Use of Transmission Line

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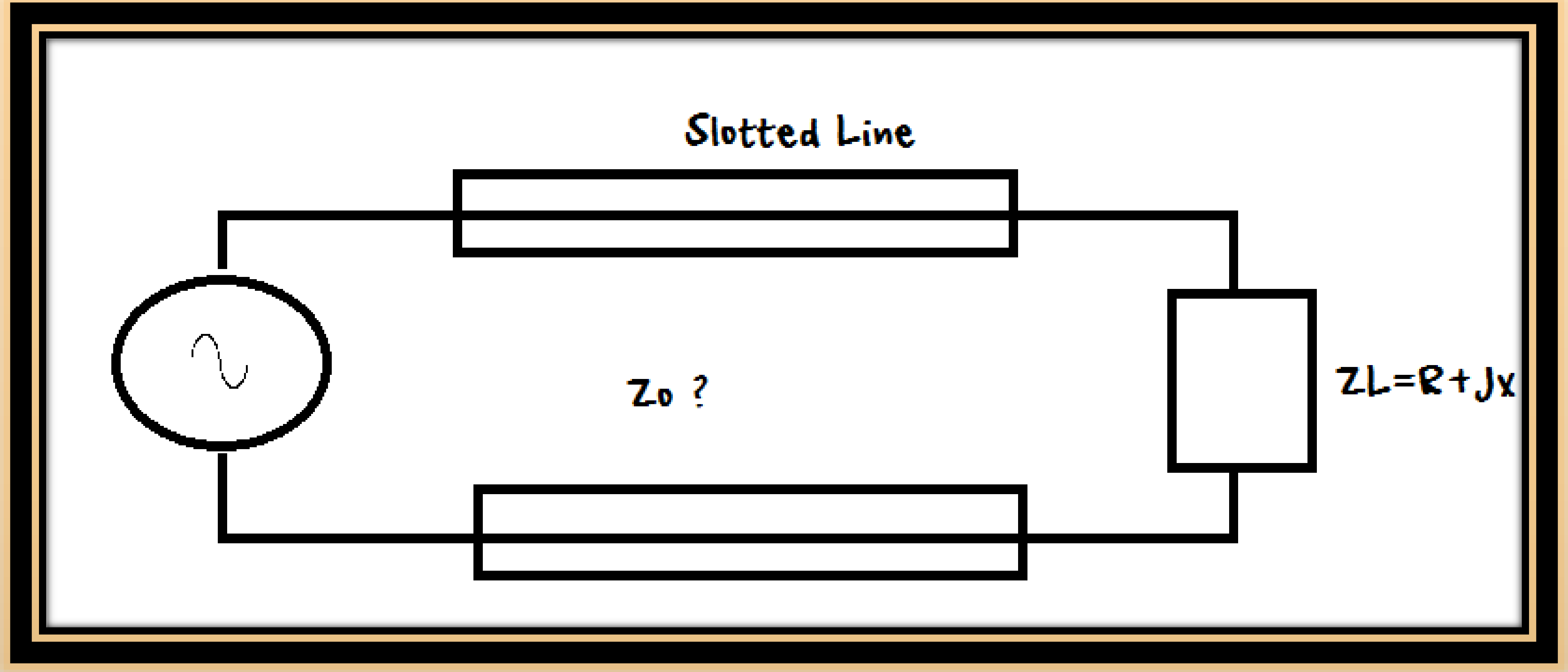
Revising the mistakes of last lecture- Done by the Teacher ☹

Micro wave Engineering

Find Undetermined Characteristics

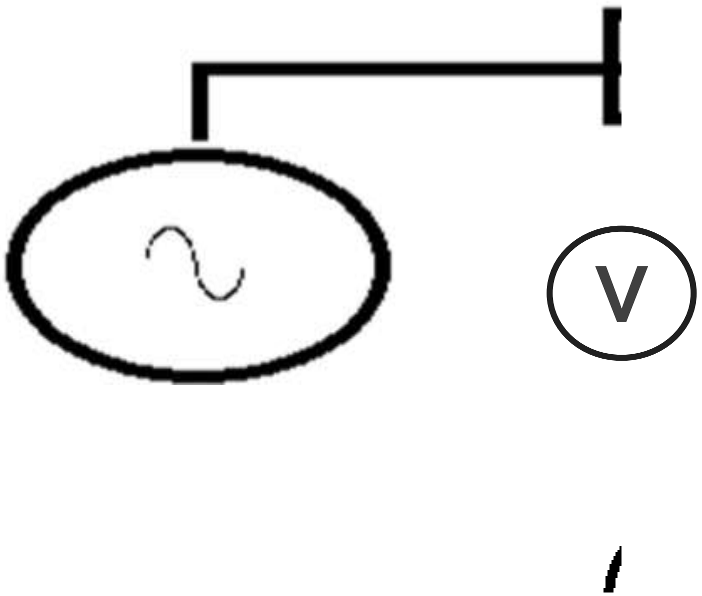


Slotted Line

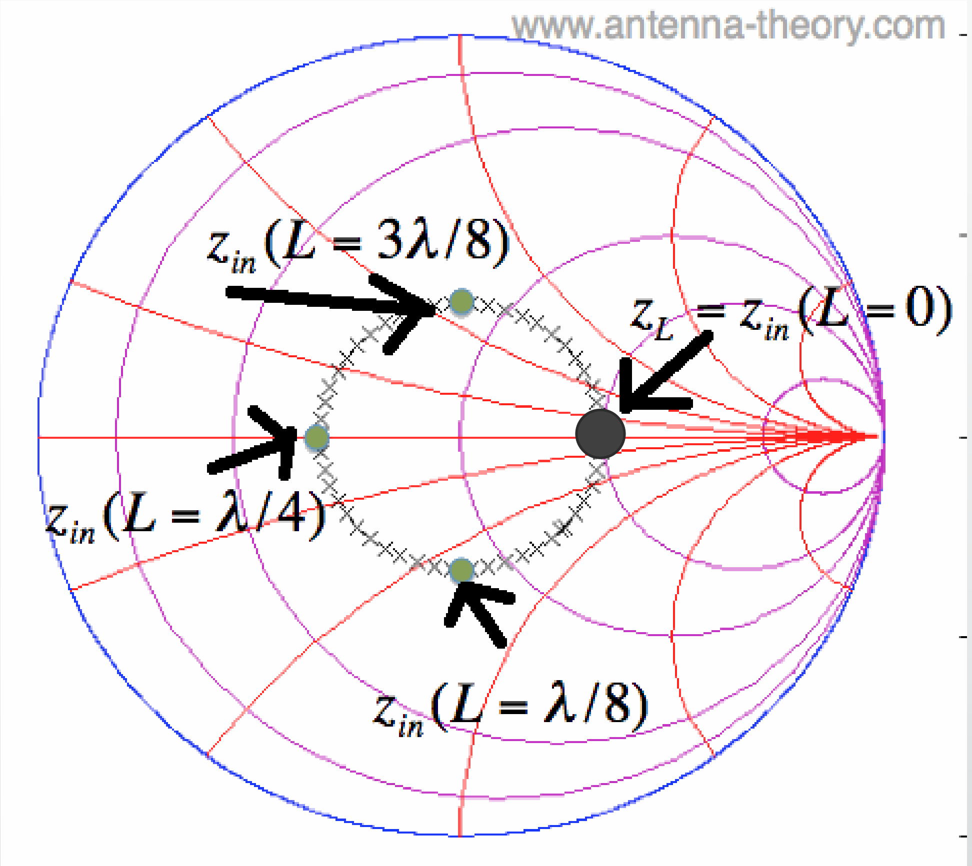
- **Slotted Transmission line is nothing but just a simple transmission line with a probe to calculate the voltage or current magnitude**
- **Slotted lines can be made with any type of transmission line (waveguide, coax, micro strip, etc.), but in all cases the electric field magnitude is measured along the line with a small probe**
- **A section in a transmission line, such as a waveguide or coaxial line, in which a lengthwise slot is cut into the outer conductor, with an adjustable probe placed in said slot. Used, for instance, for the determination of load impedance or standing wave ratios in microwave systems. Also called slotted section, slot line, or slotted waveguide.**

What is Slotted Line?

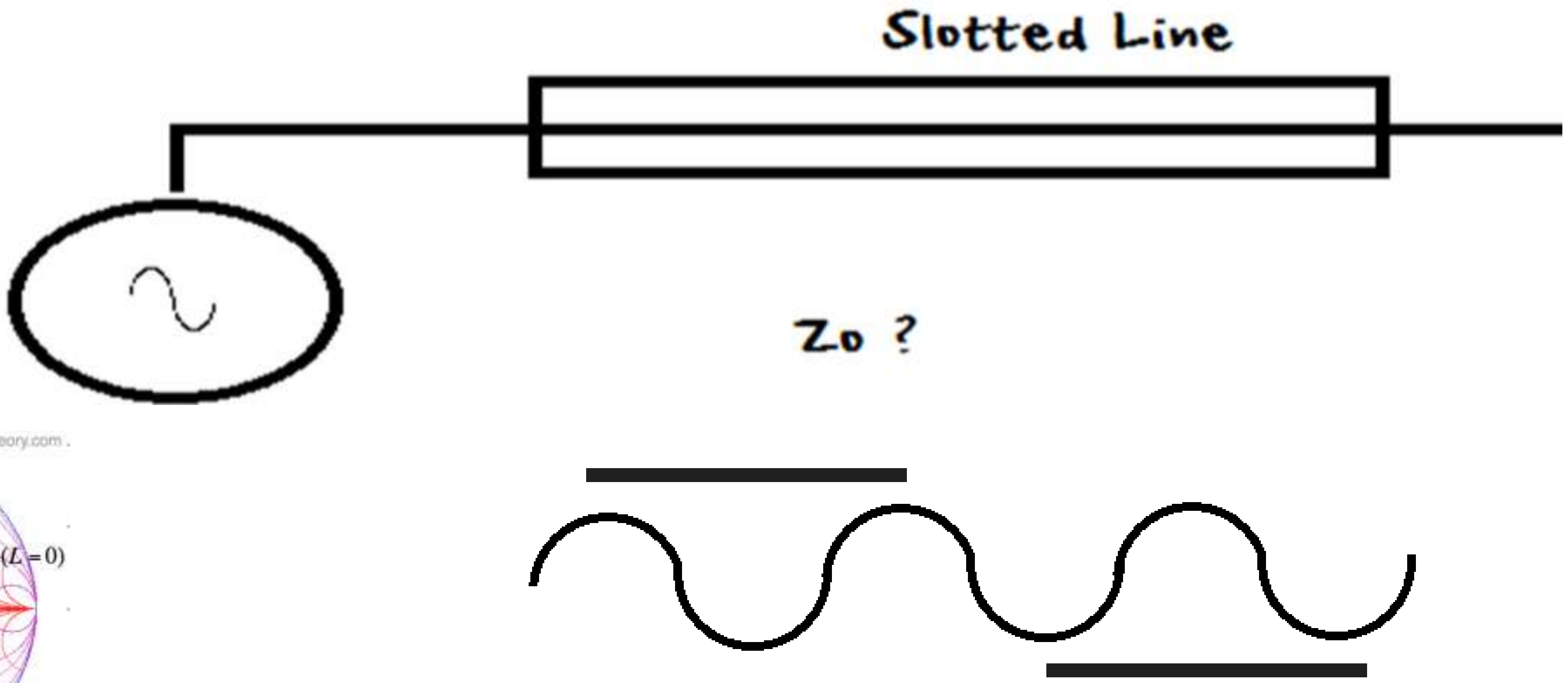
Slotted Line

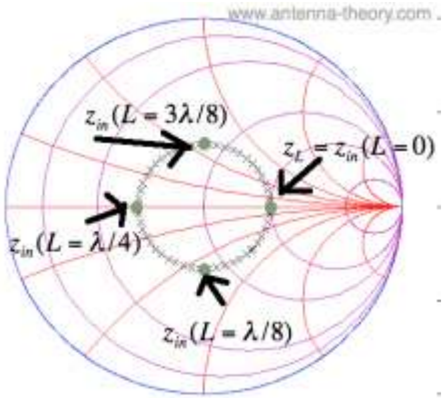


Calculating Phase :

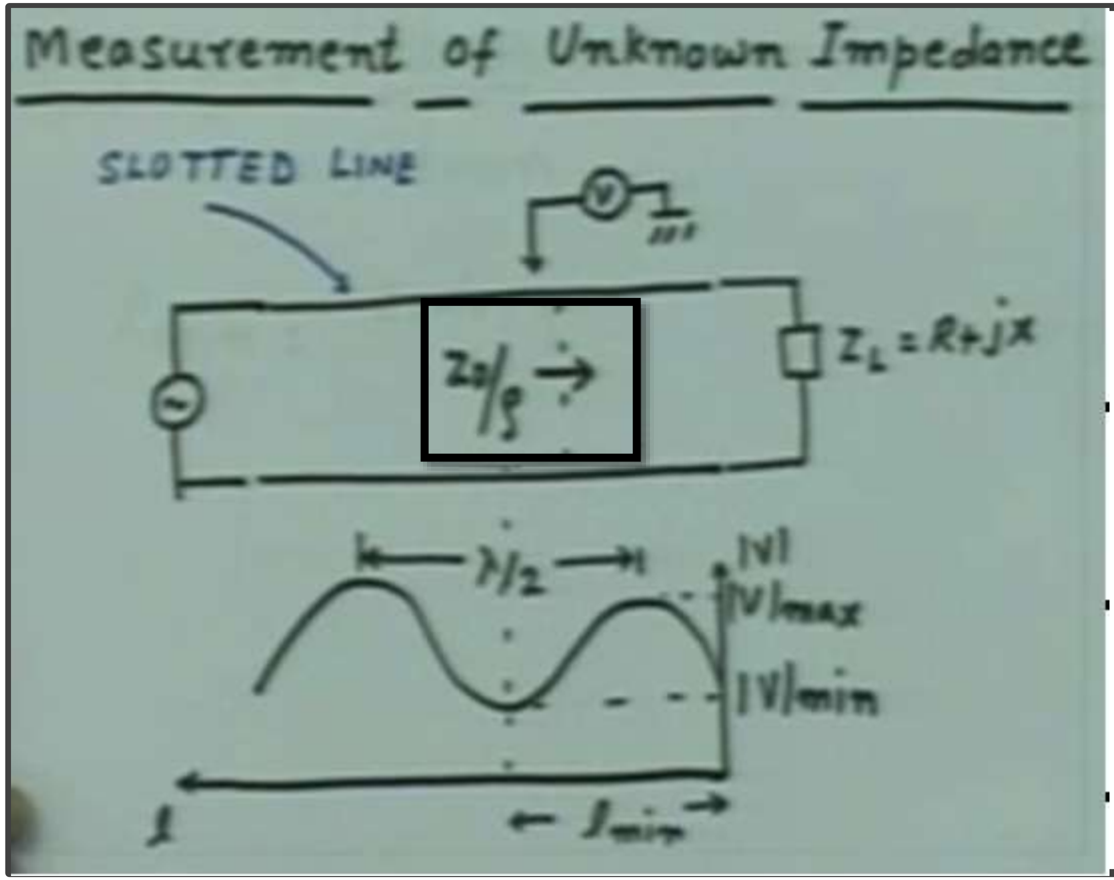


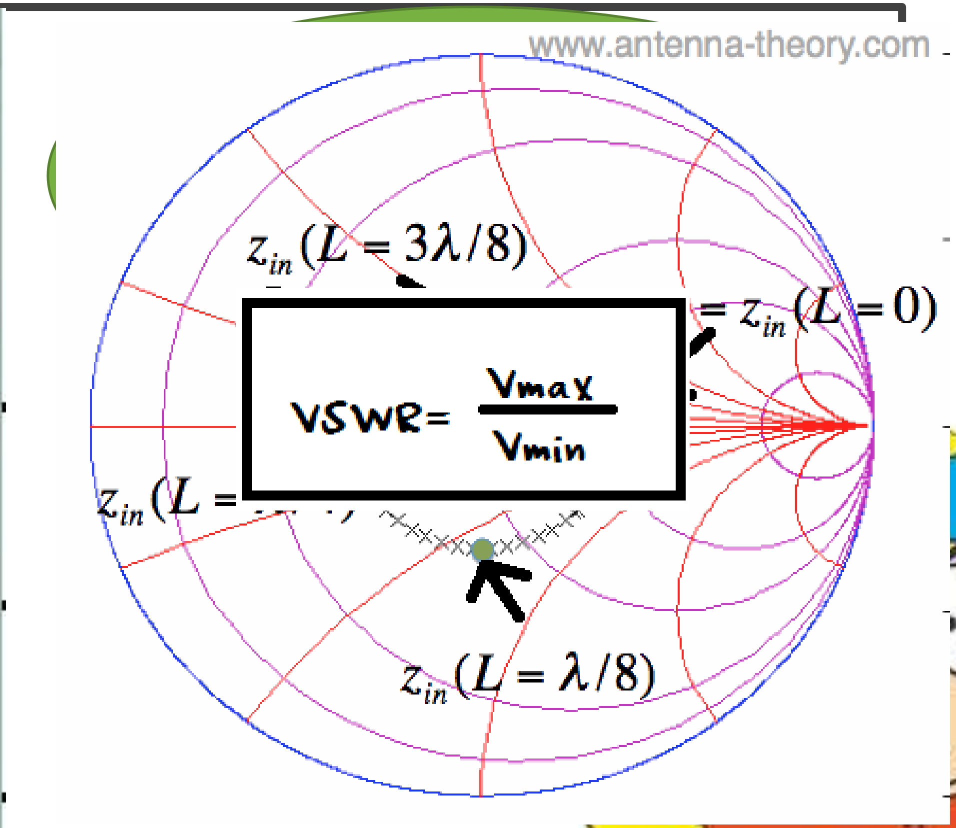
SMITH CHART And PHASE

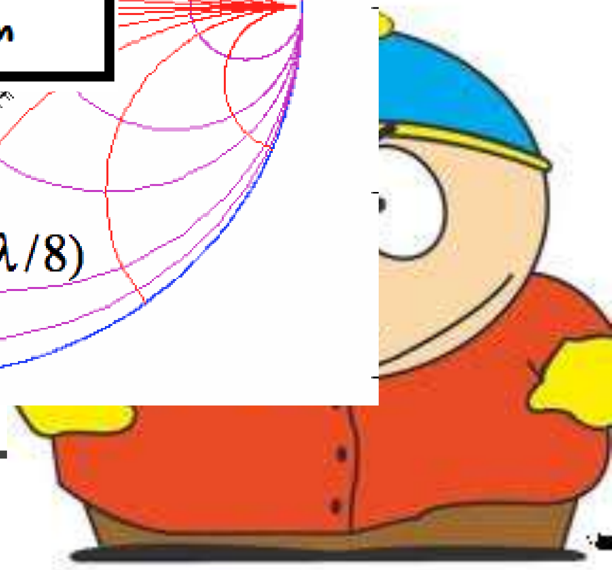




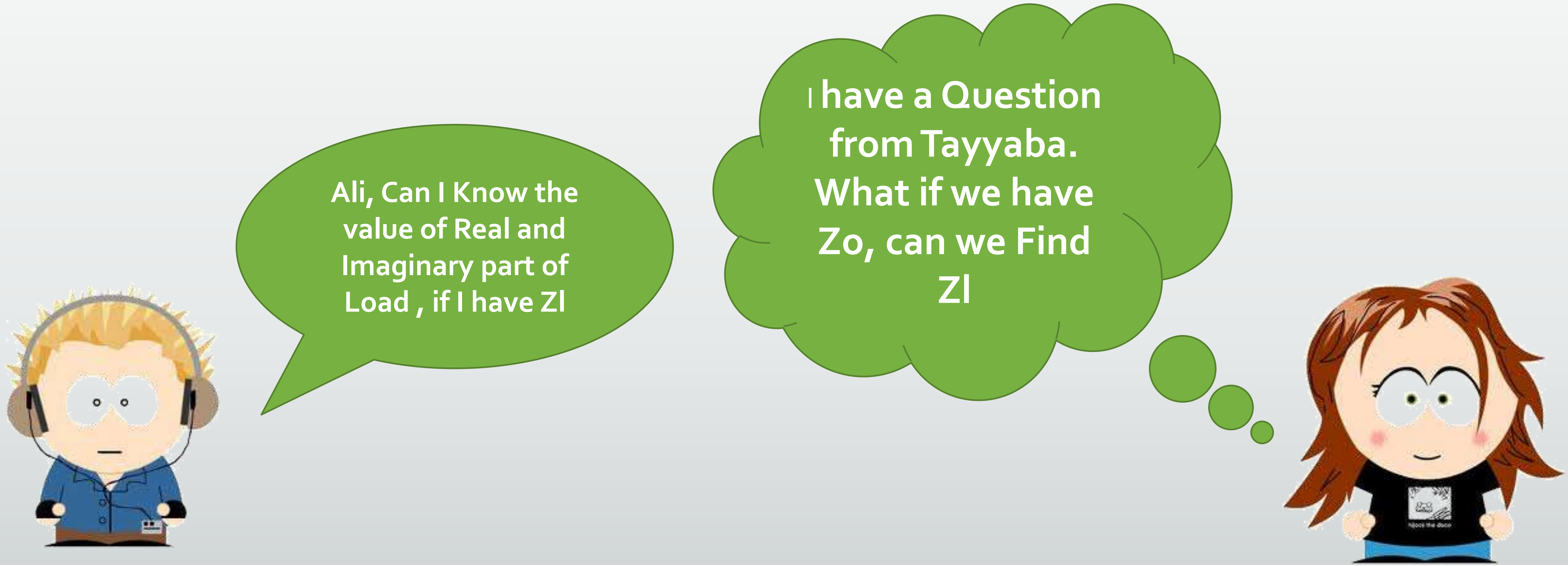
Calculating Impedance and Phase







Phase Calculations And Impedance


Ali, Can I Know the value of Real and Imaginary part of Load , if I have Zl
I have a Question from Tayyaba. What if we have Zo, can we Find Zl

$$ZL = Zo\left(\frac{\{Rmincos(-ßlmin) + jZosin(-ßlmin)}{Zocos(-ßlmin) + jRminsin(-ßlmin)}\right)$$

Separating Real and Imaginary Values

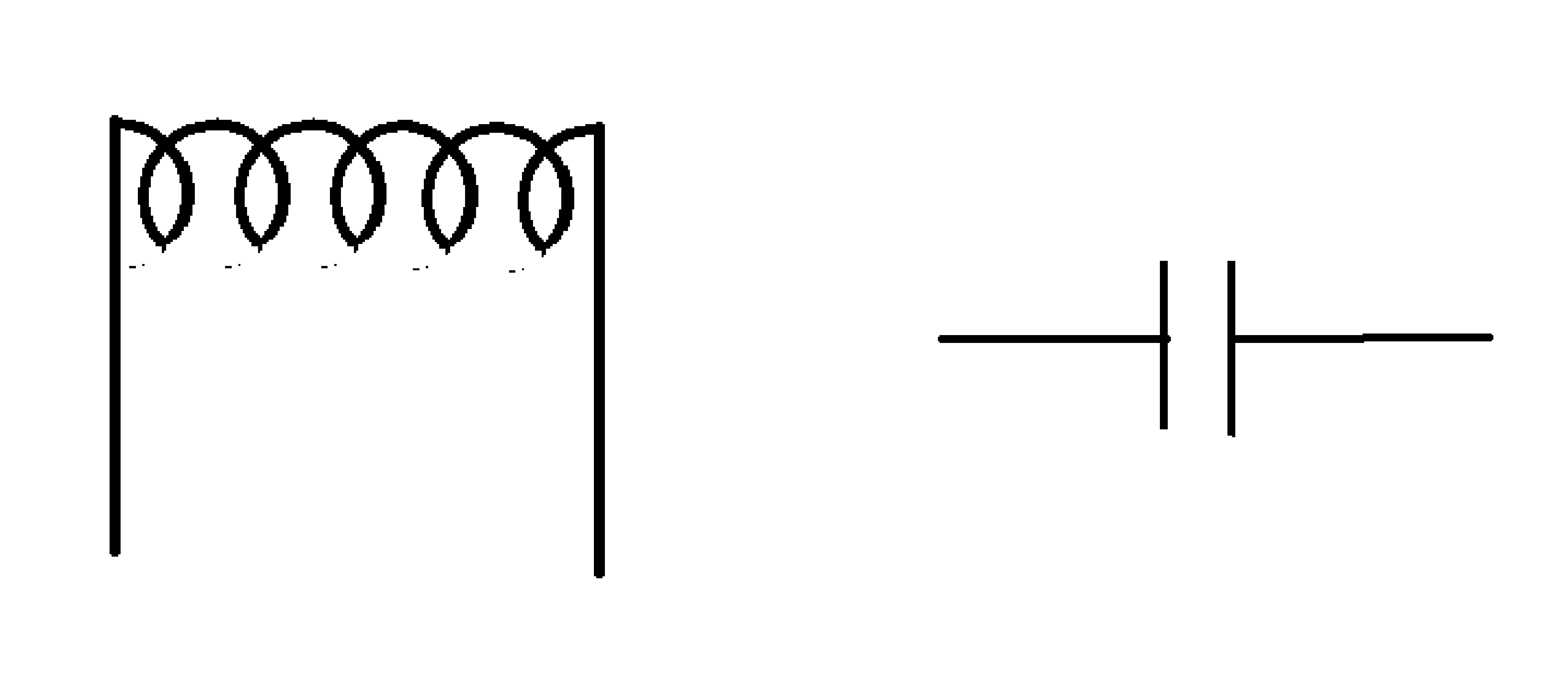
$$R = \frac{\boldsymbol{VSWR(1+tan^2}(ßlmin)}{\boldsymbol{VSWR^2+tan^2}(ßlmin)}$$

$$X = \frac{\boldsymbol{(1-VSWR^2)tan}\quad(ßlmin)}{\boldsymbol{VSWR^2+tan^2}(ßlmin)}$$

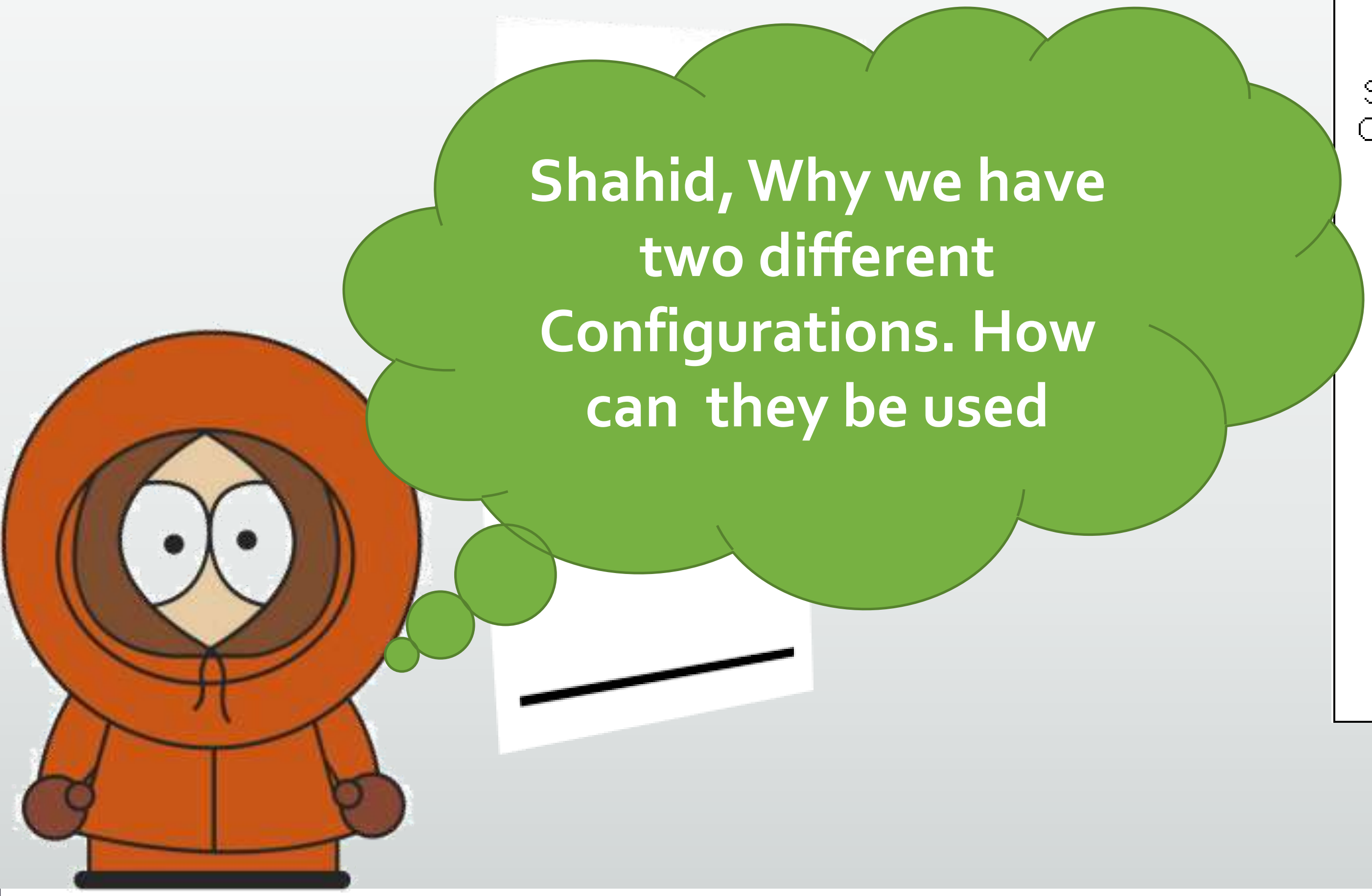
Applications of Transmission Line

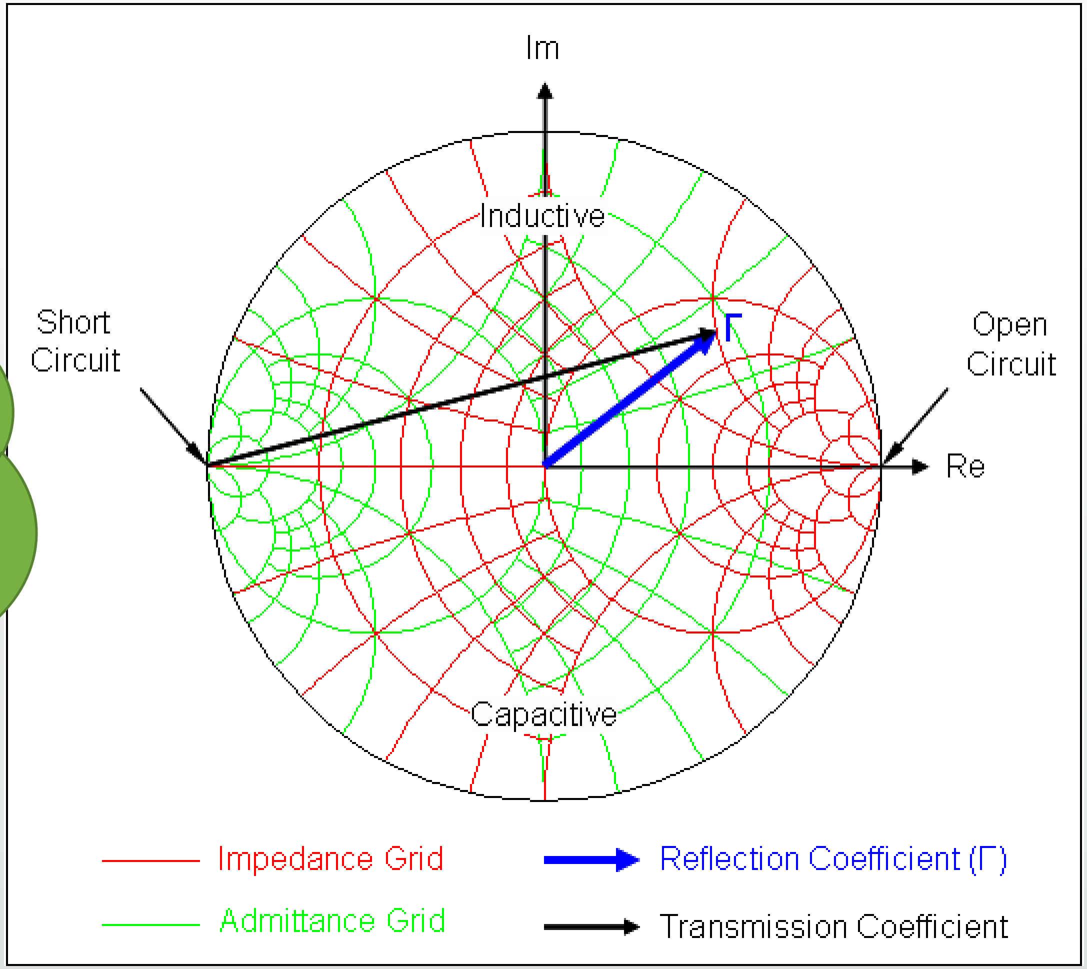
As a Circuit Element

Inductor VS Capacitor

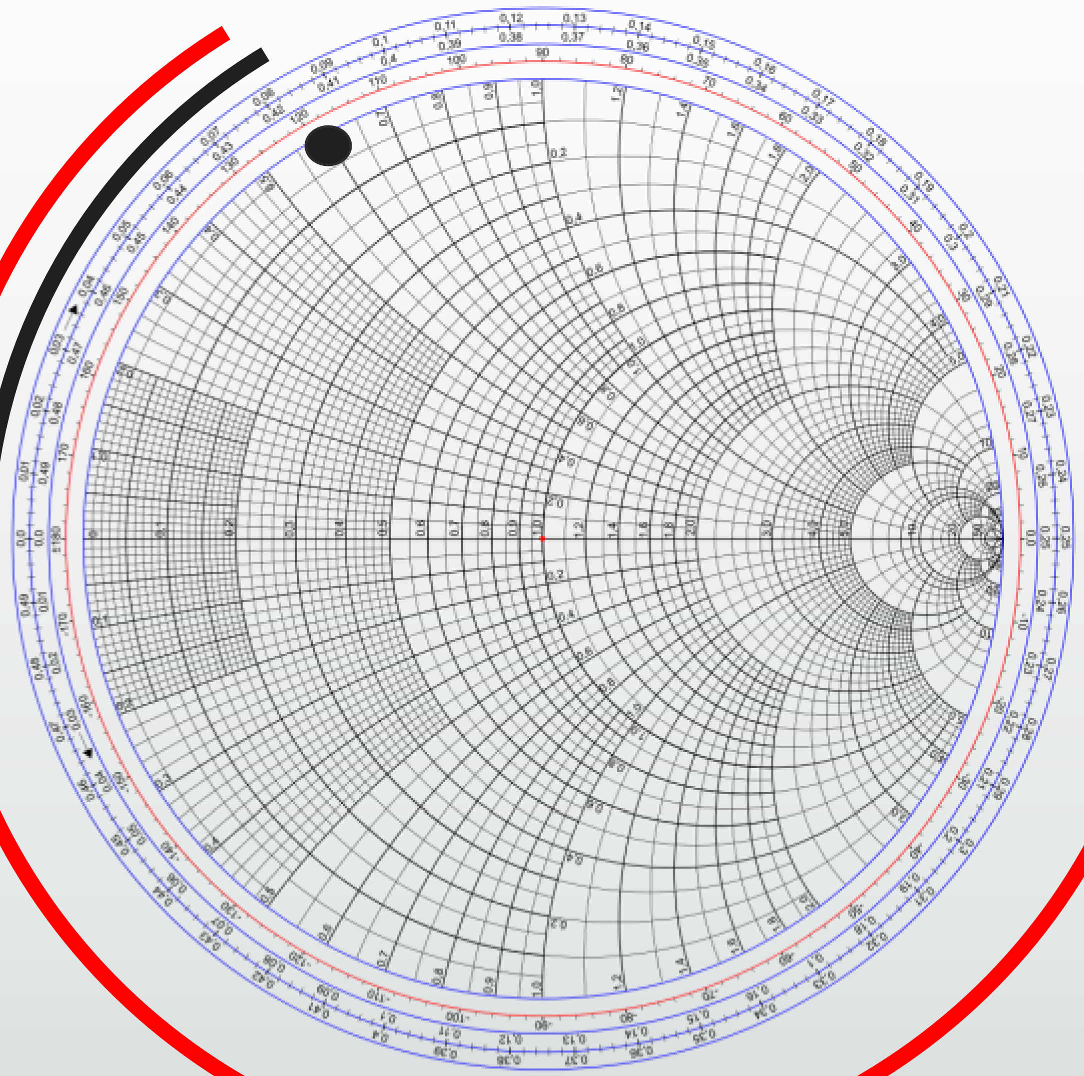


Configurations

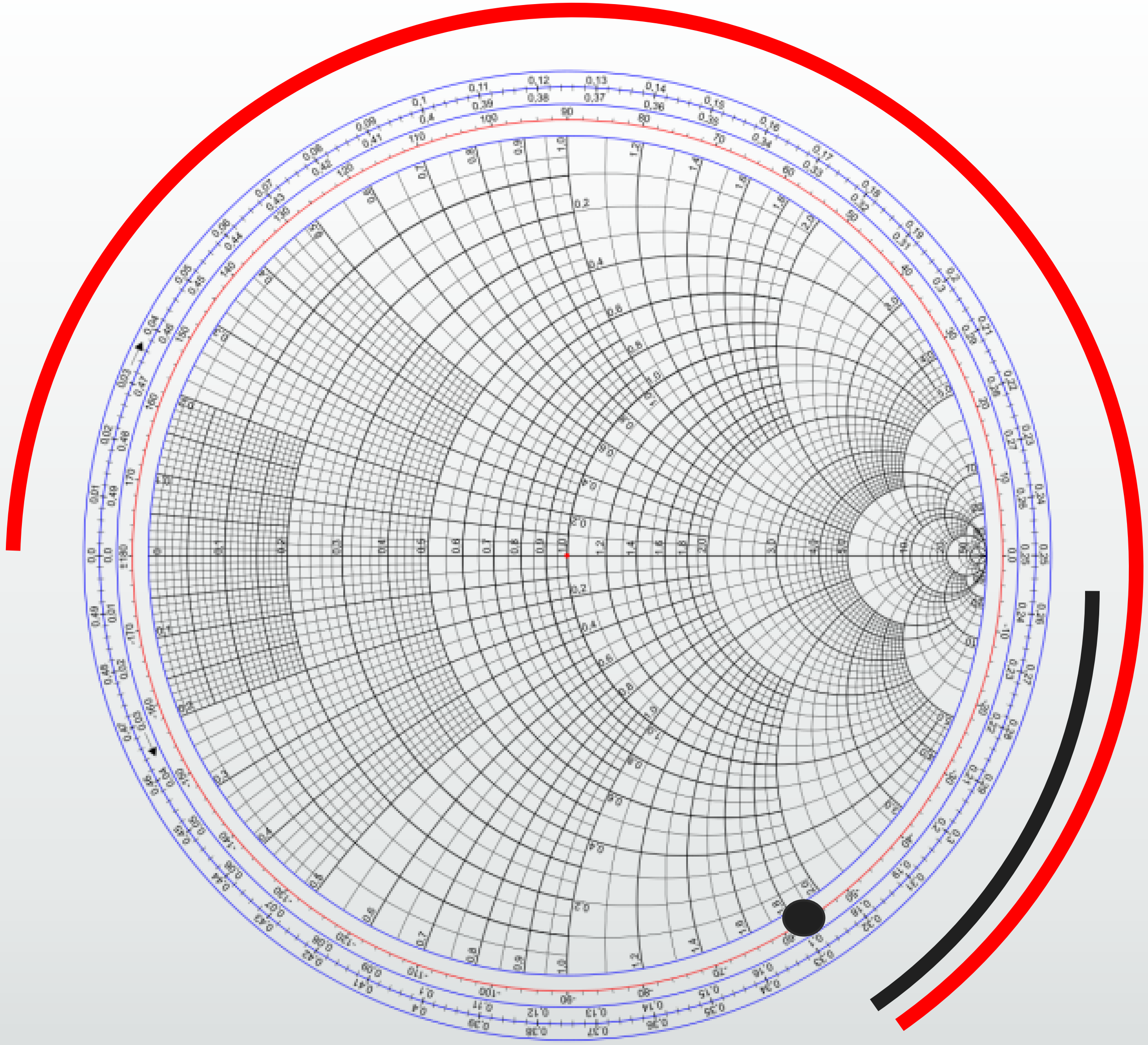




Finding Length for Certain Inductance

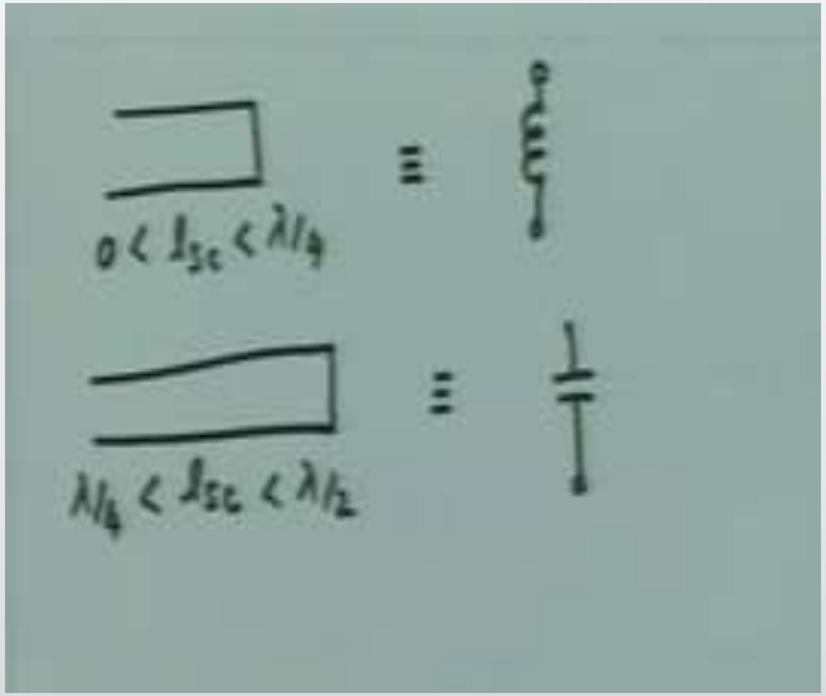


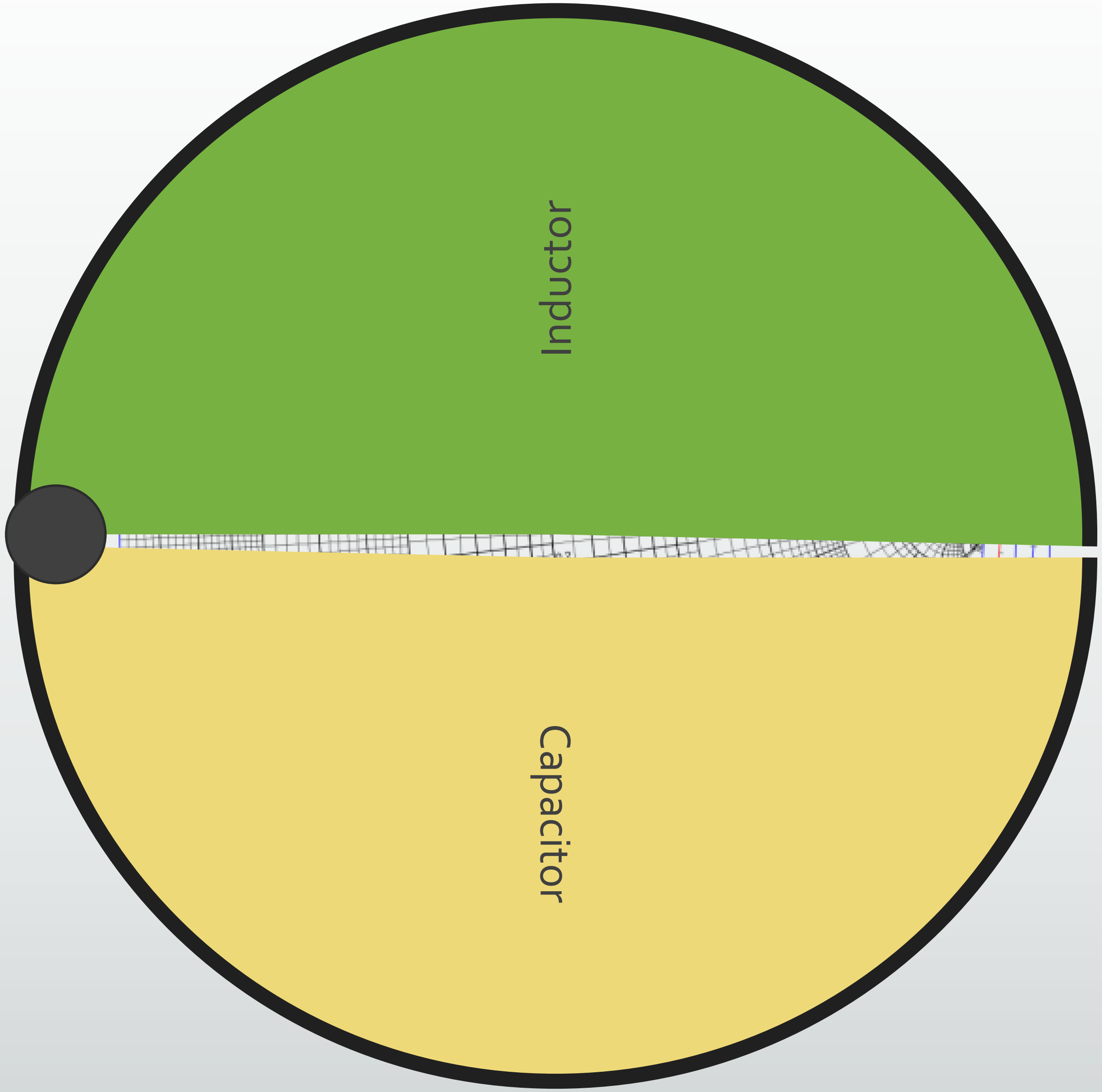
Finding Length for Certain Capacitance



Finalizing

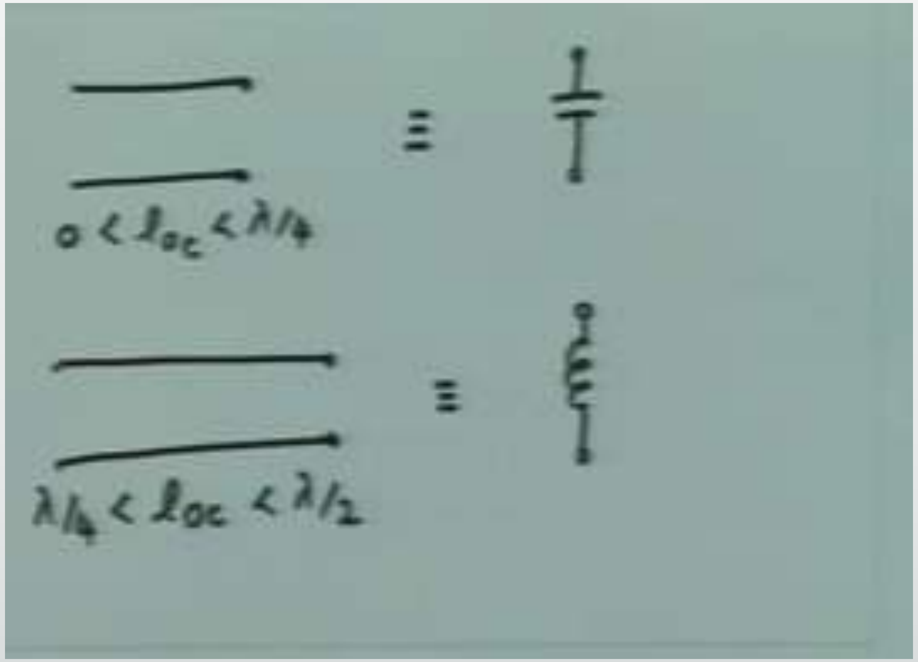
Short Circuit

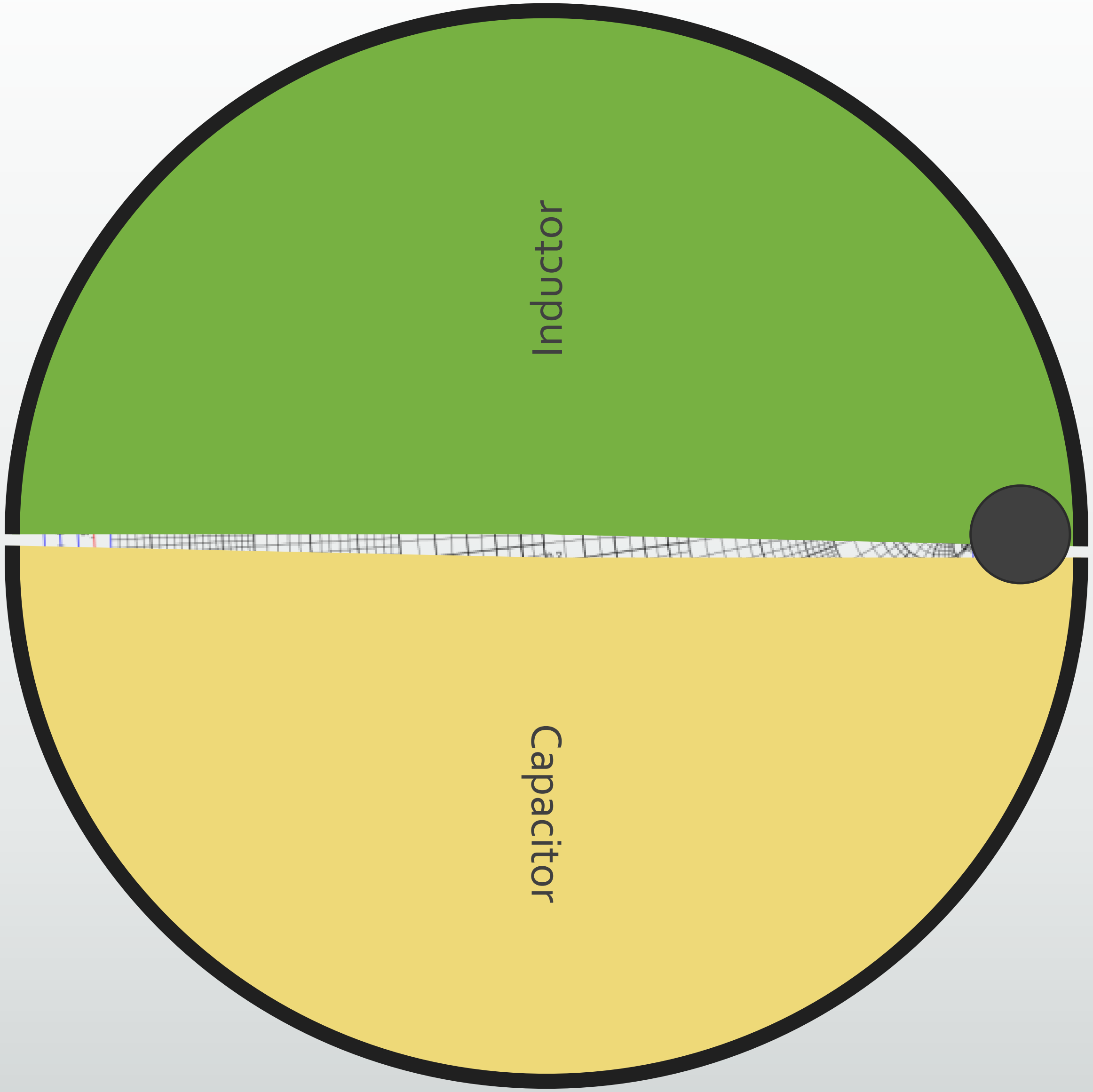




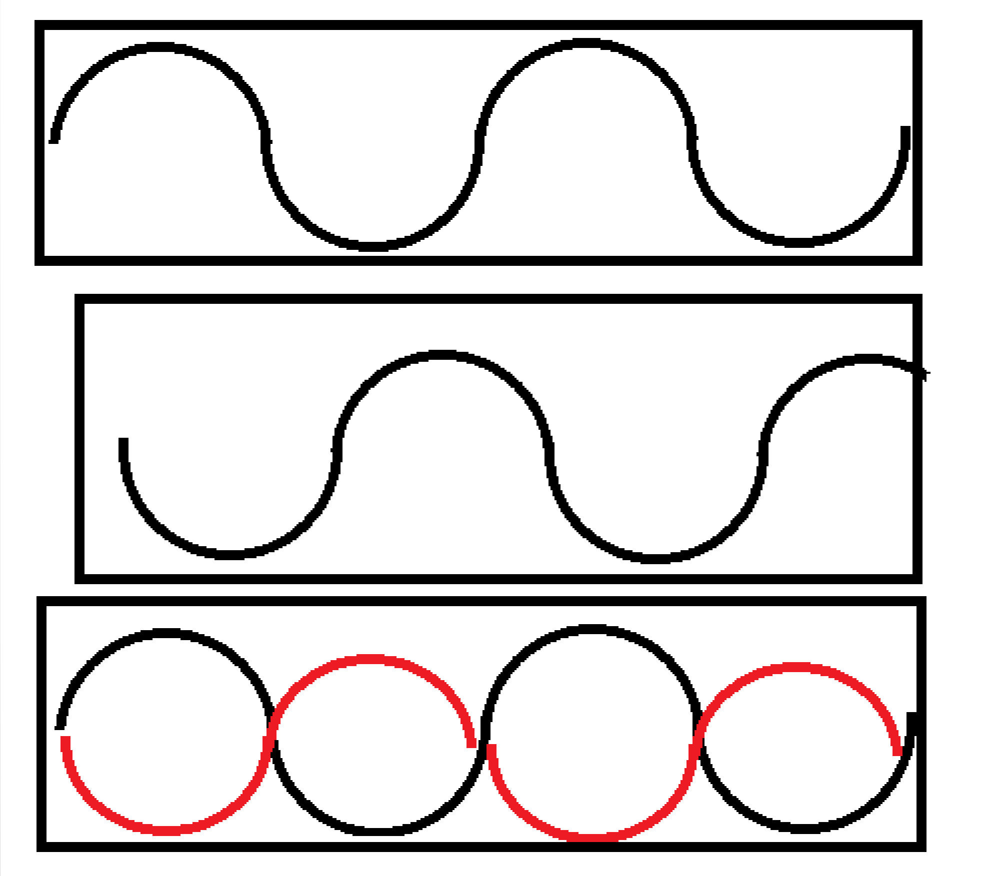
Finalizing

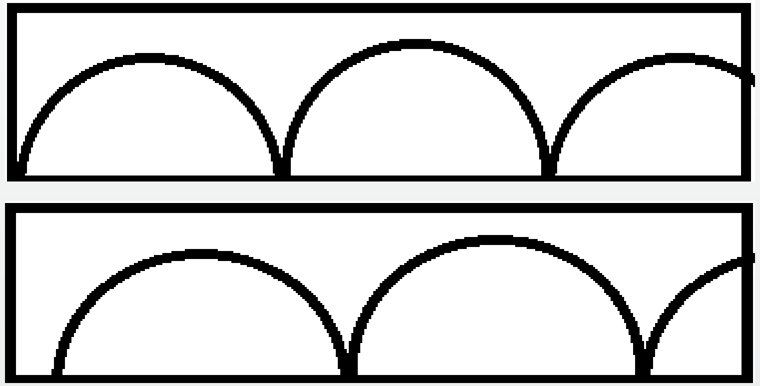
Open Circuit





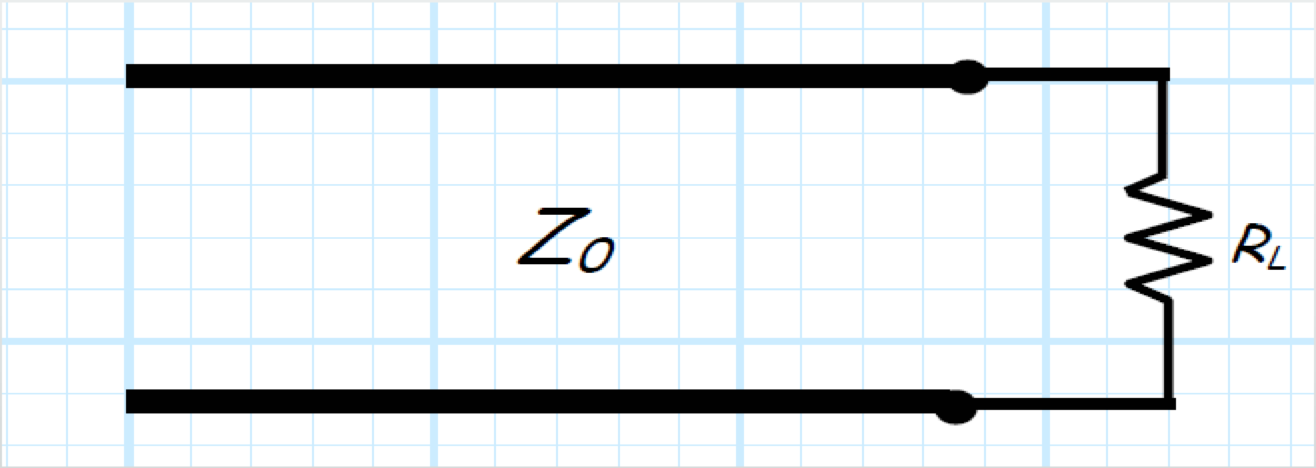
QUIZ





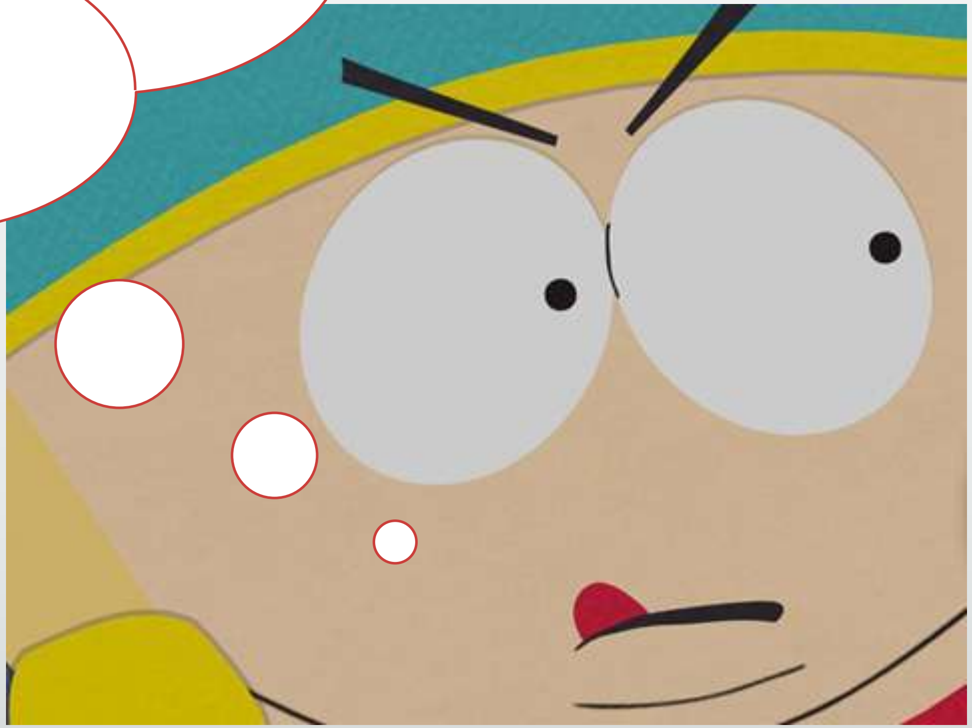
- Pure Resistance
- Capacitance Load
- R+JWL
- R-JX
- Reactive Load

- Lets say we have transmission line
- Having characteristic impedance Zo
- Terminated at “Resistive Load”

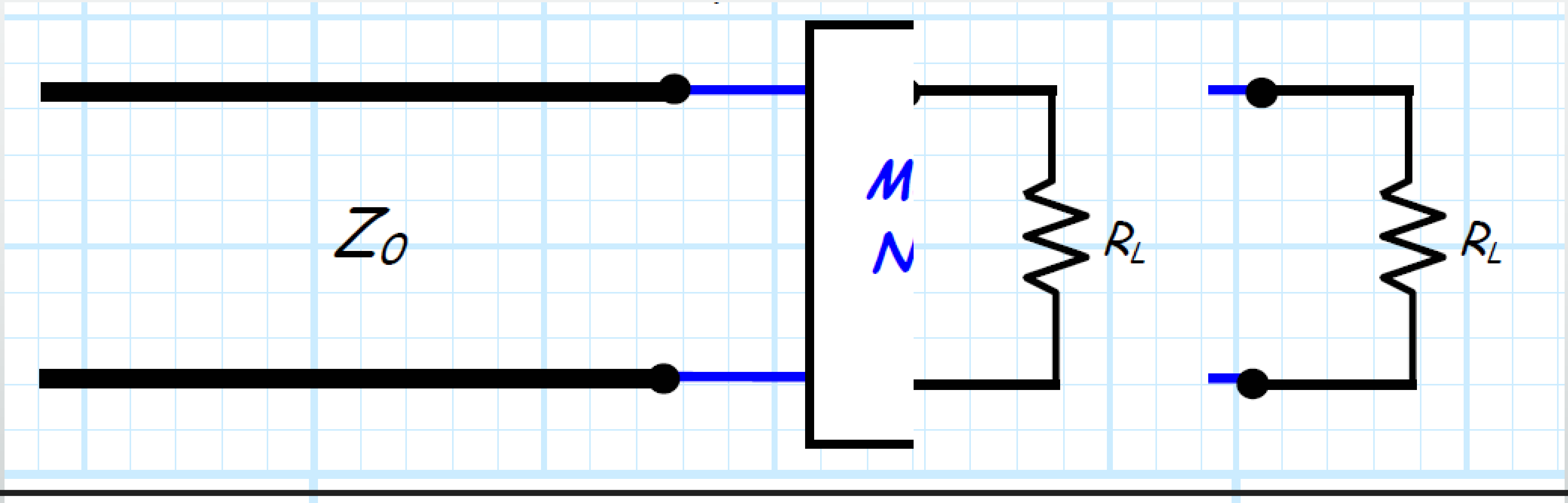


- For a good practical use, we would like that ,
- All power should be transferred to Load ,
- There is no reflection co-efficient
- Or simply $Zo= RL$

But it is not always possible to create loads or transmission line which match our need . So what we need to do than ?



- **Yes**! We can insert a **matching network** between the transmission line and the load.

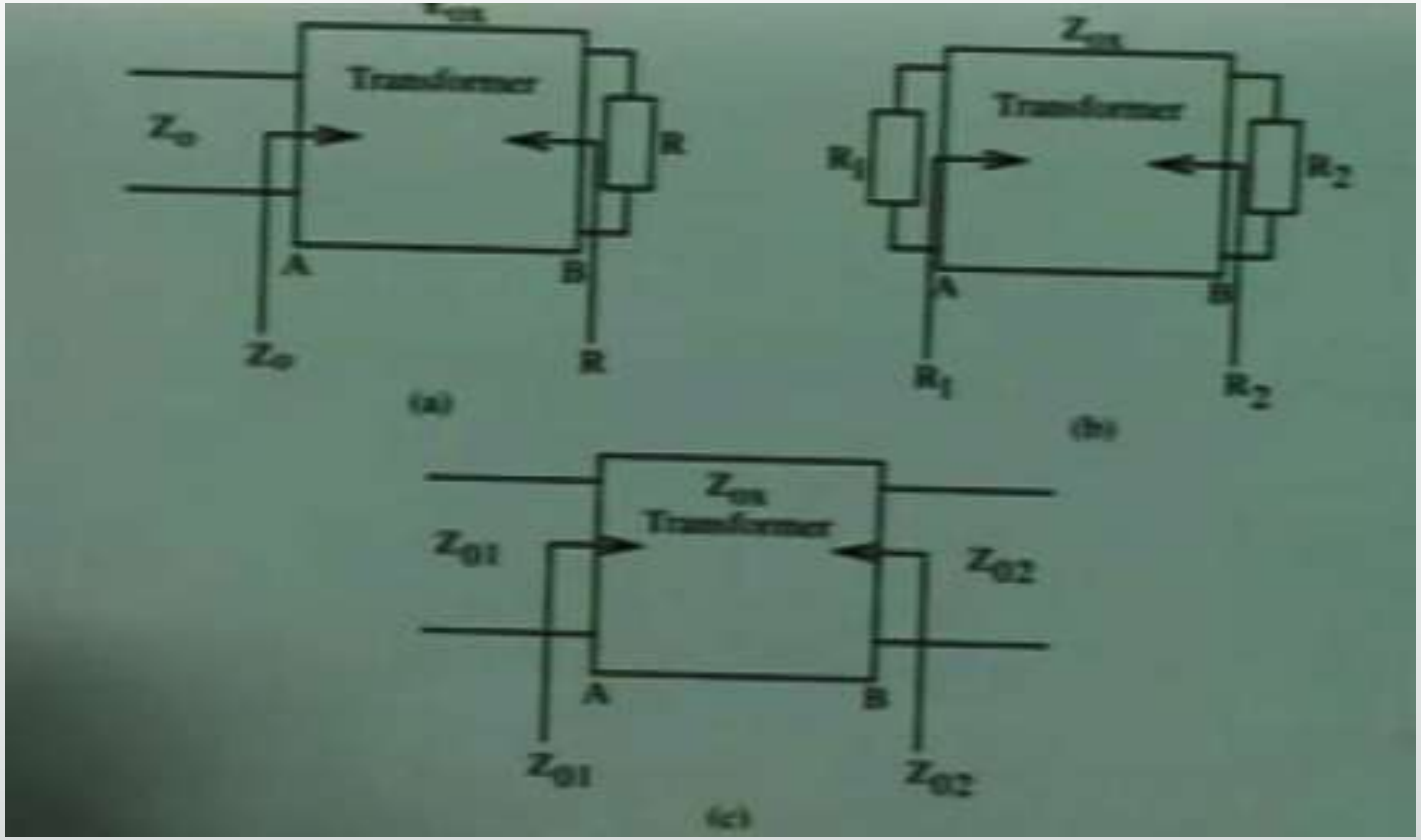


Next Question is .. What is Matching Network

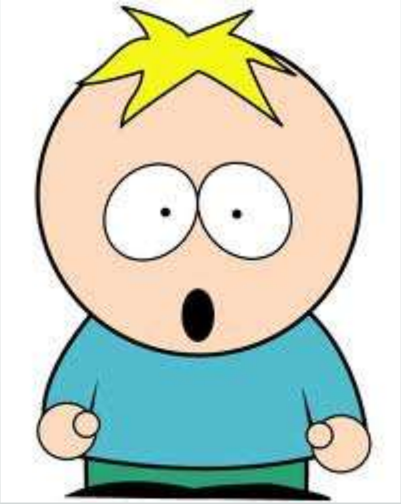
MATCHING NETWORK

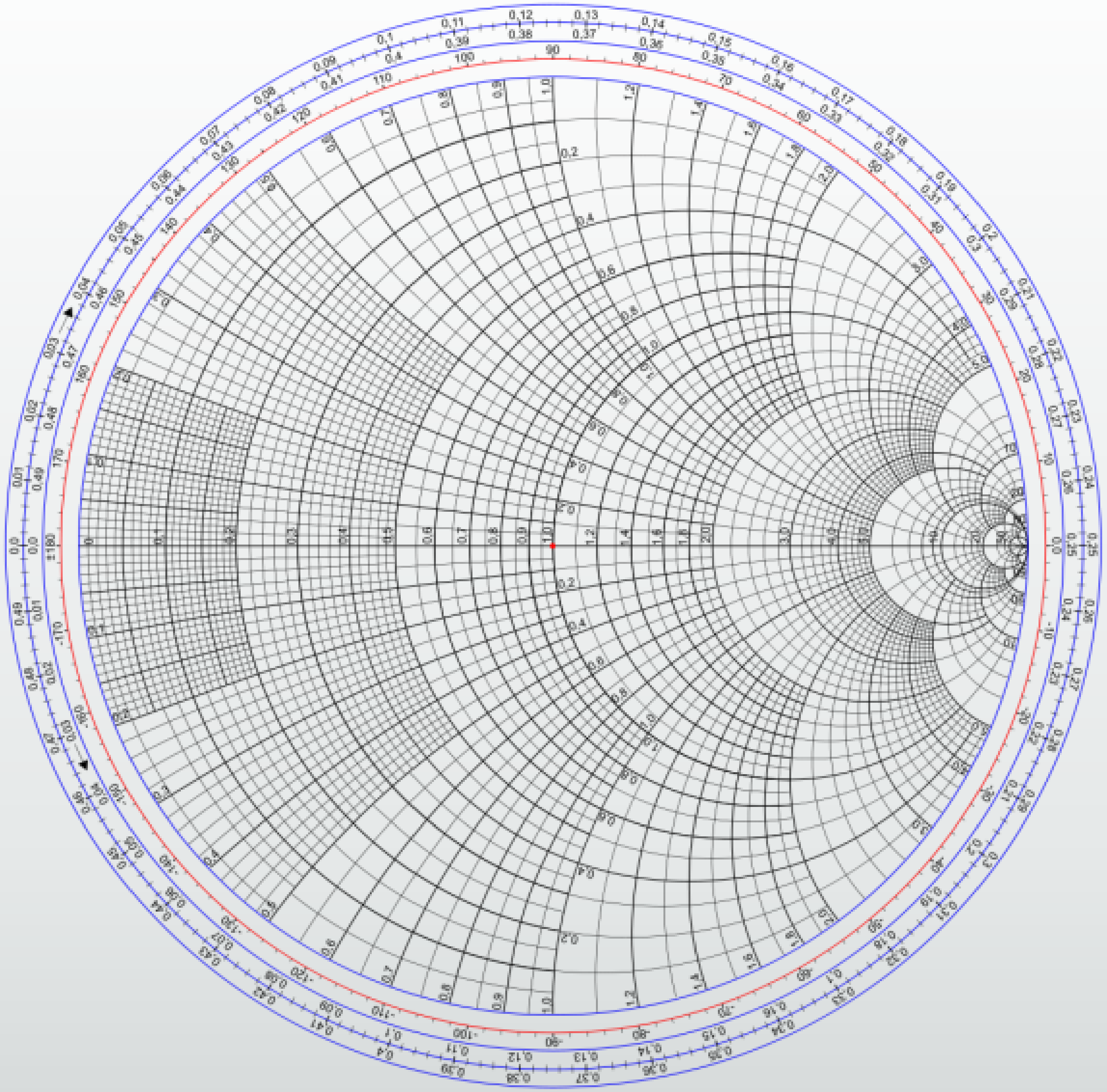
- A matching network is a **lossless, 2-port** device. Its job is to **transform**
- the load RL
- or ZL
- to a value Z0.

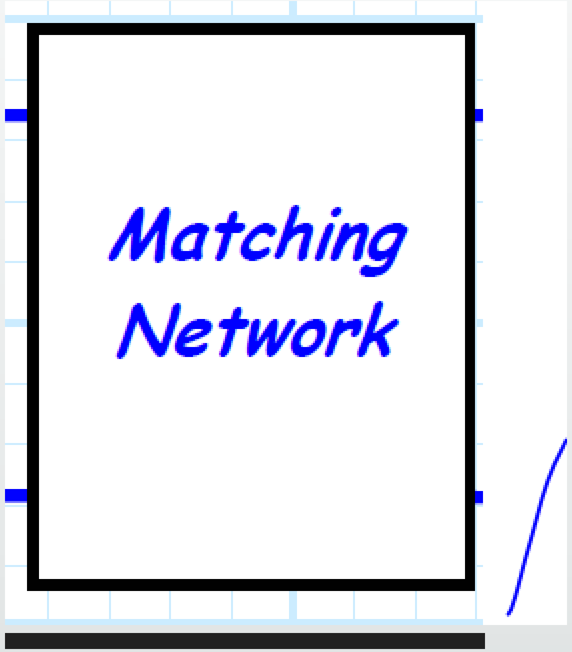
Some Uses


Transformer
Z₀
A
B
R
(a)
Transformer
R1
R2
A
B
(b)
Transformer
Z01
Z02
A
B
(c)

So how can we design them?





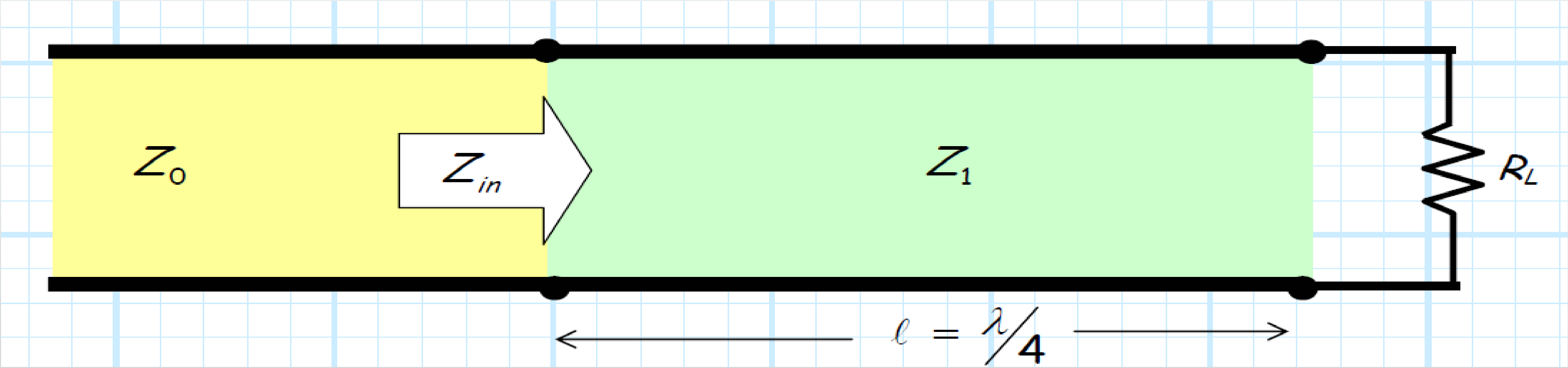


- LAMBDA/ 4

QAUTER WAVE TRANSFROM

METHOD

- Step 1 : insert a transmission line with characteristic impedance Z1
- Step 2: Make sure the length of the line is lambda by four (i.e., a quarter-wave line)
- Step 3 **Place it between** the load and the Zo transmission line.



- Remember, the quarter wavelength case is one of the **special** cases that we studied. We know that the **input** impedance of the quarter wavelength line is:

$$Z_{in} = \frac{(Z_1)^2}{Z_L} = \frac{(Z_1)^2}{R_L}$$

- if we wish for Zin to be numerically equal to Zo, we find:

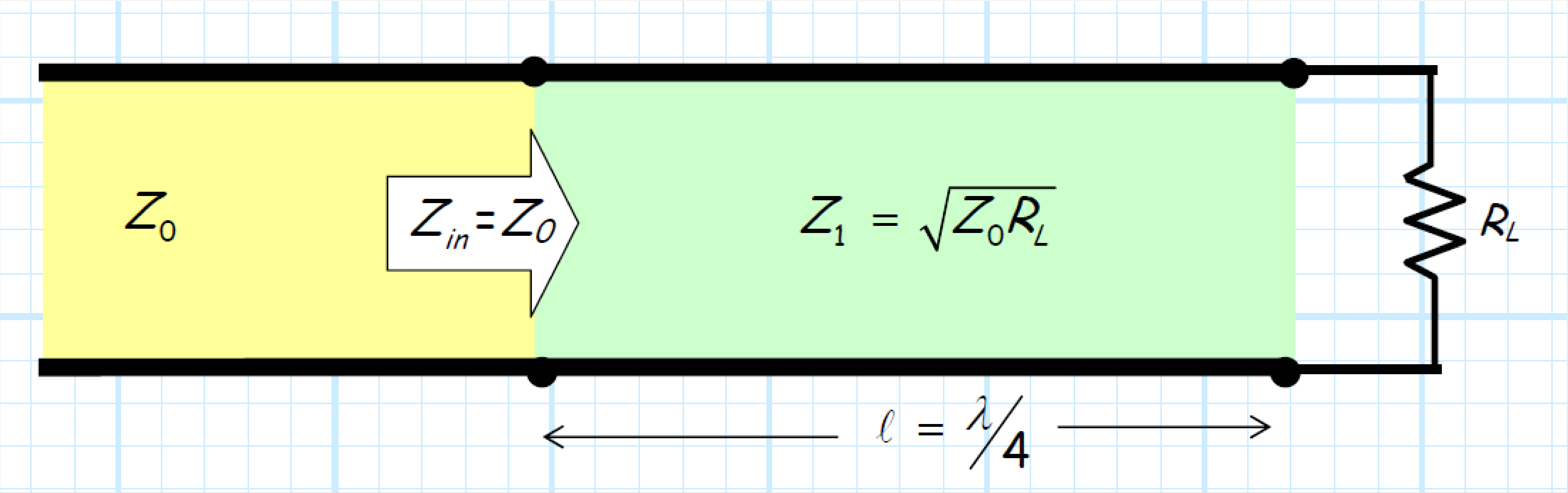
$$Z_{in} = \frac{(Z_1)^2}{R_L} = Z_0$$

Solving The Equation for Zo

$$\left(Z_1\right)^2 / R_L = Z_0$$

$$\left(Z_1\right)^2 = Z_0 R_L$$

$$Z_1 = \sqrt{Z_0 R_L}$$



Z_0
$Z_{in}=Z_0$
$Z_1 = \sqrt{Z_0 R_L}$
R_L
$\ell = \lambda/4$

Remember, **wavelength** is related to **frequency** as:

$$\lambda = \frac{v_p}{f} = \frac{1}{f\sqrt{LC}}$$

where v_p is the **propagation velocity** of the wave .

For **example**, assuming that $v_p = c$ (c = the speed of light in a vacuum), one wavelength at 1 GHz is 30 cm ($\lambda = 0.3\ m$), while one wavelength at 3 GHz is 10 cm ($\lambda = 0.1\ m$). As a result, a transmission line length $\ell = 7.5\ cm$ is a quarter wavelength for a signal at 1GHz **only**.

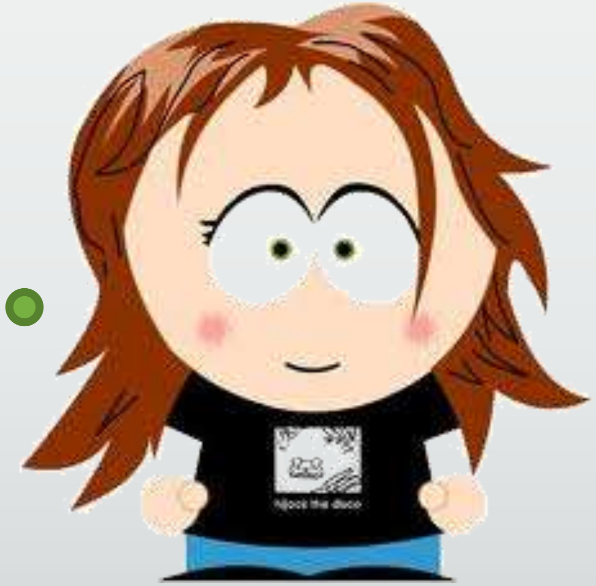
Final TERM SYLLABUS (Till Yet .....)

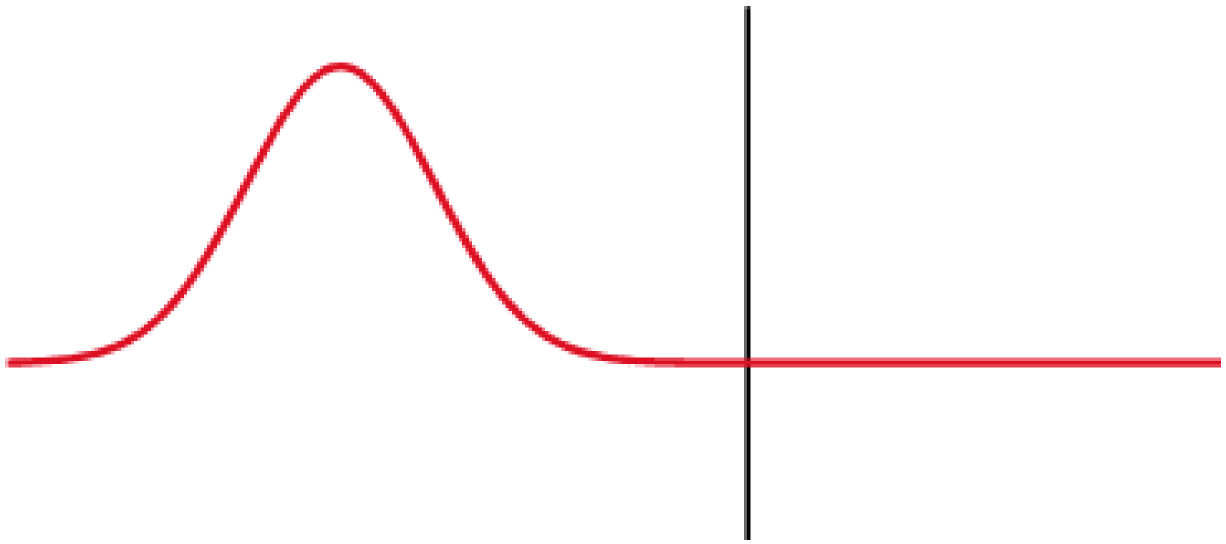
- TERMINATED LOSS LESS LINE
- Incident Reflected and Absorbed Power
- Special Cases of Transmission Line Length
- Transforming Impedances
- Reflection Co-efficient Transformation
- Smith Chart
- Smith Chart Areas
- Smith Chart Problems
- SWR and Load
- Uses of Transmission Lines
- Quarter Wave Transform

Multiple Reflection Theory

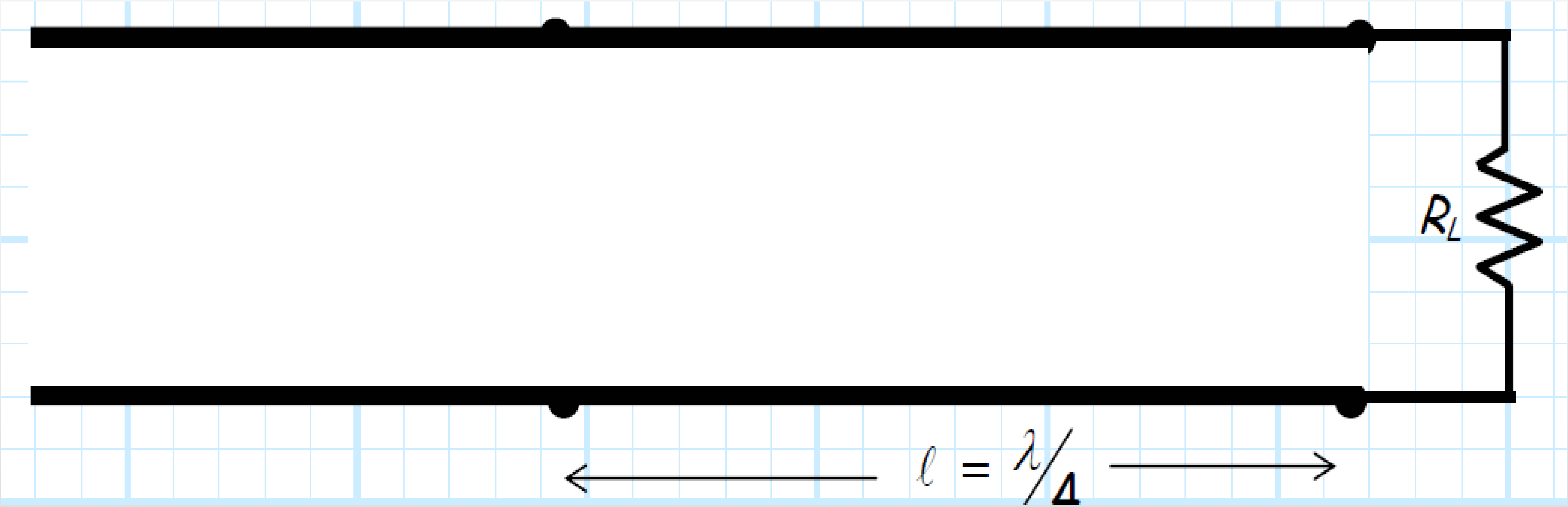
- The **quarter-wave** transformer brings up an interesting question

Will there not be any Reflection due to New Impedance Introduced

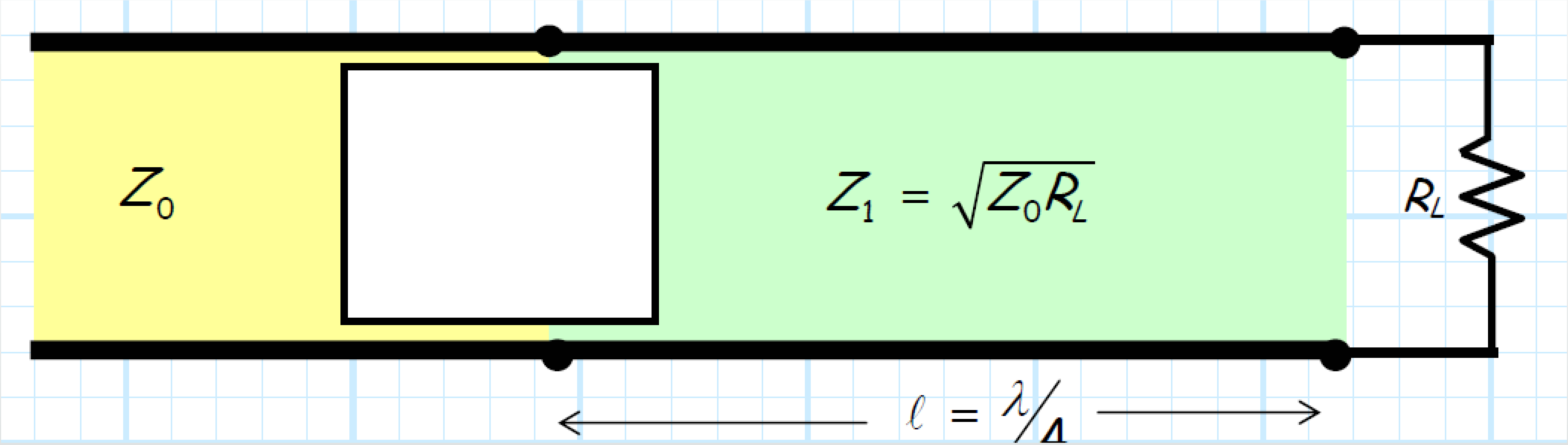




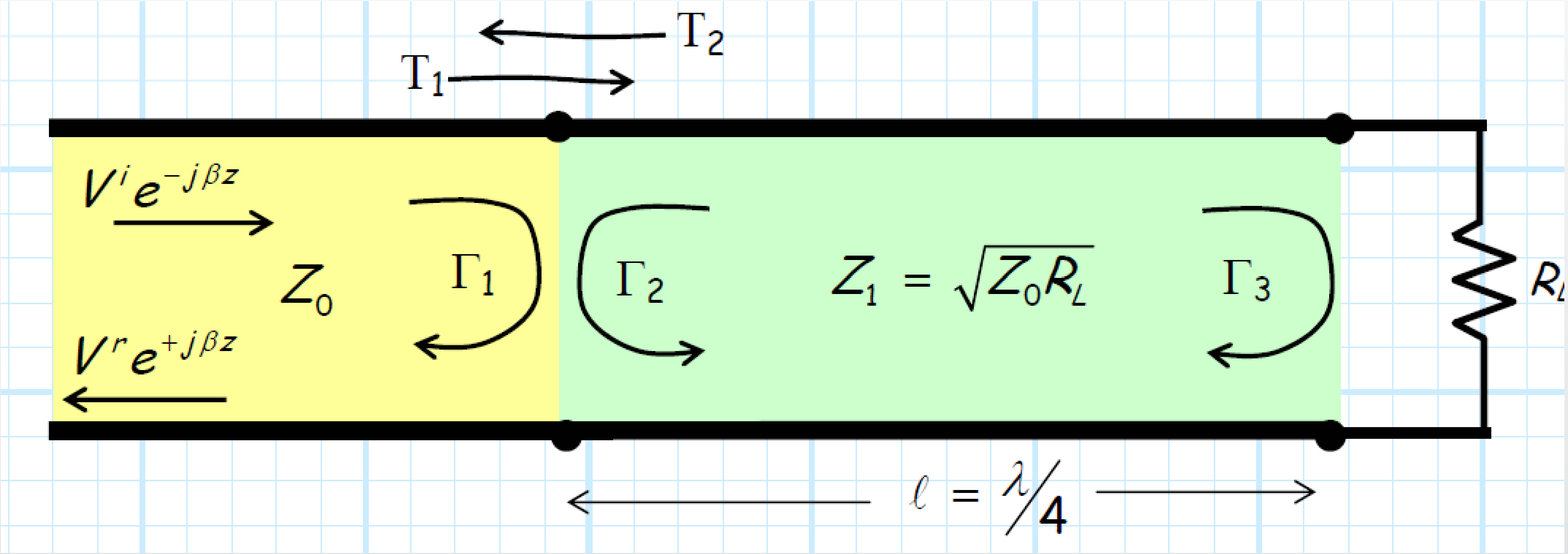
Multiple Reflection Theory



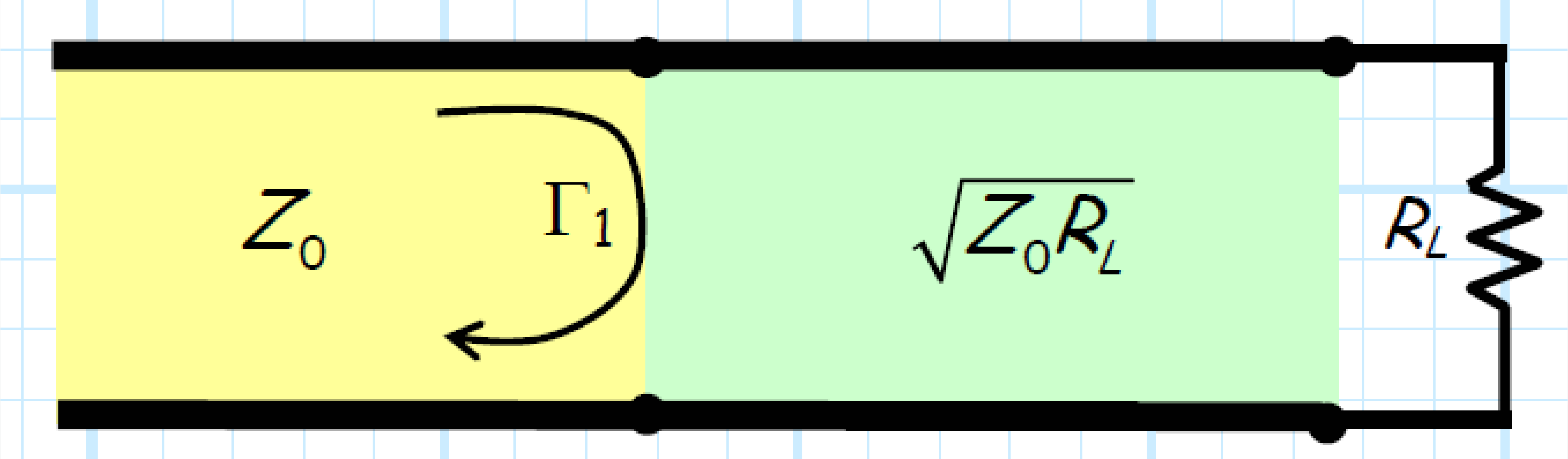
Multiple Reflection Theory



Multiple Reflection Theory



Multiple Reflection Theory



Γ_1 = **partial** reflection coefficient of a wave incident on the $z=-\ell$ interface from the Z_0 line:

$$\Gamma_1 = \frac{Z_1 - Z_0}{Z_1 + Z_0}$$

NOW LETS PUT THE WHOLE PICTURE TOGATHER

Excuse me !!!! Can some one tell us , what about our sessional marks

SURE !!!!

- Your First 10 Marks are assigned to a Presentation.
- Every presentation will be of 30 Minutes (Including Q/A Sessions)
- Ever group will consist of four people
- Every presentation will end with a quiz , conducted by Team ,
- The Quiz Score will be added to Sessional Marks
- Presentation will be carried out on multimedia
- If required, you may include Videos .
- Extra Credit will be given to Group who will include mathematical problems and numerical in presentation and Quiz
- A 4-5 page report is to be submitted

KLYSTRON

IMPATT Diodes

TWT

Microwave
Tunnel Diodes

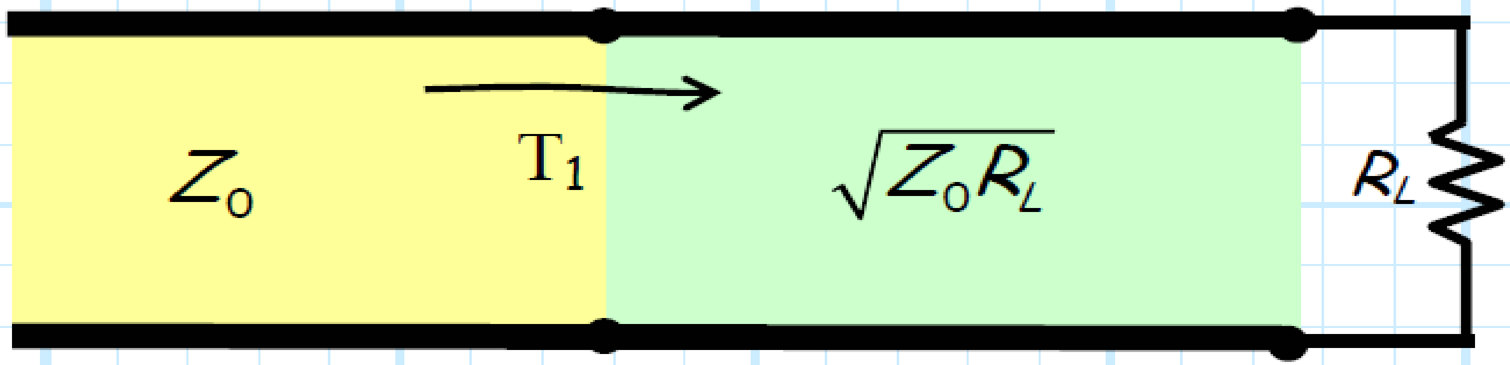
Magentron

Defining Transmission Co-efficient

- The **transmission coefficient** is used in physics and electrical engineering when wave propagation in a medium containing discontinuities is considered. A transmission coefficient describes the amplitude, intensity, or total power of a transmitted wave relative to an incident wave.

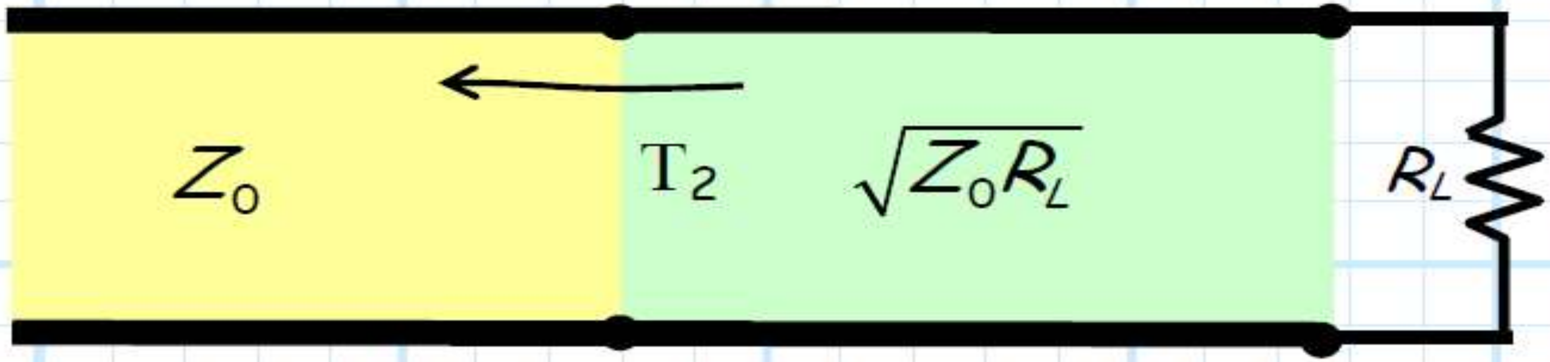
T_1 = **partial** transmission coefficient of a wave incident on the $z=-\ell$ interface from the Z_0 line:

$$T_1 = \frac{2Z_1}{Z_1 + Z_0}$$

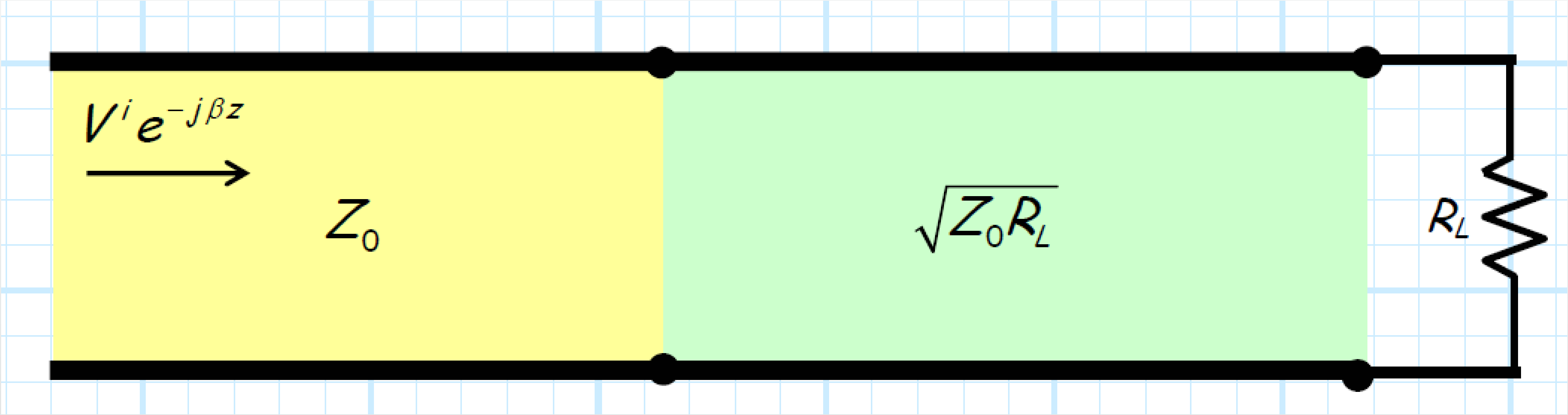


T_2 = **partial** transmission coefficient of a wave incident on the $z = -\ell$ interface from the Z_1 line:

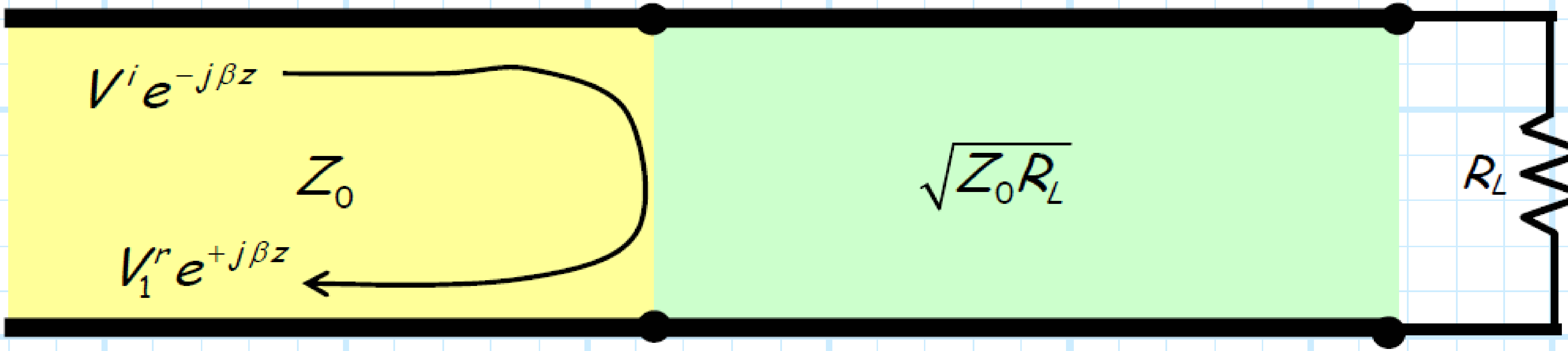
$$T_2 = \frac{2Z_0}{Z_0 + Z_1}$$



Putting The whole Picture Together

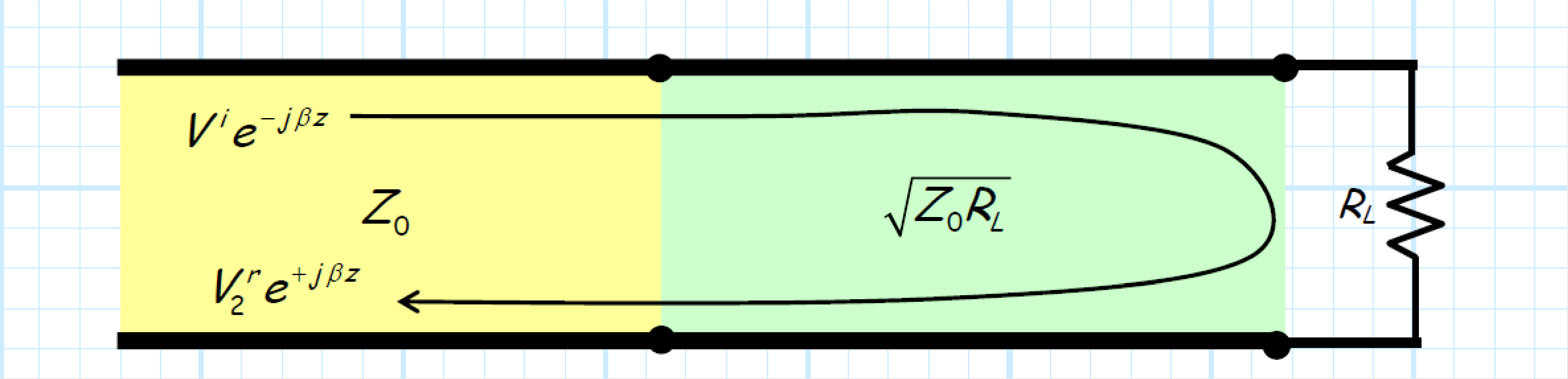


1. At $z = -\ell$, the characteristic impedance of the transmission line changes from Z_0 to Z_1. This mismatch creates a **reflected** wave:



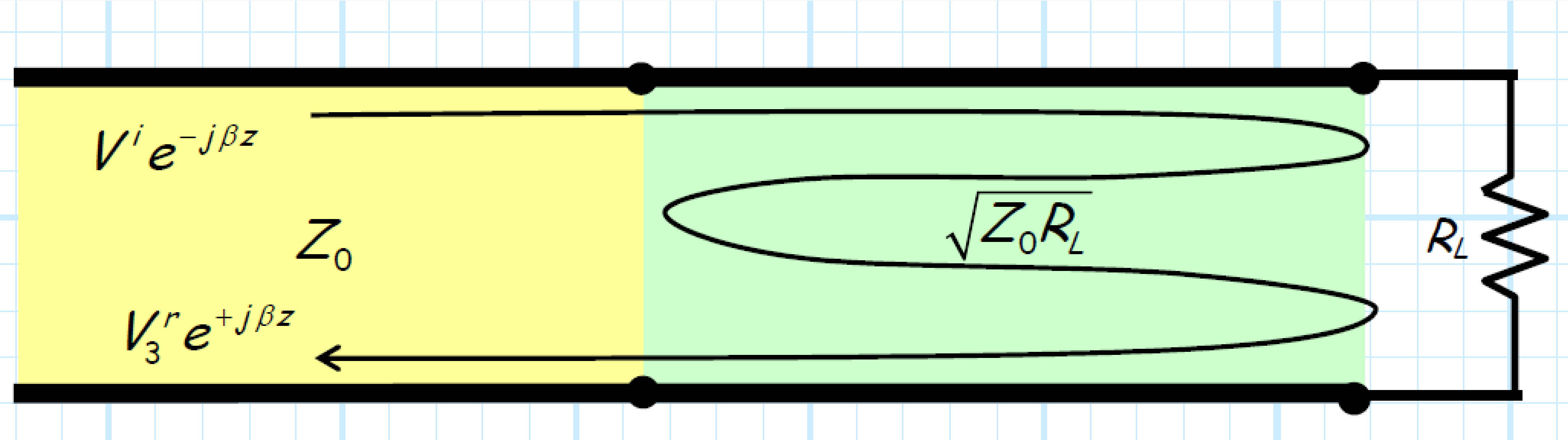
where $V_1^r = \Gamma_1 V^i$.

Step 2



$$= -T_1 \, T_2 \, \Gamma_3 V^i$$

Step 3



$$= T_1 T_2 (\Gamma_3)^2 \Gamma_2 V^i$$