



FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING
DEGREE PROGRAMME IN ELECTRONICS (MASTER'S)

RADIO ENGINEERING I
HOME ASSIGNMENT 1/2025 HW1

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- ① Transmitter deliver $P_t = 30 \text{ W}$ into the matched load of 50Ω .

Here Given,

$$\text{Load } Z_L = 80 - j40 \Omega.$$

Transmission line characteristic impedance $Z_0 = 50\Omega$

$$\begin{aligned} \text{So, Reflection co-efficient, } |\Gamma| &= \frac{Z_L - Z_0}{Z_L + Z_0} \\ &= \frac{(80 - j40) - 50}{(80 - j40) + 50} \\ &= \frac{30 - j40}{130 - j40} \\ &= 0.207 - 0.216j. \end{aligned}$$

$$\therefore |\Gamma|^2 = (0.207)^2 + (0.216)^2 \\ = 0.135.$$

Power delivered is given by,

$$\begin{aligned} P_L &= P_t (1 - |\Gamma|^2) \\ &= 30 (1 - 0.135) \\ &= 25.95 \text{ W}. \end{aligned}$$



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(b) Lumped L-section matching network to match a series PL load (with $R=100 \Omega$ and $L=2.5 \text{nH}$) to a 50Ω line at 3.5GHz .

$$\begin{aligned} \omega &= 2\pi f \\ &= 2\pi \times 3.5 \times 10^9 \end{aligned}$$

$$= 2.1992 \times 10^{10}$$

$$\begin{aligned} \text{So, Load Resistance, } X_L &= \omega L \\ &= 2.1992 \times 10^{10} \times 2.5 \times 10^{-9} \\ &= 54.97787 \\ &\approx 55 \Omega. \end{aligned}$$

$$\text{So, Load impedance, } Z_L = 100 + j55 \Omega.$$

$$\begin{aligned} \text{Converting to admittance, } Y_L &= \frac{1}{Z_L} = \frac{1}{100+j55} \times \frac{100-j55}{100-j55} \\ &= \frac{100-j55}{103025} \\ &= 7.677 \times 10^{-3} - 4.22 \times 10^{-3} j. \end{aligned}$$

$$\text{So, } G_L = 0.007677, B_L = -0.00422$$



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$$\text{Target conductance, } G_{10} = \frac{1}{50} = 0.02 \text{ S}$$

1. $G_L < G_{10}$, So, L section with the shunt susceptance B and series reactance.

$$Y' = G + j(B_0 + B) = G + jB_t.$$

$$\therefore |B_t| = \sqrt{\frac{G_1}{50} - G_t^2} = \sqrt{\frac{G_1}{50} - 0.02^2} = \sqrt{\frac{0.009726}{50} - (0.00076)^2} \\ = 0.72644 \times 10^{-3}.$$

So, the low pass form is,

$$B_t = 0.00972644,$$

$$B = 0.00972644 + 0.00422$$

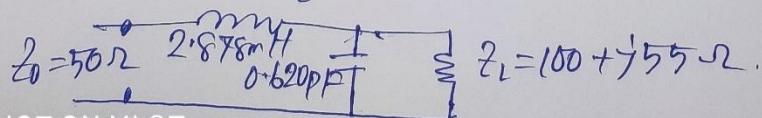
$$= \cancel{0.00422} \cdot 0.0136$$

$$\text{Impedance, } Z = \frac{1}{G + jB_t} = 50 - j63.3 \Omega$$

$$\text{Shunt capacitor, } C = \frac{B}{\omega} = \frac{0.0136}{2\pi \times 3.5 \times 10^9} \\ = 6.20 \times 10^{-12} \\ = 0.620 \text{ pF.}$$

$$\text{Series Inductor, } L = \frac{X_S}{\omega} = \frac{63.3}{2\pi \times 3.5 \times 10^9} \\ = 2.878 \text{ mH}$$

So, the circuit diagram is,



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High Pass Form:-

$$B_t = 0.00972644$$

$$\begin{aligned} B &= B_t - B_0 \\ &= 0.00972644 - 0.00422 \\ &= 5.5 \times 10^{-3} \end{aligned}$$

~~00-55~~
~~100-55~~

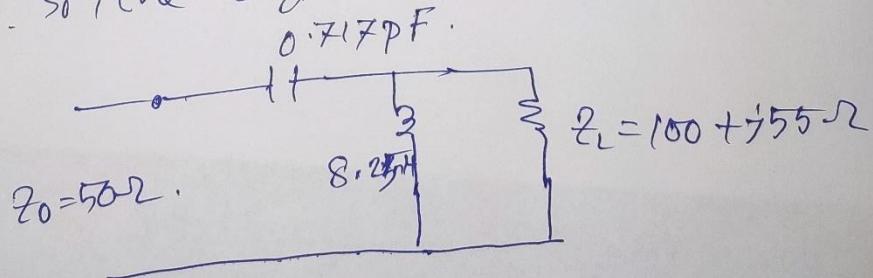
~~2x10^-3~~

$$\begin{aligned} \text{Shunt Inductor } B_L &= \frac{1}{\omega R} \\ &= \frac{1}{2\pi \times 3.5 \times 10^9 \times 5 \cdot 50 \times 10^{-3}} \\ &= 8.25 \text{ nH} \end{aligned}$$

To cancel of this effect we need a series capacitor, $X_s = -63.36$.

$$\begin{aligned} \text{So, } C_s &= \frac{1}{\omega X_s} = \frac{1}{2\pi \times 3.5 \times 10^9 \times 63.36} \\ &= 2.17 \times 10^{-13} \\ &= 0.717 \text{ pF} \end{aligned}$$

1. So, the diagram is :-



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