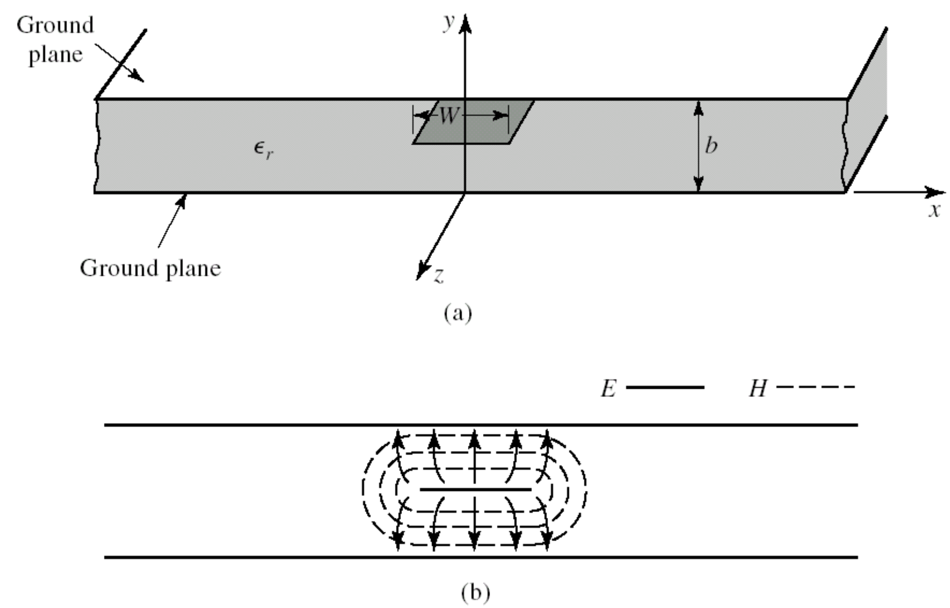
Stripline Transmission Lines

Stripline—a **TEM** transmission line!



The characteristic impedance is therefore:

$$Z_o = \sqrt{\frac{L}{C}}$$

and:

$$\begin{aligned}\beta &= \omega\sqrt{LC} \\ &= \omega\sqrt{\varepsilon\mu} \\ &= \frac{\omega}{c}\sqrt{\varepsilon_r}\end{aligned}$$

However, there are no **exact** analytic solutions for the capacitance and inductance of stripline—they must be numerically analyzed. However, we can use those results to form an analytic **approximation** of characteristic impedance:

$$Z_0 = \frac{30\pi}{\sqrt{\varepsilon_e}} \frac{b/W_e}{1+0.441\ b/W_e}$$

where W_e is a value describing the **effective width** of the center conductor:

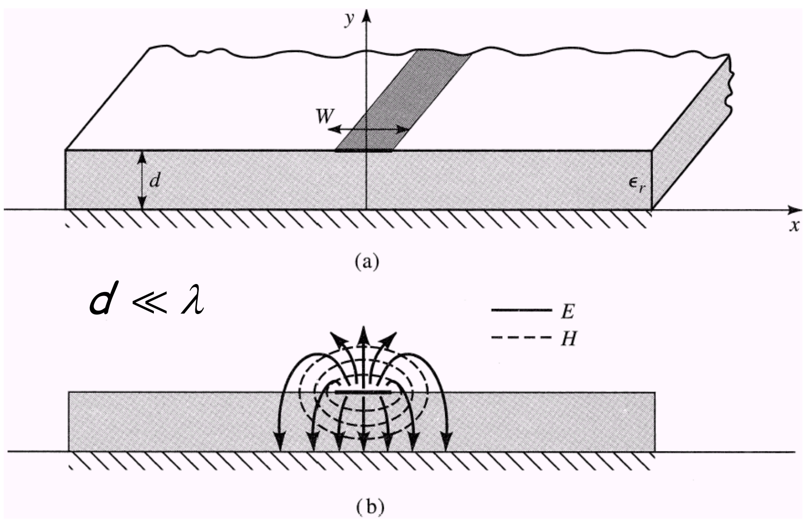
$$\frac{W_e}{b} = \frac{W}{b} - \begin{cases} 0 & \text{for } W/b > 0.35 \\ (0.35 - W/b)^2 & \text{for } W/b < 0.35 \end{cases}$$

Note that Z_0 is expressed in terms of the **unitless** parameter W/b, a coefficient value **analogous** to the ratio a/b used to describe **coaxial** transmission line geometry.

From the standpoint of stripline **design**, we typically want to determine the value W/b for a desired value Z_0 (i.e., the **inverse** of the equation above). This result is provided by equation 3.180 of your **textbook**.

Microstrip Transmission Lines

Microstrip—a **quasi**-TEM transmission line!



There are no **exact** analytic solutions for a microstrip transmission line—they must be **numerically** analyzed. However, we can use those results to form an analytic **approximation** of microstrip transmission line behavior.

The propagation constant β of a microstrip line is related to its **effective relative dielectric** ε_e:

$$\beta = \frac{\omega}{c}\sqrt{\varepsilon_e}$$

where:

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\frac{1}{\sqrt{1 + 12\, d/W}}$$

Note that $\varepsilon_e \neq \varepsilon_r$; in fact, $1 < \varepsilon_e < \varepsilon_r$.

Likewise, the characteristic impedance of a microstrip line is **approximately**:

$$Z_0 = \begin{cases} \dfrac{60}{\sqrt{\varepsilon_e}} \, ln\left(\dfrac{8d}{W} + \dfrac{W}{4d}\right) & \text{for } W/d \leq 1 \\[2ex] \dfrac{120\pi}{\sqrt{\varepsilon_e}\left[W/d + 1.393 + 0.667 \, ln\left(W/d + 1.444\right)\right]} & \text{for } W/d \geq 1 \end{cases}$$

Note that both transmission line parameters are expressed in terms of the **unitless** parameter W/d, a coefficient value **analogous** to the ratio a/b used to describe **coaxial** transmission line geometry.

From the standpoint of microstrip **design**, we typically want to determine the value W/d for a desired value Z_0 (i.e., the **inverse** of the equation above). This result is provided by equation 3.197 of your **textbook**.