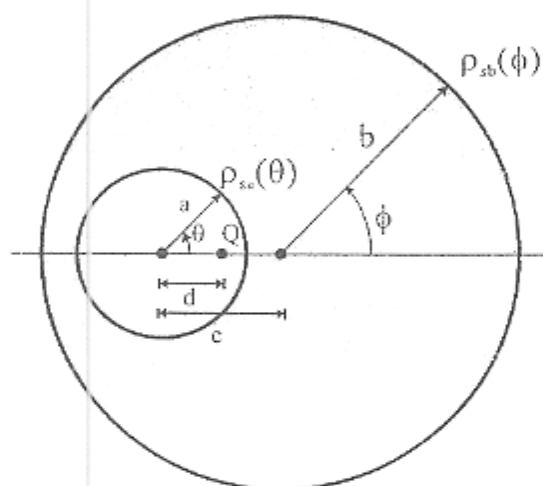


**作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!

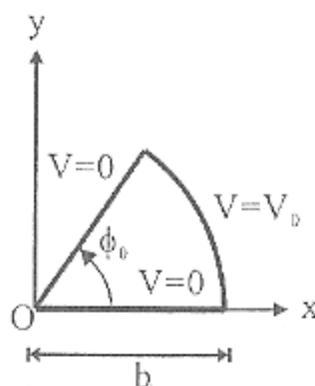
1. (25 %) As shown in the figure below, a spherical cavity of radius a is located inside a spherical conducting sphere of radius b . The distance between the centers of the two spheres is c . A point charge Q is located inside the cavity at a distance d to the center of the cavity. Determine the following.
- (5%) The total charge Q_a on the inner surface of the conducting sphere.
 - (5%) The surface charge $\rho_{sa}(\theta)$ on the inner surface of the conducting sphere.
 - (5%) The total charge Q_b on the outer surface of the conducting sphere.
 - (5%) The surface charge $\rho_{sb}(\phi)$ on the outer surface of the conducting sphere.
 - (5%) Let the origin be at the center of the conducting sphere and the voltage at infinity be zero, please find out the voltage on the outer surface of the conducting sphere.



2. (10 %) A pie-shape conducting tube extending infinitely in z -direction as shown in the figure below. The internal region of the tube is defined by $0 < \phi < \phi_0$, $0 < r < b$. The voltage on the tube wall in equation form is as follow,

$$\begin{cases} V(0 < r < b, \phi = 0) = 0 \\ V(0 < r < b, \phi = \phi_0) = 0 \\ V(r = b, 0 < \phi < \phi_0) = V_0 \end{cases}$$

Find $V(r, \phi)$ inside the tube.



國立交通大學 96 學年度碩士班考試入學試題

科目：電磁學(8022)

考試日期：96 年 3 月 4 日 第 3 節

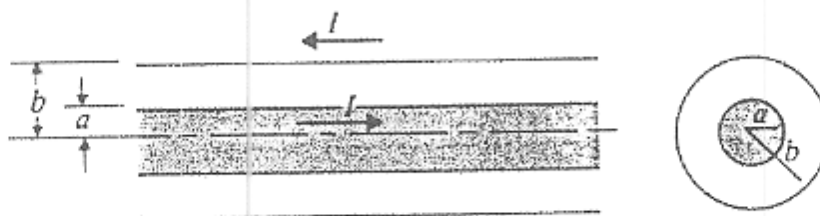
系所班別：電機學院碩士在職專班

組別：電光組-乙組

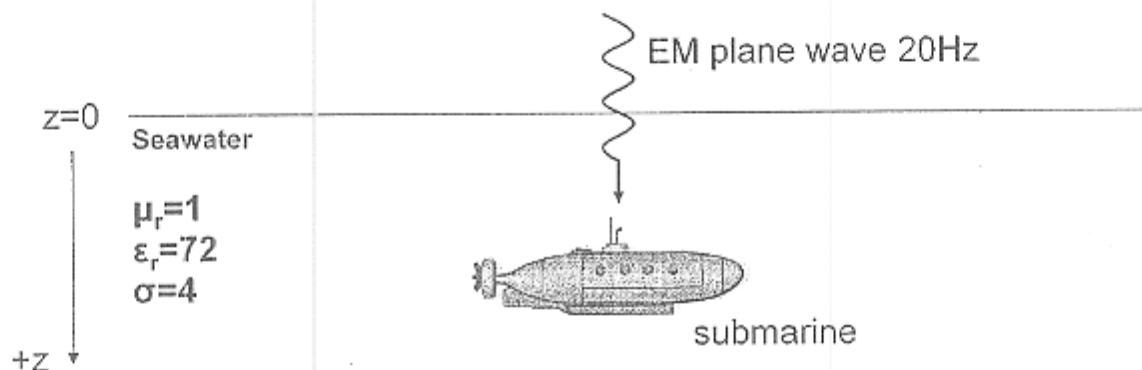
第 2 頁, 共 3 頁

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3. (10%) An air coaxial transmission line has a solid conductor of radius "a" and a very thin outer conductor of inner radius "b". (as shown in figure below) Determine the inductance per unit length of the line.



4. (20%) Maxwell's equations.
- (5%) Write down the complete Maxwell's equations
 - (5%) Please point out and show that which equation include the "continuity equation".
 - (10%) Please show that under certain "gauge" selection, we can solve these equation using scalar potential ϕ and vector potential $\vec{A}$ and, write down the non-homogeneous wave equation for vector and scalar potential
5. (20%) A 20Hz ELF (extremely low frequency) linearly polarized plane wave propagates into the sea water at z-direction (Figure). The propagation constant γ of the TEM wave in a lossy medium (μ, ϵ, σ) is $\gamma = \alpha + j\beta = j\omega\sqrt{\mu\left(\epsilon + \frac{\sigma}{j\omega}\right)}$
- (10%) Determine the attenuation constant (α), phase constant (β), and skin depth (δ)
 - (5%) Determine the phase velocity and group velocity of the plane wave in the seawater
 - (5%) If the submarine is located 100 m below the seawater surface, determine how many db decay of the EM wave power received by the submarine. (Compare with EM wave power just below the surface) (Power-ratio(db)=20log(power ratio))



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6. (10%) For a "Rectangular" wave guide,

(a) (5%) with $\gamma = j\beta = j\sqrt{\omega^2\mu\epsilon - \left(\frac{m\pi}{a}\right)^2 - \left(\frac{n\pi}{b}\right)^2}$, What's the cutoff frequency of

TM_{mn} mode?

(b) (5%) A square (width = height) waveguide is filled with dielectric of refractive index $n=2.0$. Please design the width range (from _____ cm to _____ cm) of the wave guide which required the guiding wave frequency = 12GHz, and allows TM₁₁ propagate with 10% safety factor ($f > 1.1f_c$) but also that f is at least 10% below the f_c of the next order TM mode.

7. For transmission line:

(a) (2%) Briefly plot and write the name of three typical types of transmission line.

(b) (3%) Give at least "one" application example of the three type transmission line, and which one can confining the E-H field in the dielectric the most?

Constant	Symbol	Value
Velocity of light	c	$\sim 3 \times 10^8$ (m/s)
Permittivity	ϵ_0	$\sim \frac{1}{36\pi} \times 10^{-9}$ (F/m)
Permeability	μ_0	$4\pi \times 10^{-7}$ (H/m)
Intrinsic impedance	η_0	$\sim 120\pi$ or 377 (Ω)