Problem 9. Power lines ***(7 points)***

i. (2 pts) Consider a rope of linear density σ (mass per unit length), which is stretched so as to maintain a mechanical tension T in the rope. Show that along such a rope, perturbations (eg. waves) will travel with the speed $k\sqrt{T/\sigma}$, and find the coefficient k.

ii. (2 pts) Now, consider a power line between two poles, the distance between of which is L; the linear density of the wire is σ, and the middle point of the wire hangs below the horizontal level at which the wire is fixed to the poles by a distance d. Find the tension T in the wires assuming that $d \ll L$. *Hint:* make use of the torque balance for a half of the wire.

iii. (3 pts) Find the lowest frequency f_0 of free oscillations of such a power line (the amplitude of the oscillations is so small that the tension in the wire remains essentially constant).