UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2018

Module Number: EE8209 **Module Name: Microwave Communication**

[Three Hours]

[Answer all questions, each question carries 10 marks]

Q1 The transmission line circuit in the Figure Q1 has $V_g = 15\ V_{rms}$, $Z_g = 75\ \Omega$, $Z_0 = 75\ \Omega$, $Z_L = 60 - j40\ \Omega$, and $l = 0.7\lambda$. Compute the power delivered to the load using three different techniques:

a) Find Γ and compute $P_L = (\frac{V_g}{2})\frac{1}{Z_0}(1-|\Gamma|^2)$; [2.5 Marks]

b) Find Z_{in} and compute $P_L = \left|\frac{V_g}{Z_g + Z_{in}}\right|^2 \mathrm{Re}\{Z_{in}\}$; [2.5 Marks]

c) Find V_L and compute $P_L = \left|\frac{V_L}{Z_L}\right|^2 \mathrm{Re}\{Z_L\}$; [2.5 Marks]

d) Discuss the rational for each of these methods. Which of these methods can be used if the line is not lossless? [2.5 Marks]

Q2 a) Derive the telegrapher equations for the T -model of a transmission line shown in Figure Q2.a. [4 Marks]

b) For the parallel plate line shown in the Figure Q2.b, derive the R, L, G, and C parameters. Assume $W \gg d$. [3 Marks]

c) For the parallel plate line of Problem Q2.b, derive the telegrapher equations using the field theory approach. [3 Marks]

Q3. a) Write short notes regarding intrinsic impedance, wave impedance and characteristic impedance. [3 Marks]

b) A radio transmitter is connected to an antenna having an impedance $80 + j40\ \Omega$ with a $50\ \Omega$ coaxial cable. If the $50\ \Omega$ transmitter can deliver 30 W when connected to a $50\ \Omega$ load, how much power is delivered to the antenna? [3 Marks]

c) A generator is connected to a transmission line as shown in the accompanying Figure Q3. Find the voltage as a function of z along the transmission line. Plot the magnitude of this voltage for $-l \le z \le 0$. [4 Marks]

Q4 a) Derive the [Z] and [Y] matrices for the two-port networks shown in the Figure Q4. [5 Marks]

b) Consider a two-port network, and let $Z_{SC}^{(1)}, Z_{SC}^{(2)}, Z_{OC}^{(1)}$ and $Z_{OC}^{(2)}$ be the input impedance seen when port 2 is short-circuited, when port 1 is short-circuited, when port 2 is open- circuited, and when port 1 is open-circuited, respectively. Show that the impedance matrix elements are given by,

$Z_{11} = Z_{SC}^{(1)}$, $Z_{22} = Z_{OC}^{(2)}$, $Z_{12}^2 = Z_{21}^2 = (Z_{0C}^{(1)} - Z_{SC}^{(1)})Z_{oC}^{(2)}$ [5 Marks]

Q5 a) A two-port network is known to have the following scattering matrix:

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

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? [4 Marks]

iii If port 2 is terminated with a short circuit, what is the return loss seen at port 1? [4 Marks]

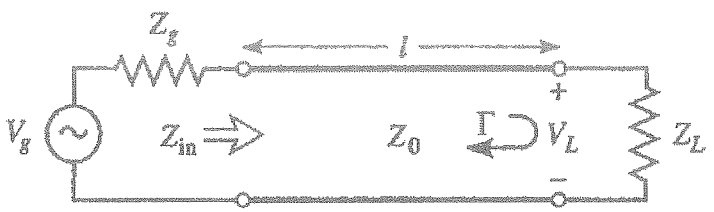

Figure Q1: The transmission line circuit

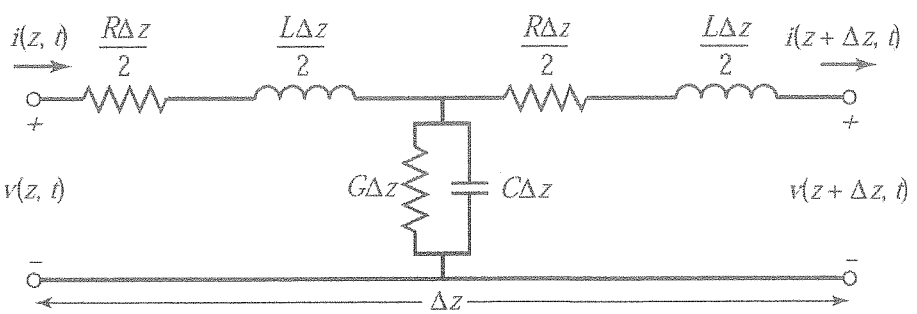

Figure Q2.a: Lumped element equivalent circuit for transmission line.

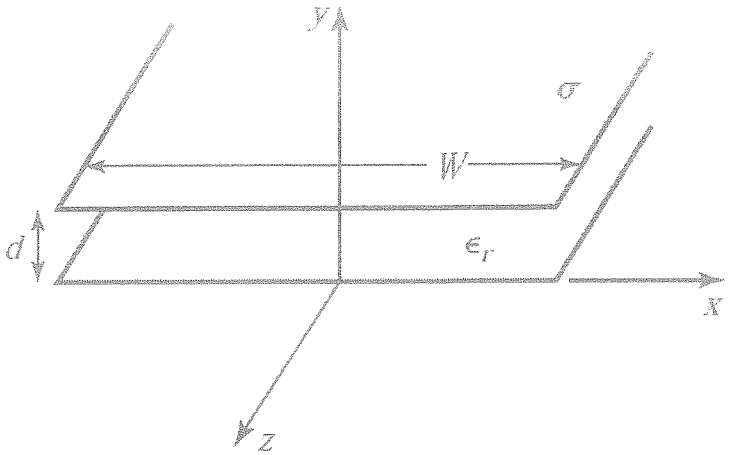

Figure Q2.b: The parallel plate line

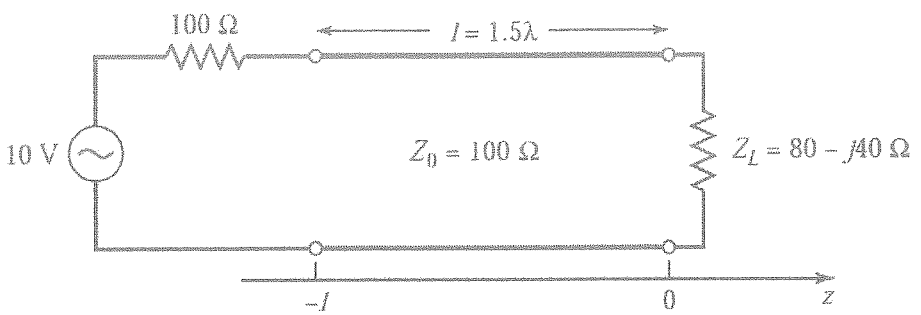

Figure Q3: Transmission line

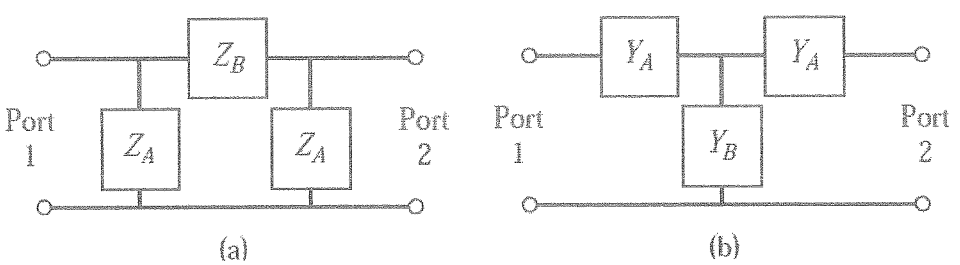

Figure Q4: Two port networks