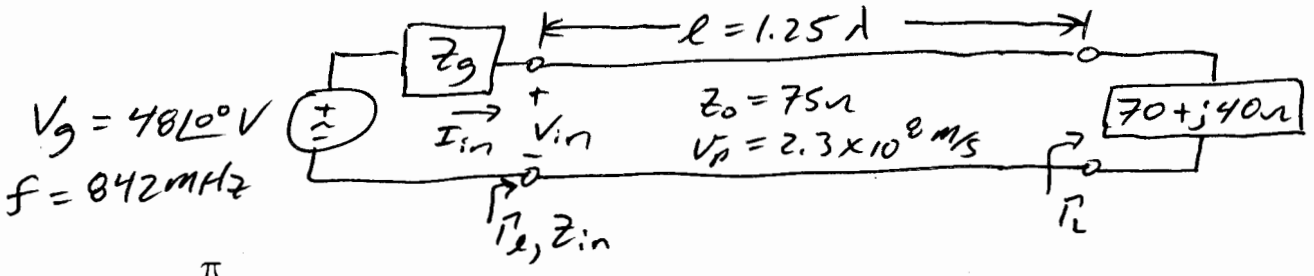
2.6 cont.

ex. Find powers and related quantities for various match conditions for the circuit shown.



$Vg := 48 \cdot e^{j \cdot 0 \cdot \frac{\pi}{180}}$ V $f := 842 \cdot 10^6$ Hz $ZL := 70 + j \cdot 40$ Ω

$l\lambda := 1.25$ $vp := 2.3 \cdot 10^8$ m/s $Z0 := 75$ Ω

Calculate variables related to transmission line

$\omega := 2 \cdot \pi \cdot f$ $\lambda := \frac{vp}{f}$ $\lambda = 0.273$ m $l := l\lambda \cdot \lambda$ $l = 0.3414$ m

$\beta := \frac{\omega}{vp}$ $\beta = 23.0019$ rad/m

Calculate reflection coefficients & input impedance

$\Gamma L := \frac{ZL - Z0}{ZL + Z0}$ $|\Gamma L| = 0.268$ $\arg(\Gamma L) \cdot \frac{180}{\pi} = 81.703$ deg

$\Gamma l := \Gamma L \cdot e^{-j \cdot 2 \cdot \beta \cdot l}$ $|\Gamma l| = 0.268$ $\arg(\Gamma l) \cdot \frac{180}{\pi} = -98.297$ deg

$Zin := Z0 \cdot \frac{(1 + \Gamma l)}{(1 - \Gamma l)}$ $Zin = 60.5769 - 34.6154i$ Ω

1) Assume we used matching network on load & matched source, i.e., Zg = Zin = Z0 and ΓL1 = 0.

$\Gamma L1 := 0$ $Zin1 := Z0$ $Zg1 := Z0$

$Vin1 := Vg \cdot \left(\frac{Zin1}{Zin1 + Zg1} \right)$ $|Vin1| = 24$ V $\arg(Vin1) \cdot \frac{180}{\pi} = 0$ deg

$V0p1 := \frac{Vin1}{e^{j \cdot \beta \cdot l} + \Gamma L1 \cdot e^{-j \cdot \beta \cdot l}}$ $|V0p1| = 24$ V $\arg(V0p1) \cdot \frac{180}{\pi} = -90$ deg

$Iin1 := \frac{Vin1}{Zin1}$ $|Iin1| = 0.32$ A $\arg(Iin1) \cdot \frac{180}{\pi} = 0$ deg

$Pin1 := 0.5 \cdot Re(Vin1 \cdot \overline{Iin1})$ $Pavg1 := 0.5 \cdot \frac{(|V0p1|)^2}{Z0} \cdot [1 - (|\Gamma L1|)^2]$ $P1 := \frac{(Vg)^2}{8 \cdot Z0}$

$Pin1 = 3.84$ W $Pavg1 = 3.84$ W $P1 = 3.84$ W

$Pavg\_inc1 := 0.5 \cdot \frac{(|V0p1|)^2}{Z0}$ $Pavg\_inc1 = 3.84$ W

$Pavg\_ref11 := 0.5 \cdot \frac{(|V0p1|)^2}{Z0} \cdot (|\Gamma L1|)^2$ $Pavg\_ref11 = 0$ W

$PVg1 := 0.5 \cdot Re(Vg \cdot \overline{Iin1})$ $PVg1 = 7.68$ W

$VSWR1 := \frac{1 + |\Gamma L1|}{1 - |\Gamma L1|}$ $VSWR1 = 1$

$RL1 = 20 \log(0) = \infty$ $\eta 1 := \frac{P1}{PVg1}$ $\eta 1 \cdot 100 = 50$ %

2) Choose Zg = Zin.

$Zg2 := Zin$ $Zg2 = 60.577 - 34.615i$ Ω $Rg2 := Re(Zg2)$ $Xg2 := Im(Zg2)$

$Vin2 := Vg \cdot \left(\frac{Zin}{Zin + Zg2}\right)$ $|Vin2| = 24$ V $\arg(Vin2) \cdot \frac{180}{\pi} = 0$ deg

$V0p2 := \frac{Vin2}{e^{j \cdot \beta \cdot l} + \Gamma L \cdot e^{-j \cdot \beta \cdot l}}$ $|V0p2| = 24.067$ V $\arg(V0p2) \cdot \frac{180}{\pi} = -74.58$ deg

$Iin2 := \frac{Vin2}{Zin}$ $|Iin2| = 0.344$ A $\arg(Iin2) \cdot \frac{180}{\pi} = 29.745$ deg

$Pin2 := 0.5 \cdot Re(Vin2 \cdot \overline{Iin2})$ $P2 := \frac{(|Vg|)^2}{8} \frac{Rg2}{Rg2^2 + Xg2^2}$

$Pin2 = 3.584$ W $P2 = 3.584$ W

$Pavg\_inc2 := 0.5 \cdot \frac{(|V0p2|)^2}{Z0}$ $Pavg\_inc2 = 3.8613$ W

$Pavg\_ref12 := 0.5 \cdot \frac{(|V0p2|)^2}{Z0} \cdot (|\Gamma L|)^2$ $Pavg\_ref12 = 0.2773$ W

$PVg2 := 0.5 \cdot Re(Vg \cdot \overline{Iin2})$ $PVg2 = 7.168$ W

$$VSWR2 := \frac{1 + |\Gamma L|}{1 - |\Gamma L|}$$ VSWR2 = 1.732

$$RL2 := 20 \cdot \log(|\Gamma L|)$$ RL2 = −11.437 dB

$$\eta 2 := \frac{P2}{PVg2}$$ $\eta 2 \cdot 100 = 50$ %

3) Choose Zg = Zin*.

$Zg3 := \overline{Zin}$ Zg3 = 60.577 + 34.615i Ω $Rg3 := Re(Zg3)$ $Xg3 := Im(Zg3)$

$$Vin3 := Vg \cdot \left(\frac{Zin}{Zin + Zg3}\right)$$ |Vin3| = 27.642 V $\arg(Vin3) \cdot \frac{180}{\pi} = -29.74$ deg

$$V0p3 := \frac{Vin3}{e^{j \cdot \beta \cdot l} + \Gamma L \cdot e^{-j \cdot \beta \cdot l}}$$ |V0p3| = 27.719 V $\arg(V0p3) \cdot \frac{180}{\pi} = -104.32$ deg

$$Iin3 := \frac{Vin3}{Zin}$$ |Iin3| = 0.3962 A $\arg(Iin3) \cdot \frac{180}{\pi} = 0$ deg

$$Pin3 := 0.5 \cdot Re(Vin3 \cdot \overline{Iin3})$$

$$P3 := \frac{(|Vg|)^2}{8 \cdot Rg3}$$

Pin3 = 4.7543 W P3 = 4.7543 W

$$Pavg\_inc3 := 0.5 \cdot \frac{(|V0p3|)^2}{Z0}$$ Pavg_inc3 = 5.1222 W

$$Pavg\_ref13 := 0.5 \cdot \frac{(|V0p3|)^2}{Z0} \cdot (|\Gamma L|)^2$$ Pavg_ref13 = 0.3679 W

$$PVg3 := 0.5 \cdot Re(Vg \cdot \overline{Iin3})$$ PVg3 = 9.5086 W

$$VSWR3 := \frac{1 + |\Gamma L|}{1 - |\Gamma L|}$$ VSWR3 = 1.732

$$RL3 := 20 \cdot \log(|\Gamma L|)$$ RL3 = −11.437 dB

$$\eta 3 := \frac{P3}{PVg3}$$ $\eta 3 \cdot 100 = 50$ %

$P_3 = 4.754\,W > P_1 = 3.84\,W > P_2 = 3.584\,W$

VSWR = 1.73 VSWR = 1 VSWR = 1.73

$\eta = 50\%$ in all cases.