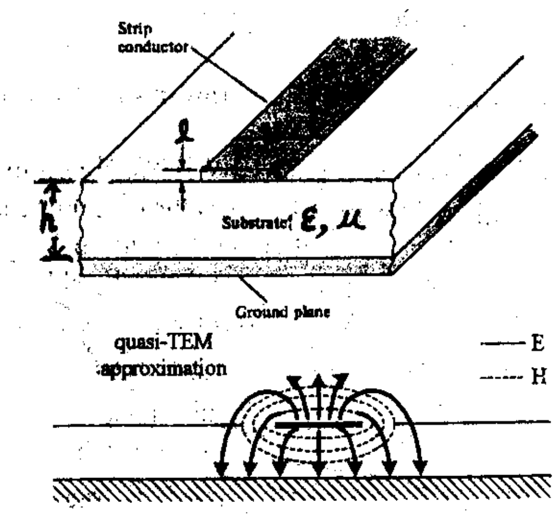
本試題是否可以使用計算機： ☑可使用 ， □不可使用 （請命題老師勾選）

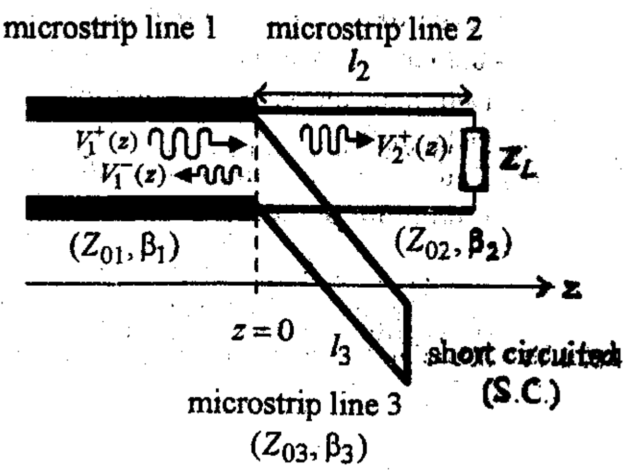
* Useful constants : $\varepsilon_0 = 10^{-9}/36\pi$; $\mu_0 = 4\pi \times 10^{-7}$; $\eta_0 = 120\pi$

1. If a two-port network has the following S-parameters, determine the **input SWR and the forward gain (or loss)** in dB. (5%)

$$\begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} = \begin{bmatrix} 0.2 & 0.5 \\ 0.5 & 0.2 \end{bmatrix}$$

2. The illustration of the microstrip (transmission) line are shown in the following figures. The microstrip substrate and thickness are $\varepsilon_r = 4$ and $h = 1\text{mm}$.
   (a) Determine the line width (W) of the microstrip line to have Z_0=50Ω
   Use the simple parallel-plate formula with TEM wave approximation. (5%)
   (b) To have a more accurate dimension of the microstrip length from the effective dielectric constant ε_{eff} derived from the quasi-TEM approximation. Determine the length ℓ of a $\lambda/4$ microstrip line at f = 1GHz if ε_{eff} = 3. (5%)
   (c) If Z_{01}=100Ω, $Z_{02} = Z_L$ = 50Ω (l_2 = 0.25 λ) and Z_{03} =200Ω (l_3 = 0.25 λ with a short circuited load), If the voltage of the incident wave $V_1^+(z) = V_0 e^{-j\beta_1 z}$ is $V_0 = 1V$, determine the power P_L delivered to the load Z_L. (15%)

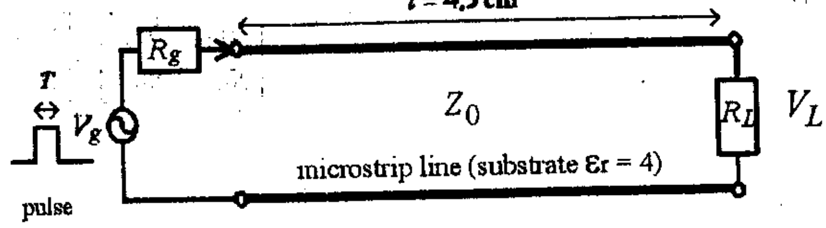




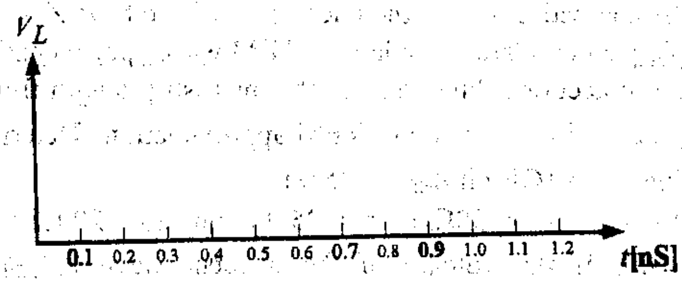
(背面仍有題目,請繼續作答)

3. As shown in the figure, a pulse signal is applied to a microstrip line (substrate $\varepsilon_r = 4$) circuit. Plot the **load voltage** (V_L) **waveform** in the **time domain** (to t = 1.2 ns). (20%)

> * Note: Use the **simple parallel-plate TEM wave approximateion** to calculate the **wave velocity** (u_p) in the microstrip line.

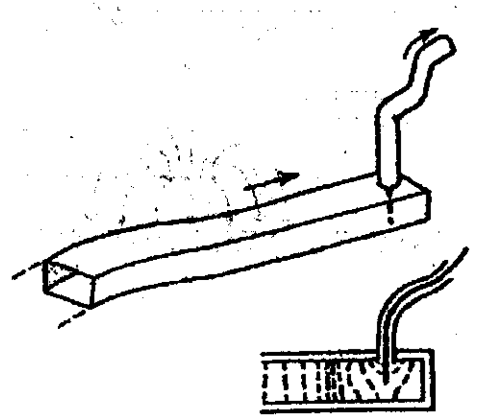


$\begin{pmatrix} V_g = 9V \\ T = 0.1\text{nS} \end{pmatrix}$ $(R_g = 25\Omega, \quad R_L = 100\Omega \quad Z_0 = 50\Omega)$



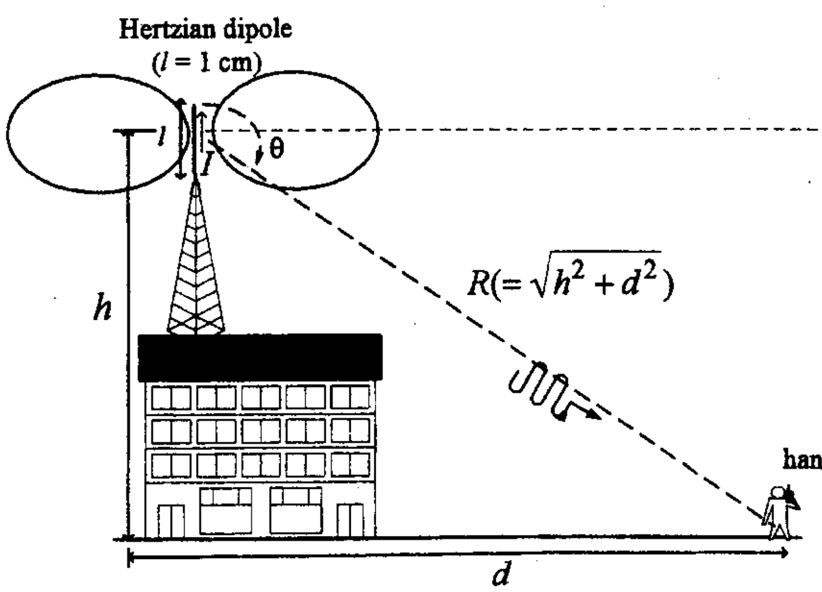
4. **A Ku-band** (12-18 GHz) **rectangular waveguide with** the inner dimensions a = **1.6 cm** and b = **0.8 cm** is connected to a coaxial transmission line.
   (a) Determine the length of a quarter-wavelength waveguide for the **dominant mode** at 15 GHz. (10%)
   (b) Determine the reflection coefficient Γ the coaxial-waveguide transition junction for the **dominant mode** [redacted] 15 GHz with a coaxial-line characteristic impedance Z_0 =50Ω . (10%)

> **Waveguide guided wavelength**
> $$\lambda_g = \lambda_0 / \sqrt{1-(f_c/f)^2}$$
> **TE$_{10}$-mode guided impedance**
> $$Z_{TE} = \eta_0 / \sqrt{1-(f_c/f)^2}$$



Coaxial-to-waveguide transition

5. As shown in the following figure, let the **input power** P_t to a base-station antenna (assuming to be a Hertzian dipole antenna with an unifrom current distribution I) is P_t = **10 W** and f = 1 GHz, h = 10 m.
   (a) Determine the polarization of the far-zone radiated wave from this Hertzian dipole: vertical-, horizontal-, or circular-polarization? (5%)
   (b) If the input SWR of the antenna is $SWR = 3$ and the antenna radiation efficiency is $\eta_r = 0.8$, what is the radiation power P_{rad} of the antenna (with an input power P_t = 10 W) (10%)
   (c) Determine the **radiation power density** p_{av} (or S) (W/m^2) from the Hertzian dipole antenna (with $I = 1A$) at a radio **handset** for a distance of $\boldsymbol{d = 1000\ m}$. (10%)
   (d) From (c), if the allowed maximum radiation power density from the RF exposure safety standard for a human body is $S = 1\ mW/cm^2$, determine the safety distance d in the horizontal direction ($\theta = 90^o$) (5%)



Hertzian dipole far-zone radiation fields

$$\begin{cases} \vec{E} = \hat{\theta} j\eta_0 kIl \dfrac{e^{-jkR}}{4\pi R} \sin\theta \\ \vec{H} = \hat{\phi} jkIl \dfrac{e^{-jkR}}{4\pi R} \sin\theta \end{cases}$$