編號： 215

國立成功大學一〇〇學年度碩士班招生考試試題

系所組別： 電腦與通信工程研究所丙組

考試科目： 電磁學及電磁波

考試日期：0220，節次：2

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* $\varepsilon_0 = 10^{-9}/36\pi$; $\mu_0 = 4\pi \times 10^{-7}$; $\eta_0 = 120\pi$

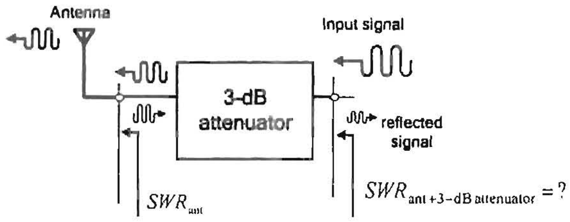
1. If a current I of 1 A following in a infinite conductor wire, determine the distance (m) from the the wire where **B field** is **2 micro-Guass** (**mG**). (5%) * 1 Tesla = 10^4 x Guass

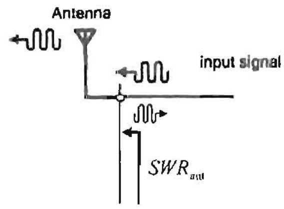
2. Determine the **power density** S (**W^2/m^2**) of a **plane wave** with a **E-field** $E = 60\ dB\mu V/m$. (5%) * $E(dB\mu V/m) = 20 \times \log[E(V/m) \times 10^6]$

3. (a) As shown in the following *left figure*, if the input SWR of an antenna is SWR_{ant}=3 and the **input signal power** is **1 W**, determine the **signal power (W) delivered to the antnna** when the antenna is connected to a 3-dB attenuator. Also detrmine the value of $SWR_{ant+3\text{-}dB\ attenuator}$. (Assume the attenuator is perfectly matched) (10%)

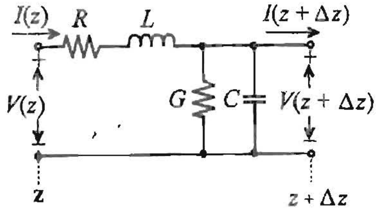
*You must solve the problem from the basic definition of SWR, reflection coefficient Γ, and 3-dB attenuation.

(b) As shown in the following *right figure*, if the input SWR of an antenna is SWR_{ant}=2 and the **input signal power** is **1 W**, determine the **antenna radiation power (dBm)** if the **antenna gain G = 10 dB**. (5%)



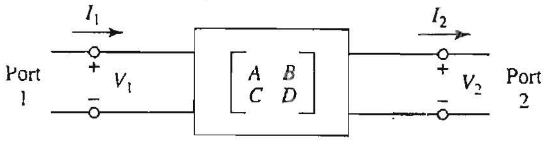


4. From the equivalent circuit of the transmission line (TL), the propagation constant γ can be derived as $\gamma = \sqrt{(R + j\omega L)(G + j\omega C)}$. Determine the **attenuation constant α**, **propagation constant β**, and **phase velocity u_p** of a **lossless TL**. (10%)



5. The **transmission (ABCD) matrix** of a two-port network is defined as

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}$$



Deterine the (ABCD) matrix of a **transmission line** with a length $l = \lambda/4$. (10%)

$Z_0, l = \lambda/4$

(背面仍有題目,請繼續作答)

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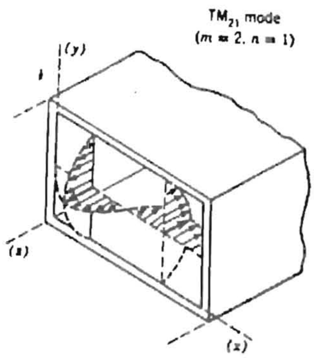
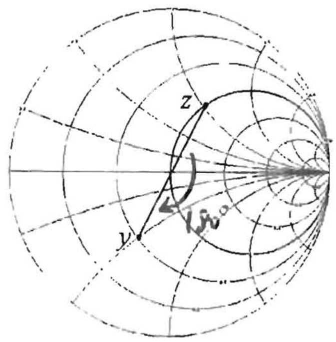
6. (a) Find the expresson for the H_z **field** and **induced current** of the **TM_{21} mode** on the waveguide wall (with a x b cross section) at $x = 0$ and $y = 0$. (10%)
   (b) Fom the propagation constant γ_{mn}, find the expression of the cutoff frequency $f_{c_{mn}}$ for each mode. (10%)

$$\textbf{TM}_{mn}\ \textbf{waveguide mode}: \ h_{mn}^2 = \left(\tfrac{m\pi}{a}\right)^2 + \left(\tfrac{n\pi}{b}\right)^2 \ ; \quad \gamma_{mn} = \sqrt{h_{mn}^2 - \omega^2 \mu\varepsilon}$$

$$\begin{cases} E_x = -\dfrac{\gamma_{mn}}{h_{mn}^2}\left(\tfrac{m\pi}{a}\right)E_0 \cos\left(\tfrac{m\pi}{a}x\right)\sin\left(\tfrac{n\pi}{b}y\right) \\ E_y = -\dfrac{\gamma_{mn}}{h_{mn}^2}\left(\tfrac{n\pi}{b}\right)E_0 \sin\left(\tfrac{m\pi}{a}x\right)\cos\left(\tfrac{n\pi}{b}y\right) \\ E_z = E_0 \sin\left(\tfrac{m\pi}{a}x\right)\sin\left(\tfrac{n\pi}{b}y\right) \\ H_x = \dfrac{j\omega\varepsilon}{h_{mn}^2}\left(\tfrac{n\pi}{b}\right)E_0 \sin\left(\tfrac{m\pi}{a}x\right)\cos\left(\tfrac{n\pi}{b}y\right) \\ H_y = -\dfrac{j\omega\varepsilon}{h_{mn}^2}\left(\tfrac{m\pi}{a}\right)E_0 \cos\left(\tfrac{m\pi}{a}x\right)\sin\left(\tfrac{n\pi}{b}y\right) \end{cases}$$



7. (a) For a normalized **impedance** $z = r + jx$ (Ω), prove the location point of the **admittance** y in the Smith Chart is at the **180° rotation** from the point of z. (10%)
   (b) Plot the normalized impedance point (to 50 Ω) in the Smith Chart of a **2-pF capacitor** and a **5.3-nH inductor** at **3 GHz**. (5%)
   (c) For a transmission line with a load of **2-pF capacitor,** determine the **line length** (λ) *approximately* to let the input impedance equivalent to **5.3-nH inductor (at 3 GHz).** (5%)



* Draw the approximate Smith Chart figure .

8. (a) Fo the **TE_{10} mode** in an air-filled WR15 **rectangular waveguide** (with a x b cross section, $a = 2b$), determine the **size of a (mm)** to have a **cutoff frequency f_c = 50 GHz.** and the **waveguide impedance Z_{TE}** (Ω) at 60 GHz.(5%)
   (b) Determine the **length (mm)** of a **short-circuited** WR15 waeguide filled with a **dielectric of ε_r =9** to have an **infinite input impedance** for the **TE_{10} mode** operating at **60 GHz. (10%)**

$$Z_{TE} = \eta \Big/ \sqrt{1 - (f_c/f)^2} \qquad \lambda_g = \lambda \Big/ \sqrt{1 - (f_c/f)^2}$$

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