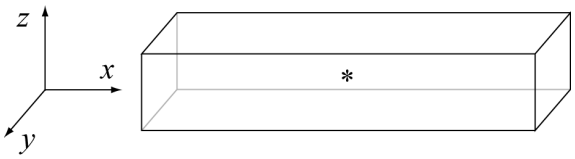
FA11 Nanoscale Devices & Systems MS Exam

Consider a 1D semiconductor nanowire with square cross-sections. Its width at *y*- and *z*-direction is *W*, its length along *x*-direction is very long.



(a) If only the lowest subband is occupied and assuming transmission probability of unity, how much is the conductance d*I*/d*V* ?

(b) The effective mass for electrons in this nanowire is m^*. Calculate the energy spacing between the bottom of 1st and 2nd subbands.

(c) There is a single impurity inside the wire acting as a potential barrier. The potential can be expressed in the form of a delta function: $V(x) = V_0\lambda\delta(x-x_0)$, where x_0 is the location of the impurity. Solve the 1D Schrödinger equation to calculate the transmission probability *T* of electrons across the barrier.

(d) If two barriers are inside the nanowire, forming a double-barrier structure and it is observed to have its first resonant tunneling peak occurring at bias voltage of V_1. Estimate the distance *d* between the two barriers.