2. A 50 ohm transmission line 20 feet long is terminated with a load
$Z=50-j50$ ohms. What is the input impedance at 14.1 Mhz? The coax
has a $Z_0=50$ ohms and a velocity of propagation equal to .66c. Use
Smith chart A to do your work. [10]

\[
\frac{Z_{\text{in}}}{\text{norm}} = \frac{Z}{Z_0} = \frac{24-j10.7}{50-j50} = \frac{-0.12-j0.21}{50-j50} \\
\Rightarrow \quad Z_{\text{in}} = 120-j35
\]

Normalized $Z$ is $1-j1$

\[\lambda = \frac{66c}{14.1 \times 10^6} = 14.04 \text{ m} \]

\[\text{line is } \frac{6.096}{14.04} = \frac{0.4342}{\text{long}} \]

\[20\text{ft} = 6.096 \text{ meters} \]

3. We have an antenna operating at 7Mhz that presents a feedpoint impedance of
$150-j65$. It is fed with 50 coax with a velocity of propagation equal to
$.66c$. Design a stub matching system so that the input impedance at the transmitter
end of the coax is 50 ohms resistive. The length of the coax from the
transmitter to the selected stub location is 50ft.

a) On Smith chart B, graphically solve for the first two stub locations for both
the series and shunt solutions. Clearly show your work on the Smith chart.
Then enter the values for your solution below.

<table>
<thead>
<tr>
<th>stub location</th>
<th>series case</th>
<th>shunt case</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.057</td>
<td>1.612</td>
</tr>
<tr>
<td>4</td>
<td>0.4025</td>
<td>1.39</td>
</tr>
<tr>
<td>4</td>
<td>0.1505</td>
<td>4.258</td>
</tr>
<tr>
<td>4</td>
<td>0.3050</td>
<td>8.628</td>
</tr>
</tbody>
</table>

b) On Smith chart C, graphically solve for two stub lengths for the
solutions indicated.

| position A, series, shorted stub | 0.48 | 4.187 |
| position B, shunt, open ckt stub | 0.148 | 4.187 |
c) Suppose that using a shunt, open circuit stub at position B (above) was impractical. What value of inductor or capacitor would be needed to create the match? [4]

\[ X_L = \frac{1}{2\pi f C} \]

\[ X_L = 37 \text{ ohms capacitive} \]

\[ C = \frac{1}{2\pi f (7 \times 10^6)} = 6139 \text{ nF} \]

d) To run a spice simulation to determine if your solutions are correct, you must have a couple of components that represent the antenna. Determine the values of those components and show a schematic of the representative load below. [8]

\[ -j65 \Omega \text{ at } 7 \text{ MHz} \]

\[ \frac{1}{2\pi f (7 \times 10^6)(65)} = C \]

\[ C = \frac{1}{2\pi f (7 \times 10^6)65} \]

\[ 65 = \frac{1}{2\pi f (7 \times 10^6)} \]

4. Explain in your own words what the strategy of stub matching is. Be concise and complete. [8]

Working back towards the generator, find the points where the real portion of the impedance is equal to the system impedance. Find the imaginary component at that point to cancel it out by using a T-line that presents the necessary reactive component to cancel the reactance.

5. Are reflections always bad on transmission lines? Answer and justify your answer. [10]

No, we can use the reflections to achieve impedance matching.
Series, loc A = .327 + .27 = .557 \lambda
Series, loc B = .23 + 1.725 = .4025 \lambda

Smith Chart "B"

Shunt location A
Series location B

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