HW#4

* *Single-conductor waveguides cannot support TEM waves.*

Why?

1) $\bar{B}$ *lines always close upon themselves*

2) *For TEM waves to exist,* $\bar{B}$ *and* $\bar{H}$ *lines would form closed loops in a transverse plane.*

3) *By the Ampere's circuital law.*

$$\oint \bar{H} \bullet d\bar{l} = I_c + I_d \quad \textit{transverse plane}$$

I_c : *conductor current*

I_d : *displacement current*

4) *Without an inner conductor*

$$I_c = 0$$

5) *For TEM wave,* $E_z = 0 \rightarrow$ *no longitudinal displacement current*

$$cf)\ I_d = \int_s \frac{\partial \bar{D}}{\partial t} \bullet ds = 0 \ \textit{in the z direction}$$

$$\because\ E_z = 0$$

6) *Therefore there can be no closed loops of magnetic field lines in any transverse plane*

7) *Assuming perfect conductors, a coaxial transmission line having an inner conductor can support TEM waves*

8) *When the conductors have losses, no longer TEM waves*