## University of Liverpool Department of Physics

## Semiconductor Applications PHYS389: Tutorial 2 Work should be handed to your tutor by 5.00pm on Tuesday 7<sup>th</sup> December for a tutorial on Thursday 9<sup>th</sup> December

- 1. What is the reason for utilising lithographic methods? Describe the three primary processes used in lithography, with the aid of diagrams.
- 2. What are the principle differences between the operation of the Bipolar Junction Transistor and the Field Effect Transistor? What advantages do Schottky contacts offer over traditional p-n junctions?
- 3. Draw a schematic diagram of a bulletised n-type closed end coaxial germanium detector used for high resolution gamma-ray spectroscopy. Label the respective contacts.

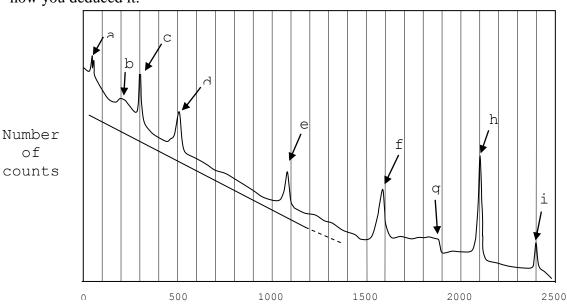
The voltage required to fully deplete a true coaxial germanium detector is:

$$V_{d} = \frac{\rho}{2\varepsilon} \left[ r_{1}^{2} \ln \left( \frac{r_{2}}{r_{1}} \right) - \frac{1}{2} (r_{2}^{2} - r_{1}^{2}) \right]$$

For a detector of 8cm outer diameter and 1.5cm inner diameter calculate the voltage required for full depletion.

A photon interacts via the photoelectric effect at a radial position 5mm from the outside of the detector. Calculate the charge collection time for the electrons in a fully depleted n-type germanium detector, assuming that the electric field strength is  $10^5 V/m$ .

4. A radionuclide is known to decay by high-energy positron emission and to emit two gamma rays. One of these is at 300 keV. When a low activity source of this nuclide is counted close to a germanium detector the following spectrum is seen. Identify and explain briefly all the features (a) to (i). Where possible calculate or state the precise energy [or energies] of each feature and how you deduced it.



Energy (keV)