



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2025

Module Number: EE8211

Module Name: Microwave Communication
C-18 (TE)

[Three Hours]

[Answer all questions, each question carries 10 marks]

- All the notations have their usual meanings.
- Assume permittivity of free space is $\frac{10^{-9}}{36\pi} \text{ F/m}$

Q1 a) Show that the admittance matrix of the two parallel-connected two-port π networks shown in Figure Q1(a) below can be found by adding the admittance matrices of the individual two-ports. Apply this result to find the admittance matrix of the bridged-T circuit shown in Figure Q1(b).

[3 Marks]

b) What is the corresponding result for the impedance matrix of two series-connected T-networks in part a)?

[2 Marks]

c) Consider a series RLC circuit with a current I . Calculate the power lost and the stored electric and magnetic energies and show that the input impedance can be expressed in-terms of stored energy and power lost.

[5 Marks]

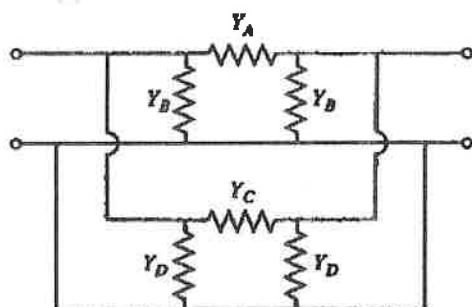


Figure Q1(a)

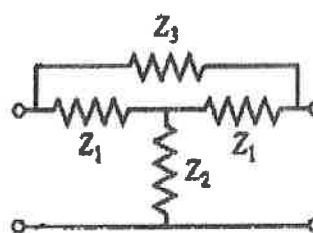


Figure Q1(b)

Q2 a) Briefly explain the following parameters of a transmission line.

i) Intrinsic impedance

[2 Marks]

ii) Wave impedance

[2 Marks]

iii) Characteristics impedance

[2 Marks]

- b) Derive the $[Z]$ and $[Y]$ matrices for the two-port networks shown in Figure Q2(a) and Figure Q2(b) below.

[4 Marks]

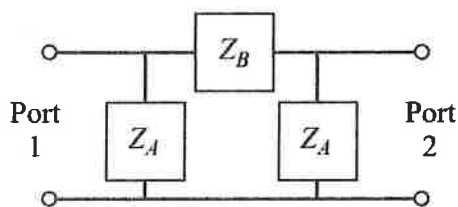


Figure Q2(a)

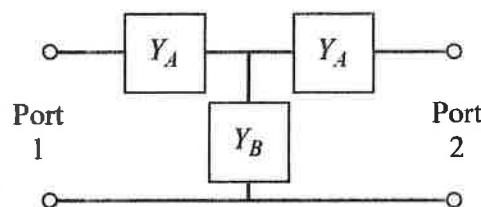


Figure Q2(b)

- Q3 a) Explain why conventional voltage and current-based parameters are not suitable for circuit analysis at microwave frequencies?

[2 Marks]

- b) Describe How S-parameters are used to analyzing reflection and transmission in microwave networks?

[2 Marks]

- c) A two-port network is known to have the following scattering matrix:

$$[S] = \begin{bmatrix} 0.15\angle 0^\circ & 0.85\angle -45^\circ \\ 0.85\angle 45^\circ & 0.2\angle 0^\circ \end{bmatrix}$$

- i) Determine if the network is reciprocal and lossless.

[2 Marks]

- ii) If port 2 is terminated with a matched load, what is the return loss seen at port 1?

[2 Marks]

- iii) If port 2 is terminated with a short circuit, what is the return loss seen at port 1?

[2 Marks]

- Q4 a) Show that the T-model of a transmission line is shown in the accompanying Figure Q4(a) and derives the telegrapher equations.

[3 Marks]

- b) What is a series RLC resonator?

[1 Mark]

- c) State three applications for series RLC resonator.

[1 Mark]

- d) State the relationship between Q-factor and bandwidth for a series PCL resonator.

[1 Mark]

- e) A series RLC resonator with an external load is shown in Figure Q4(b). Find the resonant frequency, the unloaded Q, and the loaded Q.

[4 Marks]

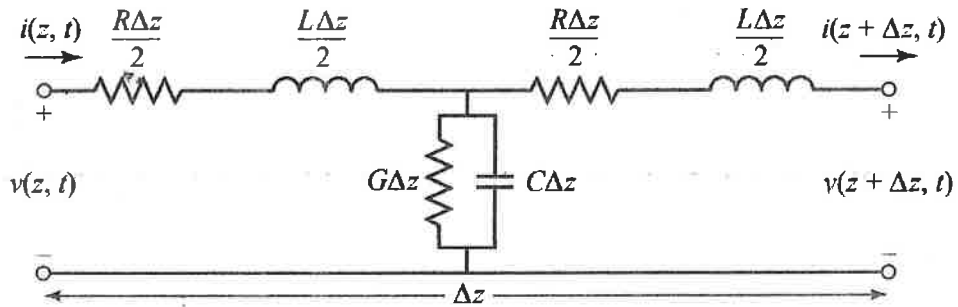


Figure Q4(a)

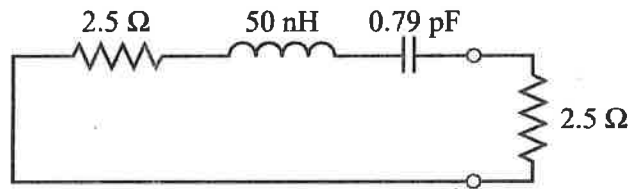


Figure Q4(b)

- Q5 a) What is a smart antenna? And what are the main types of smart antennas?

[2 Marks]

- b) List advantages of smart antenna systems.

[1 Mark]

- c) Explain what is meant by spatial diversity in smart antennas?

[2 Marks]

- d) Explain the principle of adaptive beamforming in smart antennas.

[2 Marks]

- e) Explain the concept of Space Division Multiple Access (SDMA) in smart antennas.

[2 Marks]

- f) What is the role of smart antennas in Massive MIMO systems?

[1 Mark]