UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 6 Examination in Engineering: November 2014

Module Number: EE6322 **Module Name: Communication Systems**

[Two Hours]

[Answer **all questions**, each question carries 5 marks]

All notations have their usual meaning.

Use the Smith Chart to answer Q3.

Q1 a) A distortionless line is the one in which the attenuation constant (α) is frequency independent while the phase constant (β) is linearly dependent on the frequency of the transmission line. i.e., $\frac{R}{L}=\frac{G}{C}$.

i) Show that $\alpha=\sqrt{RG}$ and $\beta=\omega\sqrt{LC}$.

ii) Find the expressions for characteristic impedance (Z_0) of the transmission line and phase velocity (u).

[2 Marks]

b) A distortionless line has $Z_0=60\ \Omega$, $\alpha=20$ mNp/m and $u=0.6c$, where c is the speed of light in a vacuum. Find the line parameters (R, L, G, C) and the wavelength of transmission line at 100 MHz.

[3 Marks]

Q2 a) For a transmission line, the primary constants are $R=0.25\ \Omega$, $G=0$, $L=0.3\ \mu$H/m and $C=15$ pF/m. Determine the

i) phase and attenuation constants of the transmission line at 1 GHz and

ii) the characteristic impedance.

[2 Marks]

b) A 300 Ω loss-less transmission line is connected to a load has maximum and minimum currents of 20 A and 12 A respectively. What is the power delivered to the load?

Hint: The amount of power delivered to the load is given by

$$P_L=\frac{\left|V^+\right|^2}{2Z_0}\left[1-\left|\Gamma_L\right|^2\right].$$

[3 Marks]

Q3 a) "A grphical representation of a transmission line helps in pictorial visualization of some basic concepts". Explain how the same Smith Chart is used to deal both impedances and admittances of a transmission line.

[1 Mark]

b) An antenna with an impedance (40 + j30) is to be matched to a 100 Ω lossless line with a short circuited stub which is added in parallel to the main transmission line. Determine

i) the required stub admittance,
ii) the distance between the stub and the antenna and
iii) the stub length.

[4 Marks]

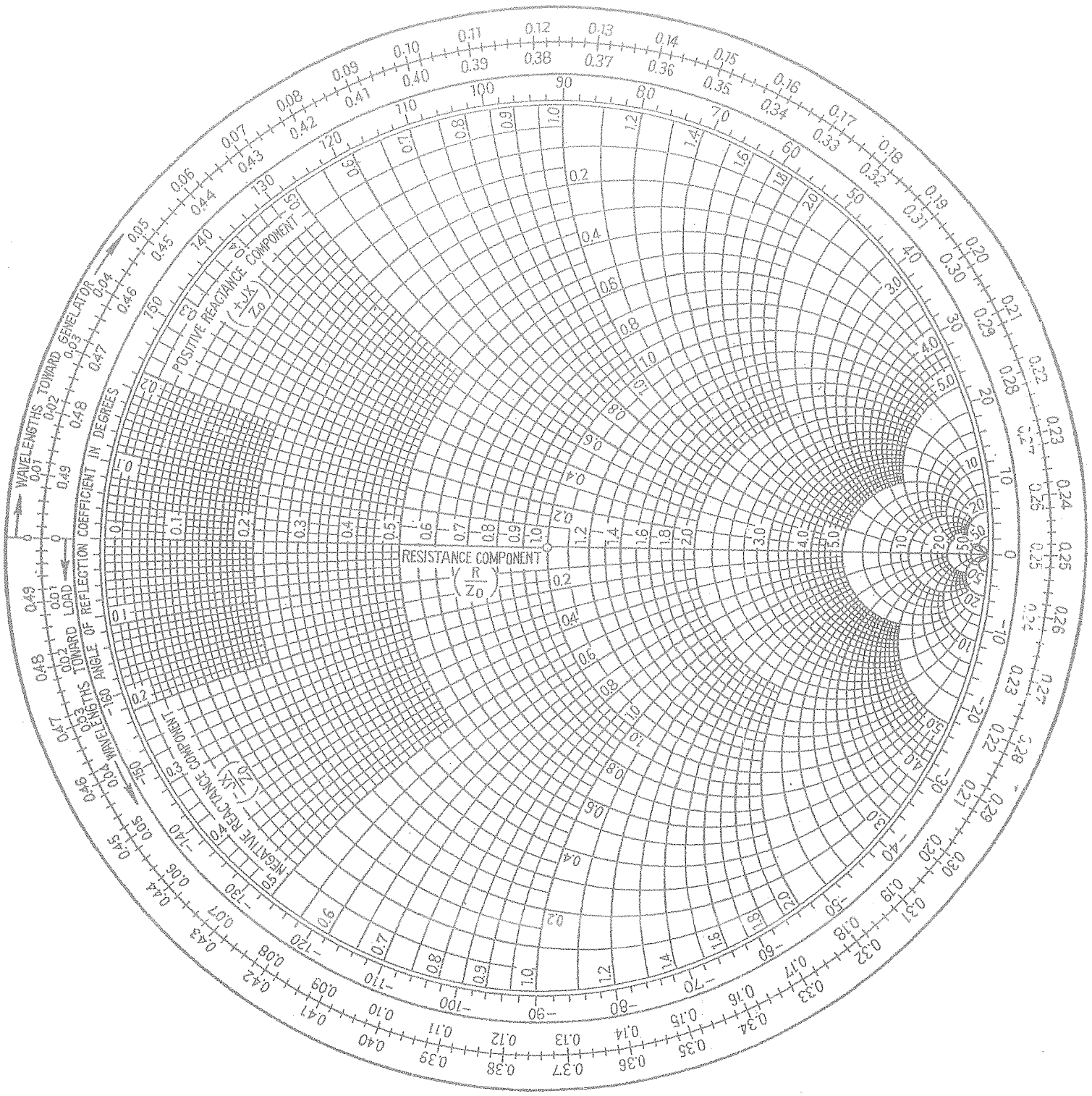
Q4 a) Is it possible to use any value of n and m in order to define a Transverse-Magnetic (TM_{nm}) mode of a rectangular waveguide? Explain clearly.

[1.5 Marks]

b) A $2.0\times3.0\,cm^2$ waveguide is filled using a dielectric material with a relative permittivity of $\varepsilon_r = 4$. If the waveguide is operated at 20 GHz and TM_{11} mode, determine

i) the cut-off frequency,
ii) the phase constant and
iii) the phase velocity.

[3.5 Marks]


WAVELENGTHS TOWARD GENELATOR
WAVELENGTHS TOWARD LOAD
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
POSITIVE REACTANCE COMPONENT
(+jX/Z0)
NEGATIVE REACTANCE COMPONENT
(-jX/Z0)
RESISTANCE COMPONENT
(R/Z0)