ECET 3410 - High ƒ Systems **Chapters Four (4) Exam Problems**

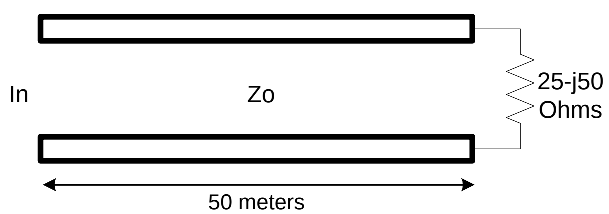
Instructions: This exam is closed book, except for one 8.5”x11” sheet of handwritten notes (as specified for exam I).

Coaxial Cables											
RG #	AWG Material	Insulation	# Shields	Jacket	Nom. O.D. (inch)	Nom. Imp. (Ohms)	Nom. Vel. Of Prop.	Nom. Cap. (pF/ft.)	Nom. Attenuation per 100’ MHz	dB	Standard Spool Lengths
14/U	20 Copper	Poly- ethylene	1	Black Vinyl	.420	95	66%	16.0	100 200 400	3.0 4.5 6.0	100, 500
14A/U	20 Copper	Poly- ethylene	1	Black Vinyl	.420	92	66%	16.0	100 200 400	3.5 5.0 7.0	100, 500
16A/U	18 Copper	Cellular Poly-ethylene	1	Black Vinyl	.195	50	78%	30.8	100 200 400	5.0 7.0 9.5	100,500 1000
18/U	18 Copper	Cellular Poly-ethylene	1	Black Vinyl	.280	75	78%	24	100 200 400	4.0 6.0 8.0	100,500 1000

Problem #1) A 50 meter long, lossy (coaxial) transmission line (Z_o = 50 Ω, γ = 0.005 +j0.02513 /meter) is connected to a 25-j50 Ω load and is supplied by an 828 kHz, r.f.-source.

Determine the **input impedance** of the line **using a Smith Chart**.

Note – if you are not able to determine the length of the line in wavelengths, you may use the value .7λ, but points will be deducted from your score.



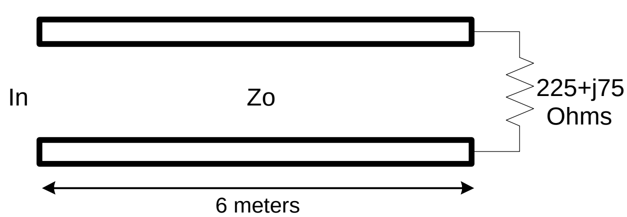
Z_{in} = ___________**26.5+j16.5**_______Ω

Problem #2) A 6 meter long, lossy (coaxial) transmission line has the following characteristics:

Z_o = 75 Ω, γ = 0.037 +j1.365 (Np/m and rad/m respectively)

The line is connected to a 225+j75 Ω load and is supplied by an 43 MHz, r.f.-source.

Determine the **input impedance** of the line ***using a Smith Chart***.



Z_{in} = __________**37.5+j12.75**________Ω

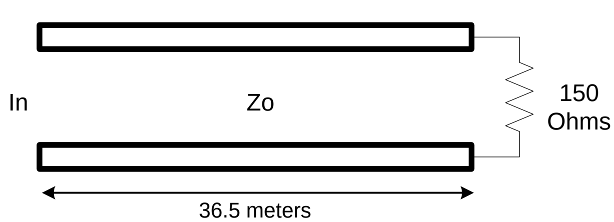
Problem #3) A 36.5 meter long, lossy transmission line has the following characteristics:

Z_o = 75Ω, γ = 0.0189 +j19.04 (Np/m and rad/m respectively)

The line is connected to a 150 Ω load and is supplied by a 600 MHz, r.f.-source.

Determine the actual **input impedance** of the line.

You must use and completely LABEL the Smith Chart for your solution.



Z_{in} = ______________________________________Ω

Multiple Choice and TRUE/FALSE

If a Smith Chart is used to determine the **input impedance** of a transmission-line terminated with a known load:

a) the solution will require a rotation around the Smith Chart in the clock-wise direction
b) the input impedance will be closer to the chart's center than the load impedance for a lossy line
c) the plotted impedances must be normalized if the impedance value of the chart's origin (center point) is not equal to the line's characteristic impedance
d) All of the above (a-c) are correct

Given a transmission-line with known input impedance, solving for the **load impedance** connected to the receiving-end of the line requires a rotation on a Smith Chart:

a) in the clockwise direction.
b) in the counter-clockwise direction.
c) in a direction that is dependent on the initial input impedance value.
d) that will reverse direction with every ½-wavelength of line length traveled.

A (lossless) **short-circuited stub** of length L:

a) can appear as an open-circuit at its input depending on the length L.
b) can appear as any desired inductance value at its input depending on the length L.
c) can appear as any desired capacitance value at its input depending on the length L.
d) All of the above choices (a-c) are correct.

Given a lossy transmission line, the plotted position of the line's normalized **load-impedance** on a Smith Chart:

a) will be in the top half of the chart for a "capacitive" load.
b) will change is the line was actually lossless.
c) will be further from the "origin" than the position of the line's normalized input impedance.
d) All of the above choices (a-c) are correct.

Compared to a ¼-wavelength tuner, a **single-stub tuner**:

a) always utilizes standard transmission-line impedance values (such as in table 1-3 of the text).
b) can be used to match a complex load-impedance to a purely resistive source impedance.
c) will result in a better match for a purely real load to a purely real source impedance.
d) All of the above choices (a-c) are correct.

____True___ The **magnitude** of the **reflection coefficient** due to a load impedance on a transmission-line relates to the distance from the normalized load impedance to the center of the Smith Chart.

____True___ The **circle** that provides the outer-boundary of the impedance portion of the Smith Chart defines a set of impedance points all of which have real values of zero (purely imaginary impedances).

____False___ The set of normalized load impedances defined by a circle centered at the origin of a Smith Chart will all result in the same **reflection coefficient** on the transmission-line.

____True___ The set of normalized load impedances defined by a circle centered at the origin of a Smith Chart will all result in the same **VSWR** on the transmission-line.

____False___ The point with the **largest impedance magnitude** within a set of impedances defined by a circle centered about the Smith Chart's origin will be the "left-most" point on the circle.

____False___ Adding **½ wavelength** of line to a transmission-line terminated by a load will effectively cause an additional rotation of ½-revolution during the solution of the problem on a Smith Chart.

____True___ A **rotation** in the "clock-wise" direction around a Smith Chart relates to a movement on a transmission line from a "known impedance" location towards the "sending end" of the line.

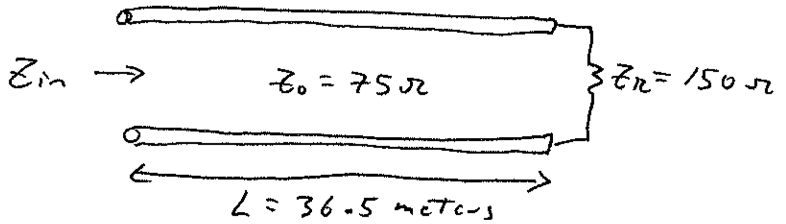
____True___ To account for **losses** on a transmission line when using a Smith Chart to solve for an unknown impedance, both a rotation and a change in the distance from the origin are required.

____True___ All of the impedances shown on the **top half** (above but **not** including the horizontal axis) of a Smith Chart have a (non-zero) ***inductive reactance*** component.

____True___ Given an impedance plotted on a Smith Chart, the **admittance** value of the plotted impedance may be determined by drawing a circle centered at the origin that passes through the impedance point and then finding the point that is 180° around the circle from the plotted impedance.

"more Sample Exam Problems for Exam II" - Problem #3

$\gamma = 0.0189 + j19.04$ at $f = 600$ MHz.



Determine Z_{in} using S.C.

① Determine length of line in "wavelengths"

$$\lambda = 2\pi/\beta = 2\pi/(19.04) = 0.330 \text{ meters}$$

$$L(\text{wavelengths}) = \frac{L(\text{meters})}{\text{wavelength}/\text{meter}} = \frac{36.5 \text{ meters}}{0.330\ m/\lambda} = \underline{\underline{110.606 \text{ wavelengths}}}$$

② Normalize and plot load, and draw circle centered @ origin through load

$$\overline{Z}_R' = Z_R/Z_0 = 150/75 = 2\ \Omega$$

③ Draw line from origin through $\overline{Z}_R$ and determine starting marker

④ Add line length to START to determine END position

START	0.250
+ length	110.606
END	110.856
−	110.500
Equiv END	0.356

← subtract whole multiples of $\frac{1}{2}\lambda$ to get equivalent end

⑤ Draw line from origin to end marker position

⑥ Determine $|\Gamma_R|$ from circle through $\overline{Z}_R$

⑦ Determine $|\Gamma_{in}|$ from $|\Gamma_R|$ and α

$$|\Gamma_{in}| = |\Gamma_R| e^{-2\alpha L} = (0.33)\left(e^{-2(0.0189)(36.5)}\right) = 0.083$$

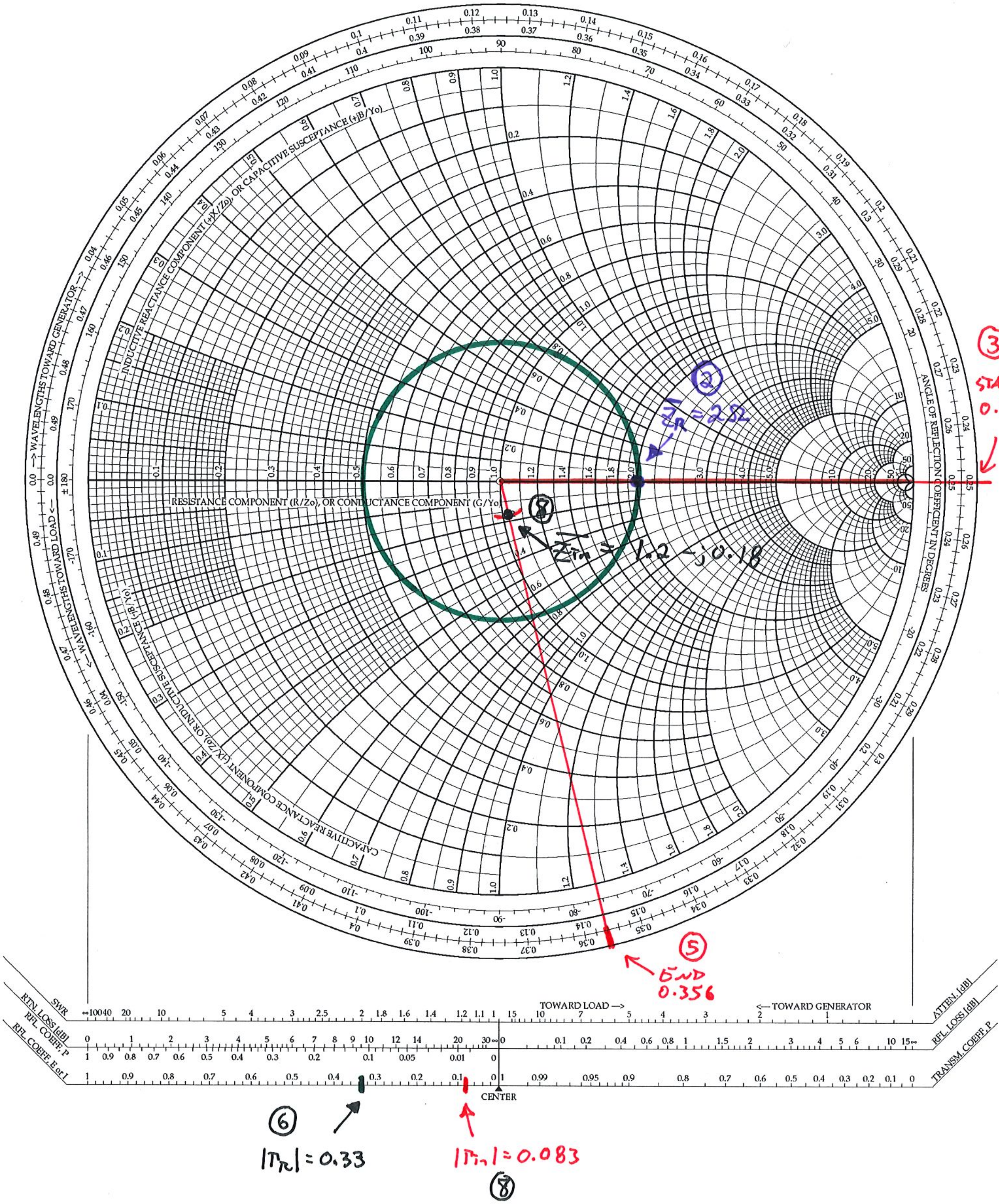
⑧ measure $|\Gamma_{in}|$ on $|\Gamma|$ scale and determine point on END line $|\Gamma_{in}|$ from origin

⑨ Read $\overline{Z}_{in}$ from SC.

$$\overline{Z}_{in} = 1.2 - j0.18\ \Omega$$

⑩ Unnormalize the input impedance

$$Z_{in} = \overline{Z}_{in} \cdot Z_0 = (1.2 - j0.18)(75) = \boxed{90 - j13.5\ \Omega}$$



WAVELENGTHS TOWARD GENERATOR →
← WAVELENGTHS TOWARD LOAD
INDUCTIVE REACTANCE COMPONENT (+jX/Zo), OR CAPACITIVE SUSCEPTANCE (+jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo), OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
SWR
RTN. LOSS [dB]
RFL. COEFF, P
RFL. COEFF, E or I
TOWARD LOAD →
← TOWARD GENERATOR
ATTEN. [dB]
RFL. LOSS [dB]
TRANSM. COEFF, P
CENTER
③ START 0.250
② $\bar{Z}_R = 2\Omega$
⑧ $\bar{Z}_{in} = 1.2 - j0.18$
⑤ END 0.356
⑥ $|\Gamma_R| = 0.33$
$|\Gamma_{in}| = 0.083$
⑧