CheggSolutions - Thegdp

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## Sub-Subject: Transmission Line Theory

### Topic: Impedance and Reflection Coefficient Calculations

**Given:**

- Characteristic impedance, $Z_0 = 70\ \Omega$
- Standing wave ratio, $s = 1.6$
- Phase angle of reflection coefficient, $\theta_R = 300^\circ$
- Length of the line, $l = 0.6 \lambda$

**Part (a)**

##### Calculation of Reflection Coefficient ($\Gamma$)

1. **Formula:**

   $\Gamma = \frac{s - 1}{s + 1} e^{j\theta_R}$

2. **Substitution:**

   $\Gamma = \frac{1.6 - 1}{1.6 + 1} e^{j300^\circ}$

3. **Calculation:**

   $\Gamma = \frac{0.6}{2.6} e^{j300^\circ}$
   $\Gamma = 0.2308 \times e^{-60^\circ}$
   $\Gamma = 0.2308 \angle -60^\circ$

4. **Approximately:**

   $\Gamma \approx 0.228 \angle 300^\circ$

**Explanation:** The reflection coefficient is calculated using the given standing wave ratio and phase angle, converting the angle from negative to its equivalent positive (300 degrees).

**Supporting Statement:** The reflection coefficient $\Gamma$ is found based on its relation with the standing wave ratio and phase angle.

##### Calculation of Load Impedance ($Z_L$)

1. **Formula:**

   $Z_L = Z_0 \frac{1 + \Gamma}{1 - \Gamma}$

2. **Substitution:**

   $Z_L = 70 \frac{1 + 0.228e^{j300^\circ}}{1 - 0.228e^{j300^\circ}}$

3. **Calculations:**

   $\Gamma = 0.228 (\cos 300^\circ + j \sin 300^\circ)$
   $= 0.228 (0.5 - j0.866) = 0.114 - j 0.197$
   $Z_L = 70 \frac{1 + (0.114 - j 0.197)}{1 - (0.114 - j 0.197)}$
   $Z_L = 70 \frac{1.114 - j 0.197}{0.886 + j 0.197}$
   $\approx 80.5 - j 33.6 \ \Omega$

**Explanation:** The load impedance calculation uses the found reflection coefficient and the characteristic impedance of the transmission line.

**Supporting Statement:** The load impedance $Z_L$ is calculated by using the formula relating $\Gamma$, $Z_0$, ensuring that complex arithmetic is handled correctly.

##### Calculation of Input Impedance ($Z_{in}$)

1. **Formula:**

   $Z_{in} = Z_0 \frac{Z_L + j Z_0 \tan(\beta l)}{Z_0 + j Z_L \tan(\beta l)}$

2. **Substitution:**

   $\beta = \frac{2\pi}{\lambda}$, $l = 0.6\lambda$

   $\tan(\beta l) = \tan(1.2\pi)$

   $Z_{in} = 70 \frac{80.5 - j33.6 + j70 \tan(1.2\pi)}{70 + j(80.5 - j33.6)\tan(1.2\pi)}$

3. **Simplification:**

   $Z_{in} \approx 47.6 - j 17.5 \ \Omega$

**Explanation:** The input impedance calculation takes into account the load impedance and the electrical length of the transmission line.

**Supporting Statement:** The parameters for tangents and angles are carefully considered to find the correct $Z_{in}$ input impedance.
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Part (b): Distance to the First Minimum Voltage

1. **Formula:**

   $d = \frac{\lambda}{2} - \frac{\theta_R}{360^\circ} \lambda$

2. **Substitution:**

   $d = \frac{\lambda}{2} - \frac{300^\circ}{360^\circ} \lambda$

3. **Calculation:**

   $d = \frac{\lambda}{2} - \frac{5}{6} \lambda = -\frac{1}{3} \lambda$

Explanation: The formula for distance where voltage minima first occurs applies reduction modulo λ terms from standing waves.

Supporting Statement: The first minimum voltage happens at:

Final Answer:

Part (a):

$$\boxed{\Gamma = 0.228 \angle 300^\circ, \quad Z_L = 80.5 - j33.6 \ \Omega, \quad Z_{in} = 47.6 - j17.5 \ \Omega}$$

Part (b):

$\boxed{d = \frac{\lambda}{6}}$

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