※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Problem 1: (20 Points)

If the electric filed intensity in a free space is given by $\vec{E} = E_0 \sin(\beta x - \omega t)\vec{a}_y$, (a) find the associated magnetic field intensity directly from Maxwell's equations. (b) Prove that $\beta / \omega = \sqrt{\mu_0 \varepsilon_0}$ directly from Maxwell's equations, where ε_0 and μ_0 are the permeability and permittivity of air, respectively.

Problem 2: (20 Points)

A distortion-less transmission line A has characteristic impedance 50 ohms, attenuation constant 0.02 Np/m, phase velocity $c/3$, where c is the speed of light in vacuum. Find (a) R, (b) L, (c) G, and (d) C per meter of transmission line A. (e) When a section of transmission line B is open-circuited at one end, the input impedance at the other end is found to be $j20$ ohms. When the same transmission-line section is short-circuited at one end, the input impedance at the other end is found to be $-j320$ ohms. What is the characteristic impedance of transmission line B?

Problem 3: (20 points)

Two infinitely long transmission lines are connected together. One's characteristic impedance is 20 ohms and the other's is 180 ohms. If a wave at the 20-ohm line is propagating toward the junction, what are (a) the reflection coefficient, (b) the transmission coefficient, and (c) the percentage of the power been transmitted across the junction? (d) Design a transmission-line transformer to reduce the reflection to zero. (e) What is the VSWR at this matching transmission-line section?

Problem 4: (20 Points)

(a) What are the boundary conditions for the longitudinal fields of TE and TM modes in a uniform metallic waveguide? (b) The normalized radiation intensity of an antenna is $P_n(\theta, \varphi) = 1$ for $\pi \le \varphi \le 2\pi$ and 0 for the others. Find the directivity and effective aperture of this antenna.

Problem 5: (20 Points)

A 50-ohm transmission line is terminated at a load of $25-j100$ ohms. Do all the following operations and calculations by only using a Smith chart. (a) Find the location of this load on a Smith chart, (b) the angle

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of the reflection coefficient at the location of load, (c) VSWR on the line, (d) the admittance of the load, and (e) the distance from the load to the first voltage maximum. (Note: Please plot simplified Smith charts on your answer sheets and explain your important *procedures* and *results*. No points will be given if you only write down the final results on your answer sheets or you solve these problems by other methods without using a Smith chart.)