



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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Answer mark
20: 2512200.

(a) 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, $Z_0 = 50\Omega$

$$\begin{aligned}\text{So, Reflection coefficient, } \Gamma_L &= \frac{Z_L - Z_0}{Z_L + Z_0} \\ &= \frac{(80 - j40) - 50}{(80 - j40) + 50} \\ &= \frac{30 - j40}{130 - j40}.\end{aligned}$$

$$= 0.297 - 0.216j.$$

$$\begin{aligned}\therefore |\Gamma_L|^2 &= (0.297)^2 + (0.216)^2 \\ &= 0.135.\end{aligned}$$

Power delivered is given by,

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



⑥ Lumped L-section matching network to match a series RL load (with $R=100\ \Omega$ and $L=2.5\text{ nH}$) to a $50\text{-}\Omega$ line at 3.5 GHz .

$$\begin{aligned}\omega &= 2\pi f \\ &= 2\pi \times 3.5 \times 10^9 \\ &= 2.199 \times 10^{10}\end{aligned}$$

So, Load Resistance, $X_L = \omega L$.

$$\begin{aligned}&= 2.199 \times 10^{10} \times 2.5 \times 10^{-9} \\ &= 54.97787 \\ &\approx 55\ \Omega.\end{aligned}$$

So, load impedance, $z_L = 100 + j55\ \Omega$.

Converting to admittance, $Y_L = \frac{1}{z_L} = \frac{1}{100 + j55} \times \frac{100 - j55}{100 - j55}$

$$\begin{aligned}&= \frac{100 - j55}{13025} \\ &= 7.677 \times 10^{-3} - j4.22 \times 10^{-3}\end{aligned}$$

So, $G_L = 0.007677$, $B_L = -0.00422$.



Target Conductance, $G_0 = \frac{1}{50} = 0.02 \text{ S}$

∵ $G_L < G_0$, So, L section with the shunt susceptance B and series reactance.

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

$$\therefore |B_t| = \sqrt{\frac{G}{Z_0} - G^2} = \sqrt{\frac{G}{50} - G^2} = \sqrt{\frac{0.007677}{50} - (0.007677)^2}$$

$$= 0.72644 \times 10^{-3}$$

So, the low pass filter is,

$$B_t = 0.00072644$$

$$B = 0.00072644 + 0.00422$$

$$= \cancel{0.01346} \cdot 0.0136$$

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

$$\text{Shunt capacitor, } C = \frac{B}{\omega} = \frac{0.0136}{2\pi \times 3.5 \times 10^9}$$

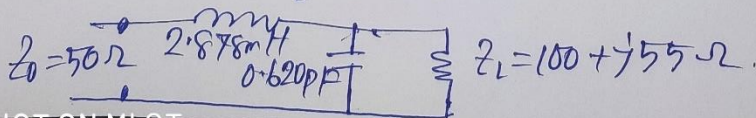
$$= 6.20 \times 10^{-12}$$

$$= 0.620 \text{ pF}$$

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

$$= 2.878 \text{ nH}$$

So, the circuit diagram is,



High Pass Form:-

$$B_t = 0.00972644$$

$$B = B_t - B_0$$

$$= 0.00972644 - 0.00422$$

$$= 5.5 \times 10^{-3}$$

Shunt Inductor $B_L = \frac{1}{\omega L}$

$$= \frac{1}{2\pi \times 3.5 \times 10^9 \times 5.5 \times 10^{-3}}$$

$$= 8.25 \text{ nH}$$

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

$$\text{So, } C_s = \frac{1}{\omega |X_s|} = \frac{1}{2\pi \times 3.5 \times 10^9 \times 63.36}$$

$$= 7.17 \times 10^{-13}$$

$$= 0.717 \text{ pF}$$

So, the diagram is:-

