Dept. of Physics

EPL444: Functional Nanostructures

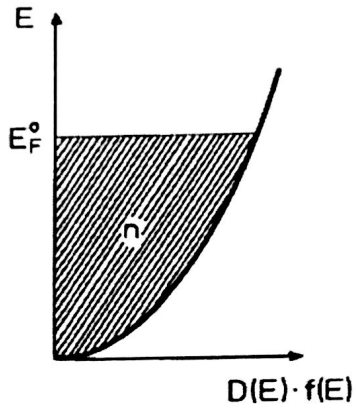
Minor I

15.02.2015

Total marks: 25

Duration: 11:00 – 12:00 hrs

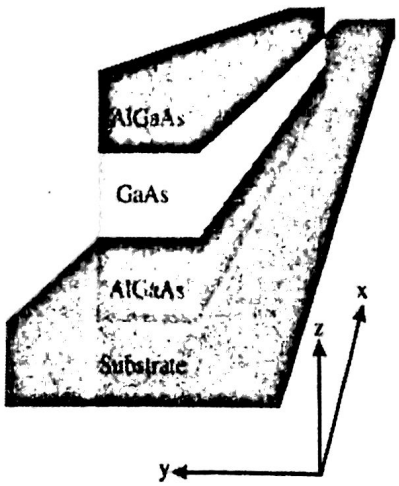
1. The figure shows the concentration of electrons $n = D(E).f(E)$ where $D(E)$ is the density of states



as a function of energy for a solid state system. What is the degree of confinement of eletrons in this system? Explain. [2]

2. Estimate the wavelength of an electron accelerated by a potential of 20 kV in an electron microscope? [2]

3. i) A quantum wire of GaAs is shown in the figure. What is the degree of freedom of electrons in



such a wire? Write the time independent Schroedinger equation for the quantum wire.

ii) What is the total energy due to the confinement?

iii) Determine the density of electronic states for such a structure.

(iv) Show a schematic plot of the Density of States as a function of Energy for this wire.

[3+3+3+1]

4. What is elastic tunnelling between two metals separated by a barrier? Explain how is it possible to measure work function of a metal using a scanning tunnelling microscope? [2+2]

5. Considering the carrier mobility and diffusivity as the two kinetic coefficients which explains the dissipative charge transport in a non-uniform conductor at temperature *T*, determine the total current density in terms of carrier mobility. [4]

6. Explain how is the wavelength of light related to the resolution in a microscope? Why is U-V light typically used in optical lithography? [2+1]