

1. Wine Barrel Filler

You own a wine tasting place in Berkeley! You have a very elegant dispenser set up for each kind of wine. To minimize the number of bottles you use, you dispense the wine directly from refillable rectangular barrels. To make sure that the barrels never run out, you want to design a level “detector” which will send the appropriate signal to the tank of wine to pour wine into a barrel until a certain level.

Two lateral faces of the barrel (opposite to each other) are coated inside with a perfectly conducting material and you have wires coming out of the barrel at the two faces. You are given that the resistivity of wine is ρ . Design a circuit to control the level of the wine. You don’t want it to go below a threshold h_{\min} and above a threshold h_{\max} . The other dimensions of the barrels are l and w . The only commands the circuit needs to output are “Fill” and “Stop Fill”.

2. Multiple plate capacitor

You are given k plates of the same dimensions and you arrange it parallelly such that the distance between the plates are $\{d_1, d_2, \dots, d_{k-1}\}$. The dielectric constant of air is ϵ . What is the effective capacitance of this setup (between the plates at the two ends)?