Problem 1: *(15 Points)*

(a) Write down the complete Maxwell's equations in differential form.

(b) Write down the boundary conditions for electric flux density, electric field intensity, magnetic flux density, and magnetic field intensity.

(c) Explain in detail the terms "*phase velocity*" and "*group velocity*".

Problem 2: *(15 Points)*

If Maxwell did not introduce the idea of displacement current, he could not have been able to predict the existence of electromagnetic wave. Please state how he did it by mathematical description. How could he also predict that "electromagnetic wave propagates in vacuum with the speed of light"? After his prediction, who did practical experiment that proved the existence of electromagnetic wave? Please explain how he did the experiment.

Problem 3: *(15 Points)*

A plane wave, of wavelength λ, is normally incident from a vacuum on a large, perfectly conducting sheet. A circular loop of radius a ($a \ll \lambda$) should be at a location at which the induced *emf* is maximal, as near as possible to the sheet. If the electric field of the incident wave is E, calculate this maximal *emf*. A schematic diagram is required.

Problem 4: *(15 Points)*

An antenna has a maximum directive gain of 20 dB and radiates 100 watts of power. 50 km away is an identical receiving antenna, oriented for maximum received power, and conjugate matched to an appropriate load. The frequency is 1 GHz. Determine the power delivered to the load.

Problem 5: *(20 Points)*

A 10 W-m^{-2}, 200 MHz uniform plane wave propagating in a nonmagnetic lossless medium with its electric field vector given by

$$\bar{E}_i = (\hat{x} - \hat{y})\frac{E_0}{\sqrt{2}} e^{-j\sqrt{2}\pi(x+y)} + \hat{z}\, j\, E_0\, e^{-j\sqrt{2}\pi(x+y)} \quad \text{V-m}^{-1}$$

is obliquely incident upon a perfectly conducting surface located at the xz plane. The variable E_0 is positive-real, and $\hat{x}$, $\hat{y}$, and $\hat{z}$ are unit vectors in x, y, and z directions, respectively. Find (a) the angle of incidence θ_i and the relative dielectric constant of the lossless medium, (b) E_0, (c) the expression for $\bar{E}_r(x, y)$ of the reflected wave, (d) the polarization of the incident and reflected waves.

(背面仍有題目,請繼續作答)

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Problem 6: *(20 Points)*

Two variable reactive elements are positioned on a transmission line to match an antenna having a feed-point impedance of $100 + j\,100\ \Omega$ to a $Z_0 = 100\ \Omega$ air-filled line at 5 GHz, as shown in the figure. (a) Determine the values of the two reactive elements to achieve matching. (b) If the reactive elements are to be replaced by shorted 50 Ω air-filled stubs, determine the corresponding stub lengths.