Module 5715 Tutorial JTSI
Friday 25th April room 204

1. The impedance of a single RC parallel element is given by

$$Z' = \left[\frac{R}{1+(\omega RC)^2}\right] \qquad Z'' = \left[R\frac{\omega RC}{1+(\omega RC)^2}\right]$$

Sketch this in Nyquist format (Z"vs Z'), using limiting values of frequency to guide the drawing. What is significant at the frequency point determined by ωRC=1.

2. What do you understand by the brick wall model that is used to describe the electrical response of a typical ceramic? What are the main electrical characteristics that allow the spectroscopic separation of grain interior (bulk) and grain boundary in impedance plots.

3. What are the principal differentiators between the structures and characteristics of a supercapacitor and a secondary lithium battery?

4. In what ways does an oxygen transport membrane resemble a solid oxide fuel cell and in what ways do they differ.

5. Suggest a materials set that might be utilised in a current secondary lithium ion battery. What approaches are being considered to improve the following characteristics of lithium ion batteries
   (i) power output
   (ii) energy storage capacity
   (iii) cost and environmental impact.

6. The ionic resistance of 1%$CdCl_2$ doped NaCl decreases with temperature according to Arrhenius behaviour, with an increase in activation energy for conduction from 0.7eV to 1.3 eV at 500^{o}C as temperature increases. Sketch this on a schematic Arrhenius type plot and suggest why this change occurs. Also add to this diagram a plot showing how the traces for 2% and 3% doping of NaCl with $CdCl_2$ would appear.