a) zero air gap = ##.## milli Henry, & (b) 1.5 mm air gap = #.## milli Henry.**

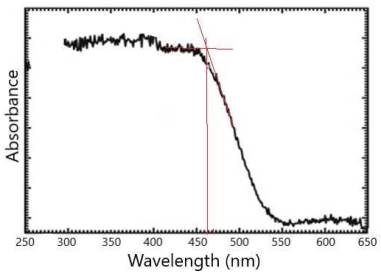
3. A flat circular diaphragm of density 6×10^3 kgm^{-3} and natural frequency 600 Hz is used as a sensor for gas pressure range of 0 to 10^4 Pa. If the sensor output has a maximum nonlinearity of 1% of its full scale, then **its (a) diaphragm thickness = #.## mm and its (b) diaphragm deflection for the above pressure range (i.e., from 0 to 10^4 Pa) is from #.### mm to #.### mm.**

4. The first order X-ray diffraction pattern of a cubic nanocrystaline solid obtained using X-rays of wavelength 1.54 Å shows a peak due to diffraction from (0 1 1) planes at $2\theta = 64.2°$ with full width at half maximum of 1.2°. Assume Schërrer's constant = 0.9. **Then, its (a) interplanar spacing = #.### Å, (b) unit cell parameter (i.e., lattice constant) = #.### Å and (c) average crystallite size = ##.# Å**

5. Figure shows thermogravimetric (solid line) and differential thermal analyzer (dotted line) curves of barium oxalate monohydrate ($BaC_2O_4.H_2O$) heated at a constant rate of 15 °C/minute exhibiting the following three step reaction, $BaC_2O_4.H_2O \rightarrow BaC_2O_4 + H_2O$
   $BaC_2O_4 \rightarrow BaCO_3 + CO$
   $BaCO_3 \rightarrow BaO + CO_2$
   at temperatures T_1, T_2 and T_3 with corresponding mass loss of Δm_1, Δm_2, and Δm_3. Atomic weights of Ba, C, O, and H are 137.3u,12u, 16u and 1u, respectively. If initial weight of $BaC_2O_4.H_2O$ is 15 mg, **then (a) Δm_1 after T_1= ##.## %, (b) Δm_2 after T_2= ##.## %, (c) Δm_3 after T_3 = ##.## %, and (d) the amount of final product BaO after T_3 = #.## mg.**



6. A semiconducting sample of 0.8 M concentration transmits 75% of the incident light intensity of wavelength 375 nm after passing through it for 1 cm. The absorbance spectra of the sample is shown in figure. If Planck's constant value of 4.14×10^{-15} eVs, **its (a) absorbance at 375 nm = #.#### , (b) molar absorptivity at 375 nm = #.### $M^{-1}cm^{-1}$ and (c) optical band gap = #. ### eV.**



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