University of Liverpool
Department of Physics

Semiconductor Applications PHYS389: Tutorial 2
Work should be handed to your tutor by 5.00pm on Tuesday 7th December for a tutorial on Thursday 9th 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 10^5V/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.