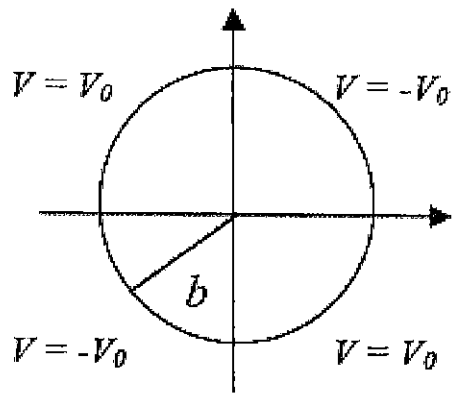
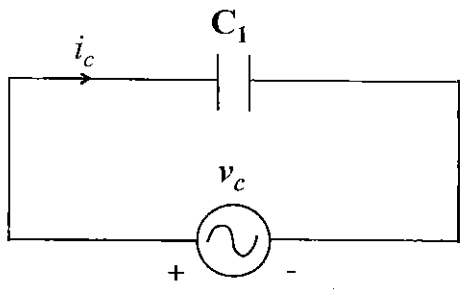
類組：電機類　科目：電磁學A(3007)　※請在答案卷內作答

1. For a vector function $\vec{A} = \vec{a}_r r^2 + \vec{a}_z 2z$, verify the divergence theorem for the cylinder defined by $r = 1$, $z = -1$, and $z = 1$. (5%)

2. A very long, thin conducting cylinder of radius b is split into four quarter-cylinders, as shown below. The quarter-cylinders in the first and third quadrants are biased at potential $-V_0$, and those in second and fourth quadrants are biased at potential V_0. Determine the potential distribution inside the cylinder. (15%)



3. An a-c voltage source of amplitude $\mathbf{V_0}$ and angular frequency $\boldsymbol{\omega}$, $v_c = V_0 \times \sin \omega t$, is connected across a parallel-plate capacitor $\mathbf{C_1}$ in following figure.
   (A) Verify that the displacement current (i_c) in the capacitor is the same as the conduction current in the wires. (5%)
   (B) Determine the magnetic field intensity at a distance **r** from the wire. (5%)



4. From Maxwell equations, please derive the source-free **homogenous vector electromagnetic wave equation.** (10%)

注意:背面有試題

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5. A slightly lossy transmission line of characteristic impedance Z_0, length $l = \lambda/2$, and propagation constant $\gamma = \alpha + j\beta$ (with $\alpha l = 1$) is short-circuited at one end. This short-circuited line is equivalent to an R-L-C series resonant circuit with resonant radian frequency ω_0.
   (A) Determine R, L, and C of this equivalent resonant circuit. (18%)
   (B) What is the Q-factor of this resonator? (2%)

6. Electric magnetic waves are guided within a z-oriented rectangular metallic waveguide where waves are bounced by conducting walls $x = 0$, $x = a$, $y = 0$, and $y = b$. Based on basic electromagnetism, we know six components E_x, E_y, E_z, H_x, H_y, and H_z are equal to (a constant)×(superposition of plane waves).
   (A) Without resorting to the E_z -H_z formula, clearly explain why $E_x/H_y = -E_y/H_x =$ constant. In your answer sheets, you are asked to give such a constant for both TE and TM modes. (6%)
   (B) Based on basic electromagnetism, derive E_x, E_y, and E_z. Here you asked to mathematically derive the above-mentioned superposition of plane waves only, i.e., neglecting the constant term. (15%)
   (C) Clearly discuss the behavior (or propagation) of an injected electromagnetic wave, which frequency is less than the cut-off frequency of any TE_{mn} and TM_{mn} modes, within the waveguide. (4%)

7. Please write down the Brewster angles with perpendicular polarization ($\theta_{B\perp}$) and parallel polarization ($\theta_{B||}$). (15%)

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