(30 pt) 1. A transmission line is constructed from two thin metal "ribbons" of width \( w \), a very small distance \( s \ll w \) apart. The current travels down one strip and back along the other, spreading out uniformly over the surface of each ribbon.

(a) Find the capacitance per unit length, \( C \).

(b) Find the inductance per unit length, \( L \).

(c) What is the speed with which an electromagnetic disturbance propagates down the line? (Assume TEM waves.)

Hint: The space between the ribbons are insulated from one another by a dielectric with permittivity \( \varepsilon \) and permeability \( \mu \).
(30pt) 2. Calculate the "threshold" (minimum) momentum the pion must have in order for the process

\[ \pi + p \rightarrow K + \Sigma \]

to occur. The proton is initially at rest. Use

\[ m_\pi c^2 = 150 \text{ MeV}, \quad m_K c^2 = 500 \text{ MeV} \]
\[ m_p c^2 = 900 \text{ MeV}, \quad m_\Sigma c^2 = 1200 \text{ MeV} \]

Hint: To formulate the threshold condition, examine the collision in the center-of-momentum frame, in which the total momentum is zero.

(30pt) 3. Calculate the average radiation pressure on a "good" conductor for an (normally) incident wave in air of amplitude \( E_0 \) and frequency \( \omega_0 \).

Hint: A "good" conductor means \( \sigma \gg \epsilon_0 \).
(30pt) 4. Two long coaxial cylindrical metal tubes (inner radius a, outer radius b) stand vertically in a tank of dielectric oil (susceptibility \(X_e\), mass density \(\rho\)). The inner one is maintained at potential \(V\), and the outer one is grounded. To what height \(h\) does the oil rise in the space between the tubes?

* The full grade is 100 pt.