FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

DEGREE PROGRAMME IN ELECTRONICS (MASTER'S)

RADIO ENGINEERING I

HOME ASSIGNMENT 1/2025 HW1

Name: Arafat Miah
Student No: 2512200

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Arafat Miah
ID: 2512200.

ⓐ Transmitter deliver $P_t = 30W$ into the matched load of 50Ω.

Here Given,

Load, $Z_L = 80 - j\cdot 40\Omega$.

Transmission line characteristic impedance; $Z_0 = 50\Omega$

So, Reflection co-efficient, $\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0}$

$$= \frac{(80-j40)-50}{(80-j40)+50}$$

$$= \frac{30-j40}{130-j40}.$$

$$= 0.297 - 0.216i.$$

$$\therefore |\Gamma_L|^2 = (0.297)^2 + (0.216)^2$$

$$= 0.135.$$

Power delivered is given by,

$$P_L = P_t (1-|\Gamma|^2)$$

$$= 30(1-0.135)$$

$$= 25.95 \text{ W}.$$

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

$\omega = 2\pi f$.

$= 2\pi \times 3.5 \times 10^{9}$

$= 2.199 \times 10^{10}$

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

$= 2.199 \times 10^{10} \times 2.5 \times 10^{-9}$.

$= 54.97787$

$\simeq 55\ \Omega$.

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

Converting to admittance, $Y_L = \frac{1}{Z_L} = \frac{1}{100 + j55} \times \frac{100 - 55j}{100 - j55}$

$= \frac{100 - j55}{13025}$.

$= 7.677 \times 10^{-3} - 4.22 \times 10^{-3} i$.

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

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

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

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

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

$$= 9.72644 \times 10^{-3}.$$

So, the Low pass form is,

$$B_t = 0.00972644.$$

$$B = 0.00972644 + 0.00427$$

$$= \cancel{0.01399} \; 0.0136$$

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

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

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

$$= 0.620\,pF.$$

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

$$= 2.878\,mH$$

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 $B_L = \frac{1}{\omega B}$

$= \frac{1}{2\pi \times 3.5 \times 10^{9} \times 5.50 \times 10^{-3}}$.

$= 8.25\ nH$.

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

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

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

$= 0.717\ pF$.

∴ So, the diagram is:-