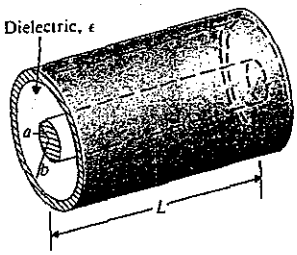
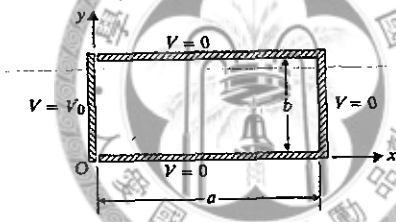
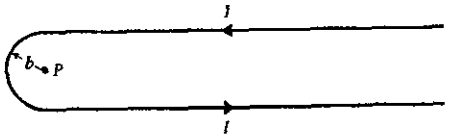
1. A cylindrical capacitor consists of an inner conductor of radius a and an outer conductor whose inner radius is b. The space between the conductors is filled with a dielectric of a constant permittivity ε, and the length of the capacitor is L. Determine the capacitance of this capacitor. (20%)



2. Consider the rectangular region shown in the figure as the cross section of an enclosure formed by four conducting plates. The left and right plates are grounded, and the top and bottom plates are maintained at constant potentials V_1 and V_2, respectively. Determine the potential distribution inside the enclosure. (15%)



3. A long wire carrying a current I folds back with a semicircular bend of radius b. Determine the magnetic flux density at the center point P of the bend. (20%)



4. Consider two coupled circuits, having self-inductances L_1 and L_2, that carry currents I_1 and I_2, respectively. The mutual inductance between the circuits is M. Find the ratio I_1/I_2 that makes the stored magnetic energy W_2 a minimum. (15%)

5. A conducting sliding bar oscillates over two parallel conducting rails in a sinusoidally varying magnetic field

$$\mathbf{B} = \mathbf{a}_z 5\cos\omega t \quad (\text{mT}),$$

as shown in the figure. The position of the sliding bar is given by $x = 0.35(1-\cos\omega t)$ (m), and the rails are terminated in a resistance $R = 0.2$ (Ω). Find i. (15%)

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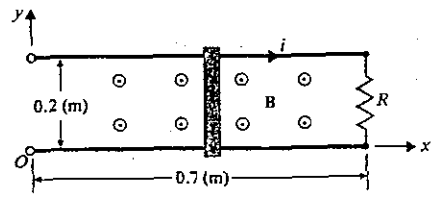

6. A uniform plane wave with $\mathbf{E} = \mathbf{a}_x E_x$ propagates in a lossless simple medium ($\varepsilon_r = 4$, $\mu_r = 1$, $\sigma = 0$) in the $+z$-direction. Assume the E_x is sinusoidal with a frequency 100 (MHz) and has a maximum value of $+10^{-4}$ (V/m) at $t = 0$ and $z = 1/8$ (m).
   (a) Write the instantaneous expression for $\mathbf{E}$ for any t and z. (8%)
   (b) Write the instantaneous expression for $\mathbf{H}$. (7%)