RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (Joint Major) Degree in Chemistry & Physics

Fourth Year – Semester II Examination – October/November 2014

PHY 4208 CHARACTERIZATION TECHNIQUES

Answer **four** questions.   Time: Two hours

Use of a non programmable calculator is permitted.

1   a.   State and explain the *Rayleigh Criterion* for the resolution of two point sources.

    b.   A laser printer puts tiny dots of ink (toner) on the paper. The dots should be sufficiently close to each other, so that the individual dots are not seen; rather, we see letters or graphics. Approximately how many dots per inch (dpi) on the paper ensure that the individual dots are not seen, when viewing a page 0.40 m away from the eye in the light of wavelength 400 nm? Use the pupil (of the eye) diameter of 2.5 mm.

    c.   What is X-ray microanalysis? Discuss the advantages and disadvantages of "Energy dispersive X-ray microanalysis" and "Wavelength dispersive X-ray microanalysis"

    d.   *"In Scanning Electron Microscopy, electrically insulating samples should be coated with a thin layer of conducting material such as gold"* Briefly explain the above statement.

a. An electrolyte is sandwiched between perfectly non-blocking electrodes. By using an appropriate equivalent circuit, prove that the impedance of the electrolyte represent a semicircle in the complex impedance plane

b. Show that the bulk resistance of the electrolyte is given by the intercept of the real axis.

c. An electrochemical cell is prepared by sandwiching a 0.4 mm thick cylindrical electrolyte between non- blocking electrodes of 9 mm diameter. Nyquist diagram of the cell is shown in Fig 1.

    i. What is the bulk dc resistance of the electrolyte?

    ii. Calculate the bulk dc conductivity of the electrolyte?
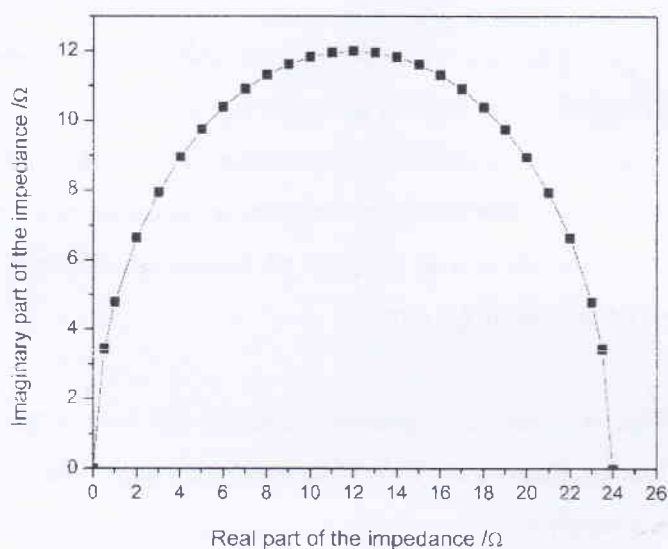

Fig 1.

3. The capacitance of a capacitor which does not contain any medium between two parallel plates is given by equation; $C_o = \varepsilon_o A / d$, where, "$\varepsilon_o$" is permittivity in vacuum, "A" cross section area and "d" distance between plates. The capacitor is filled with a dielectric material.

a. Show that the real and imaginary parts of the capacitance of the capacitor are given by equation (1) and (2) respectively (symbols have their usual meaning).

$$C' = \frac{-Z''}{\omega(Z'^2 + Z''^2)} \qquad (1)$$

$$C'' = \frac{Z'}{\omega(Z'^2 + Z''^2)} \qquad (2)$$

b. Hence, show that real and imaginary parts of the dielectric constant are given by equation (3) and (4) respectively;

$$\varepsilon'_r = \frac{-Z''}{\omega C_o (Z'^2 + Z''^2)} \qquad (3)$$

$$\varepsilon''_r = \frac{Z'}{\omega C_o (Z'^2 + Z''^2)} \qquad (4)$$

c. At 50 Hz frequency, the real and imaginary parts of the impedance of a cell are 40 Ω and -20 Ω. The area of the plates and the distance between two pates are 1 cm^2 and 0.5 mm respectively

i. What are the real and imaginary parts of the capacitance?

ii. Calculate the real and imaginary parts of the dielectric constant of the material?

4.

a. Write short notes to differentiate Differential thermal analysis (DTA) and Differential scanning calorimetry (DSC)

b. What are the different factors on which thermogravimetric analysis depends?

c. Give 3 applications of TG analysis

d. The thermal decomposition of $CaC_2O_4 . H_2O$ occurs in three distinct consecutive steps with the removal of one mole of H_2O, CO and CO_2 in each step.

Draw a likely TG curve for the above decomposition and write down the three decomposition reactions.

5. a. Describe how real-time PCR can be used to quantify expression of a gene.

b. Justify the need of a real-time PCR instead of PCR for the above purpose.

c. List 5 applications of PCR