MACHAKOS UNIVERSITY

University Examinations for 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 313: TRANSMISSION LINES AND WAVEGUIDES (supp)

DATE: 27/9/2019 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

1. This paper consists of **FIVE** questions.
2. Answer **QUESTION ONE** and **ANY OTHER TWO** questions.
3. All workings must be clearly shown
4. The Smith Chart page provided should be attached to the Answer Booklet after use.
5. Take the speed of light in free space to be $c = 3x10^8 m/s$

QUESTION ONE-COMPULSORY (30 MARKS)

a) With specific examples, give **TWO** practical applications of TEM transmission lines. [2 marks]

b) Explain the following terms as applied in Transmission Lines: [4 marks]
   (i) Reflection coefficient
   (ii) Characteristic impedance

c) Figure Q1 c) shows an equivalent circuit model of a differential length Δz of a two-conductor transmission line.
   i) Use it to derive the transmission line wave equations for both voltage $V_s(z)$ and current $I_s(z)$in the line. List any assumptions made.
   ii) Find the general solutions for $V_s(z)$ and $I_s(z)$ and comment on the directions of travel for the waves involved. [8 marks]

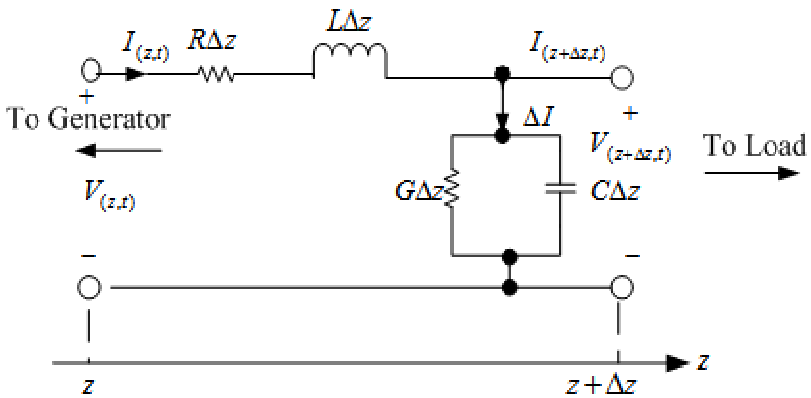


Fig.Q1 c) Two-conductor transmission line model of differential length Δz

d) A generator source with $V_{sg} = 100 < 0^0\ V, Z_g = R_g = 50\ \Omega$, f $= 100$MHz is connected to a lossless transmission line with $L = 0.25\mu H/m$, $C = 100pF/m$ and $l = 10m$. For loads of $Z_L = R_L = 0, 25, 50, 100$, and ∞ (Ω) determine: [9 marks]
(i) the reflection coefficient at the load
(ii) the standing wave ratio
(iii)the input impedance at the transmission line input terminals
(iv) voltage and current plots along the transmission line

e) Antenna with impedance $40 + j30\Omega$ is to be matched to a 100Ω lossless line with a shorted stub. Determine the following using Smith Chart: [7 marks]
i) The required stub admittance
ii) The distance between the stub and the antenna
iii) The stub length
iv) The standing wave ratio on each ratio of the system

QUESTION TWO (20 MARKS)

a) What is your take on the utilization of EM field theory and Electric Circuit theory in the analysis of transmission lines? [3 marks]

b) Explain the meaning and application of a Resonant Line as used in transmission lines. [3 marks]

c) A 40-long transmission line has $V_g = 15 < 0^0 V_{rms}$, $Z_0 = 30 + j60\Omega$, and $V_L = 5 < -48^0 V_{rms}$. If the line is matched to the load, calculate: [6 marks]
(i) The input impedance Z_{in}
(ii) The sending-end current I_{in} and voltage V_{in}
(iii)The propagation constant γ.

d) A lossless transmission line with $Z_0 = 50\Omega$ and $d = 1.5m$ connects a voltage V_g source to a terminal load of $Z_L = (50 + j50)\Omega$. If $V_g = 60\,V$, operating frequency $f = 100MHz$, and $Z_g = 50\Omega$ and assuming that the speed of the wave along the transmission line equal to the speed of light c,

   i) Find the distance of the first voltage maximum l_M, from the load.

   ii) What is the power delivered to the load P_L? [8 marks]

QUESTION THREE (20 MARKS)

a) Differentiate between a transmission line and a waveguide in terms of physical construction and the waves propagated. [2 marks]

b) Consider a lossless transmission line shown in Fig. Q3b. Use it to provide a physical description of how the waves generated by closing S_1 propagate along the transmission line. [4 marks]

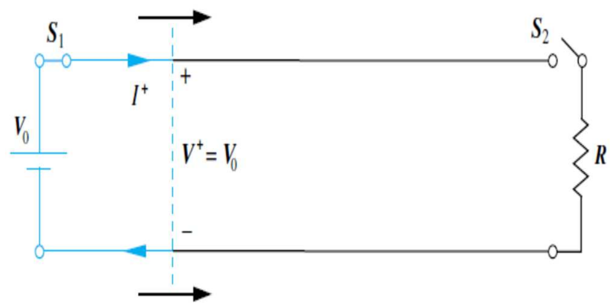


Fig.Q3b A *lossless* line

c) A signal generator is to feed equal power through a lossless air transmission line of characteristic impedance 50Ω to two separate resistive loads, 64Ω and 25Ω. Quarter-wave transformers are used to match the loads to the 50Ω line. [6 marks]

   (i) Sketch the quarter-wavelength impedance matching arrangement.

   (ii) Determine the required characteristic impedances of the quarter-wave lines.

   (iii)Find the standing-wave ratios on the matching line sections.

d) A 60Ω lossless line is connected to a source with $V_g = 10\angle 0^0\ V_{rms}$ and $Z_g = 50 - j40\Omega$ and terminated with a load $j40\Omega$. If the line is 100 m long and $\beta\ =\ 0.25\,rad/m$, calculate Z_{in} and V at [8 marks]

   (i) The sending end

   (ii) The receiving end

   (iii)4 m from the load

   (iv)3 m from the source

QUESTION FOUR (20 MARKS)

a) Define the ABCD matrix parameters as used in a two-port lossy network. [2 marks]

b) Derive the expression for the average power flow along a lossless transmission line. Give its physical interpretation and the condition (s) for maximum power delivery to the load. [4 marks]

c) A distortionless line operating at $120\,MHz$ has $R = 20\Omega/m,\ L = 0.3\mu H/m$, and $C = 63pF/m.$ [6 marks]

   i) Determine $\gamma, u, and\ Z_0$.

   ii) How far will a voltage wave travel before it is reduced to 20% of its initial magnitude?

   iii) How far will it travel to suffer a 45^0 phase shift?

e) A certain transmission line operating at $\omega = 10^6 rad/s$ has α = 8 dB/m, $\beta = 1\ rad/m$, and $Z_0 = 60 + j40\Omega$, and is $2m$ long. If the line is connected to a source of $10 < 0^0 V$, $Z_g = 40\Omega$ and terminated by a load of $20 + j50\Omega$, determine: [8 marks]

   (i) The input impedance

   (ii) The sending-end current

   (iii)The current at the middle of the line

QUESTION FIVE (20MARKS)

a) Discuss the advantages and disadvantages of single-stub matching technique of transmission lines as compared to the quarter wavelength transformer. [4 marks]

b) The parameters of a certain transmission line operating at $6 \times 10^8\ rad/s$ are $R = 20\Omega/m,\ L = 0.4\mu H/m,\ G = 80\mu S/m\ and\ \ C = 40pF/m.$ [6 marks]

   i) Find $\gamma, \alpha, \beta, \lambda, and\ Z_0$.

   ii) If a voltage wave travels $20\ m$ down the line, what percentage of the original amplitude remains and by how many degrees is it phase shifted?

c) A $100 + j150\ \Omega$ load is connected to 75 Ω lossless line. Use Smith Chart to find the following and check your answers analytically. [10 marks]

   i) The reflection coefficient Γ

   ii) The standing wave ratio s

   iii) The load admittance Y_L

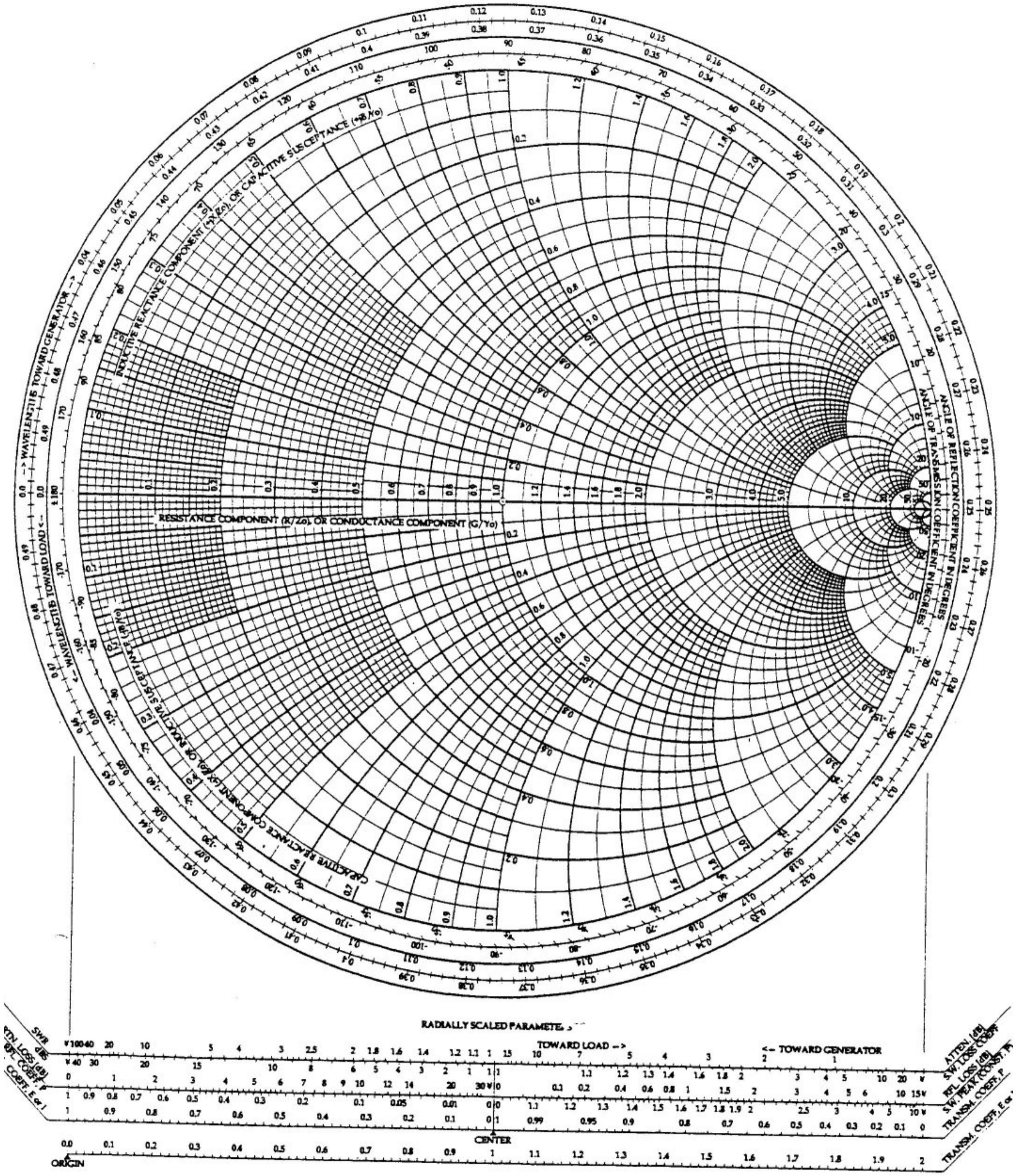
   iv)The input Impedance Z_{in} at 0.4λ from the load

   v) The locations of V_{max} and V_{min} with respect to the load if the line is 0.6λ long

   vi) Z_{in} at the generator

CANDIDATE REG. NO…………………………….

THE SMITH CHART- NO.1



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THE SMITH CHART-NO.2