1. Recall that the energy band structure for graphene is given, near each point \( K_i \), by

\[
E(k) = E_0 \pm \frac{\sqrt{3}}{2} \left| k \right| |\Delta k|,
\]

where \( \Delta k = k - K_i \).

Recall that there are a total of six points \( K_i \) in the graphene Brillouin zone.

(a) Compute the electronic density of states \( D(E) \) for the graphene conduction band (+ sign in the above equation) with the band structure as given above. Your result should be in terms of \( t, a, E_0 \).

(b) Assume that a piece of graphene of width \( d \) in the \( x \)-direction is considered as a one-dimensional system. Infinite potential energy barriers are present for \( x > d/2 \) and \( x < -d/2 \). What is the value of the energy band gap induced by the energy barriers in this structure?

(c) Consider again the piece of graphene in part (b). Compute the graphene conduction-band density of states \( D(E) \) in this case, in terms of \( t, a, E_0, \) and \( d \). You should include the possibility of multiple confined states in the conduction band.

(d) Suppose the piece of graphene from part (b) forms a nanoscale conduction channel between two large metal contacts. Assume that transport across this channel occurs in the ballistic regime, and that one contact is grounded (held at \( V = 0 \)). If the potential of the channel is taken, for simplicity, to be the average of the potentials of the two contacts, at what value of voltage applied to the other (non-grounded) contact will the conductance between the contacts become nonzero, and what will the value of the nonzero conductance be? You should assume that when the graphene channel is held at \( V = 0 \), \( E_0 \) is aligned in energy with the Fermi energy of the grounded metal contact. Also, assume that the temperature is zero, and transmission probability across the channel is one.