※以下計算題，請在答案卷內作答，詳列計算過程，無計算過程者不予計分。

1. (6%) In electrostatics, the electric field E in free space follows Gauss's law, which may be considered to originate from the postulate of electrostatics, i.e., the divergence of E is equal to the volume charge density ρ_v of free charges divided by the permittivity of free space:

$$\nabla \cdot E = \rho_v / \varepsilon_0$$

(a) (2%) Transform this postulate into Gauss's law in a bounded surface integral form by first taking the volume integral of both sides of the equation above and using the divergence theorem afterwards.

(b) (1%) Explain the physical meaning of Gauss's law.

(c) (2%) There is another postulate regarding the curl of E in free space. Express this postulate in terms of a line integral over an arbitrary closed contour C.

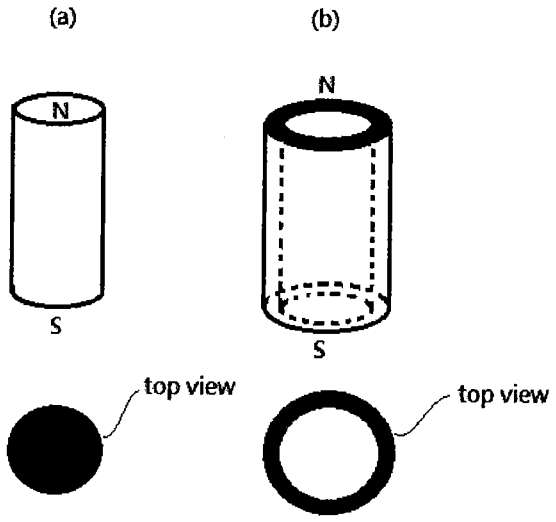
(d) (1%) And explain the physical meaning of the postulate in the line integral form.

2. (6%)

(a) (2%) Write the two postulates of magnetostatics that are related to the divergence and the curl of the magnetic flux density B in nonmagnetic media.

(b) (4%) You can use the divergence theorem and Stokes's theorem to re-express these two postulates in integral forms, respectively. Write these forms and explain their physical meanings.

3. (3%) Figures (a) and (b) below show two magnets. (a) shows a solid cylinder, while (b) represents a hollow cylinder, with their N and S poles indicated, respectively.



Draw the magnetic flux lines inside and outside the magnets. Also show the directions of the magnetic flux lines. Note that you also need to specify the magnetic flux lines in the hollow region. [1% for (a) and 2% for (b)]

注意:背面有試題

※以下計算題，請在答案卷內作答，詳列計算過程，無計算過程者不予計分。

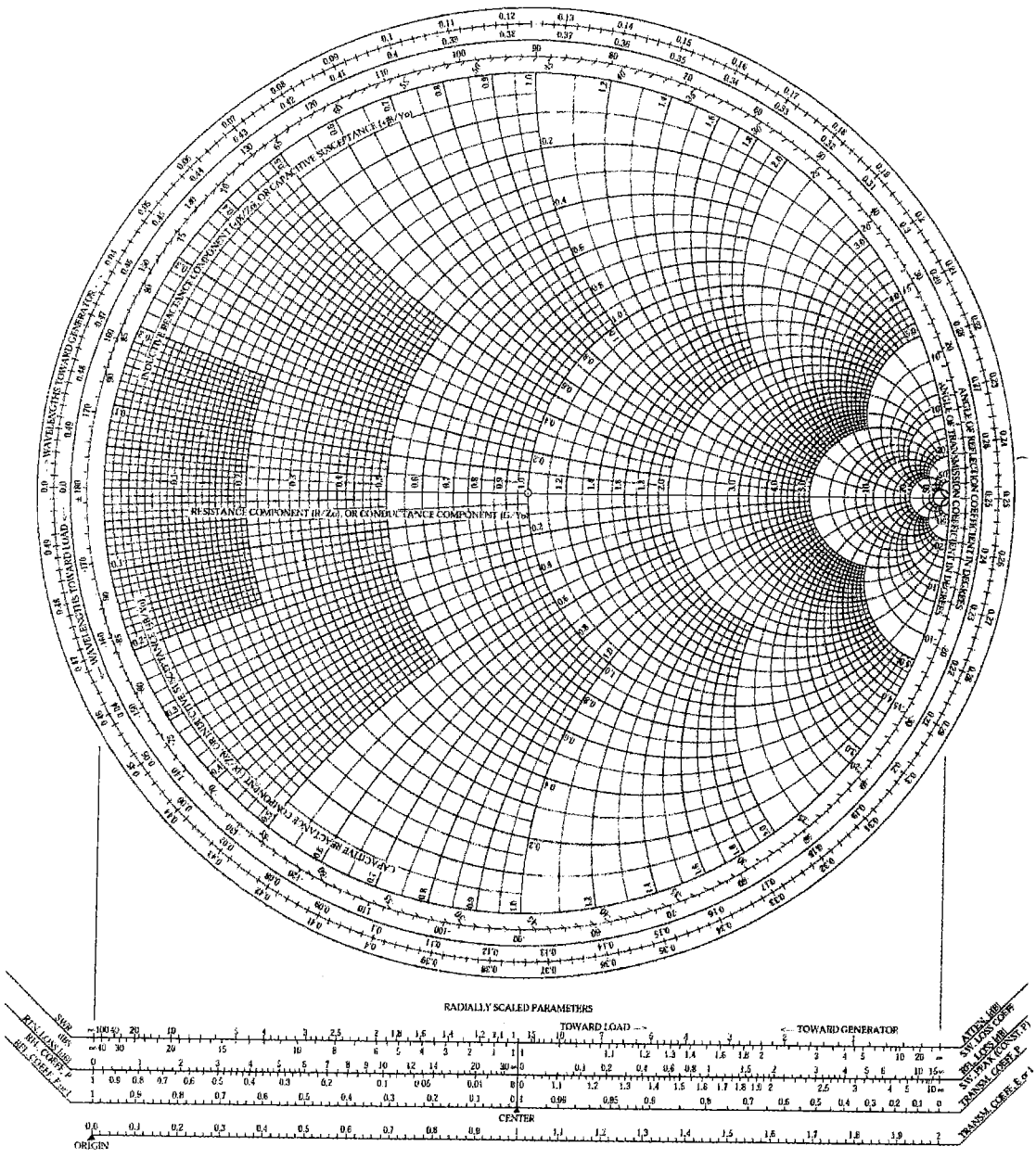
4. (30%) Consider oblique incidence of an EM wave from medium n_1 to medium n_2

(a) (10%) Derive the reflection coefficient ($\Gamma_\perp$) and transmission coefficient ($\tau_\perp$) with perpendicular polarization incidence at a plane dielectric boundary.

(b) (10%) Derive the reflection coefficient ($\Gamma_{||}$) and transmission coefficient ($\tau_{||}$) with parallel polarization incidence at a plane dielectric boundary.

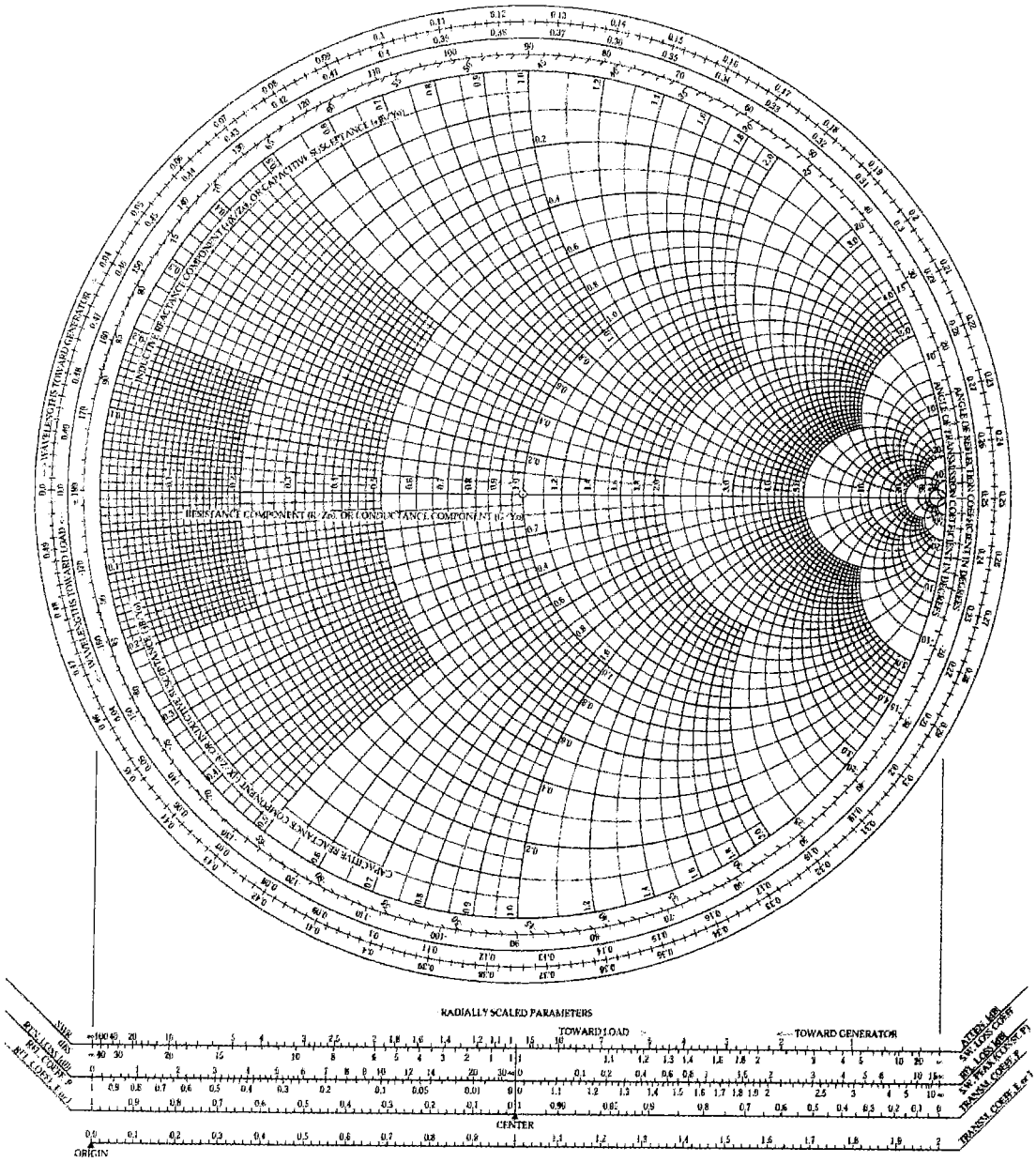
(c) (10%) Please write down the Brewster angles with perpendicular polarization ($\theta_{B\perp}$) and parallel polarization ($\theta_{B||}$) for nonmagnetic media ($\mu_1 = \mu_2 = \mu_0$).

5. (10 %) The single-stub (connected in parallel) method is used to match a load impedance 25+*j*25 (Ω) to a 50 (Ω) transmission line. Find the required **(a)** length and **(b)** position of the short-circuited stub made of a section of a 50 (Ω) transmission line. (Answers in terms of the wavelength λ)(Method is not restricted to Smith Chart)



※以下計算題，請在答案卷內作答，詳列計算過程，無計算過程者不予計分。

6. (10 %) A load impedance 100-*j*50 (Ω) is connected to a lossless line of the length 0.051 λ and characteristic impedance 50(Ω). Find **(a)** the voltage reflection coefficient and **(b)** the input impedance. (Method is not restricted to Smith Chart)

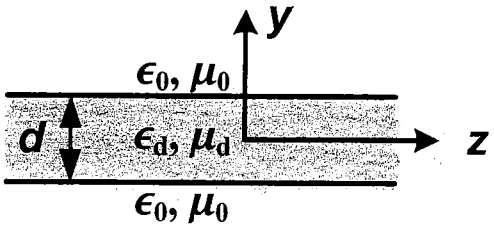


注意:背面有試題

※以下計算題，請在答案卷內作答，詳列計算過程，無計算過程者不予計分。

7. (15%) Considering the TE10 mode of a 10 mm × 4 mm rectangular waveguide:
   (a) (5%) Calculate the cut off frequency
   While the operation frequency is 20 GHz,
   (b) (2%) calculate the values of phase constant (β)
   (c) (2%), phase velocity (u_p)
   (d) (2%), guide wavelength (λ_g)
   (e) (2%), group velocity (u_g)
   (f) (2%), and characteristic impedance (Z_{TE10})

8. (10%) As shown in the following figure, a dielectric-slab waveguide with permittivity $\epsilon_d = 11.7\epsilon_0$ and permeability $\mu_d = \mu_0$ is situated in free space (ϵ_0, μ_0). Assume that there is no dependence on the x-coordinate, the dielectric is lossless, and the waves propagate in the $+z$-direction. Determine the minimum thickness of the slab material that a TM wave of the even mode at a frequency 300 GHz may propagate along the guide.



9. (10%) A waveguide consists of an infinite dielectric slab with permittivity $\epsilon_d = 11.7\epsilon_0$, permeability $\mu_d = \mu_0$, and thickness of 1 mm. It is sitting on a perfect conductor. What are the propagating modes and what are their cutoff frequencies of the lowest-order mode?