UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2017

Module Number: EE6301 **Module Name: Communication Systems**

[Three Hours]

[Answer **all questions**, each question carries 10 marks]

Q1 a) Show that the attenuation coefficient for a loss-less transmission line is equal to zero.

[1.5 Marks]

b) A loss-less short circuited transmission line has an input impedance of $(0+j150)\,\Omega$. If the characteristic impedance of the line is $50\,\Omega$, determine the length of the line in terms of the wavelength.

[3.5 Marks]

c) The characteristic and load impedances of a loss-less transmission line are $400\angle 0^0\,\Omega$ and $200\angle 0^0\,\Omega$ respectively. Determine the followings for a perfect short circuited stub by using the provided Smith chart.

i) Length of the stub
ii) Position of the stub from the load end

[5.0 Marks]

Q2 a) Discuss the availability of Transverse-Magnetic (TM_{nm}) and Transverse-Electric (TE_{nm}) modes for a rectangular waveguide.

[2.0 Marks]

b) The standing wave pattern in a rectangular waveguide of $7.6 \times 2.5\ cm^2$ cross section carrying H_{10} mode shows successive peaks 6.6 cm apart.

i) Determine the frequency of the source.

ii) What is the relative permittivity of a dielectric material which is filled to make a new waveguide, if it carries H_{10} mode with successive peaks 4.4 cm apart? Assume that new waveguide is also operated at the same frequency in part i).

[5.0 Marks]

c) Draw the field patterns for TM_{11} and TM_{21} modes in the plane perpendicular to the propagation direction (i.e. only in x-y plane).

[3.0 Marks]

Q3 a) Explain the difference between directivity and gain of an antenna.

[2.0 Marks]

b) The electric field pattern of an antenna is $E(\theta) = \cos\theta \cos 3\theta$ for $0^0 \leq \theta \leq 90^0$. Determine the

i) half-power beamwidth (HPBW)
ii) Beam width between the first nulls (FNBW)

[3.0 Marks]

c) Explain why ionospheric waves are more realistic during night times using its propagation principle.

[2.0 Marks]

d) Define the following parameters used in space wave propagation analysis.

i) Optical horizon
ii) Radio horizon
iii) Effective radius of earth

[3.0 Marks]

Q4 a) What are the main parameters required to determine the minimum range resolution and the maximum detection range of the radar system?

[2.0 Marks]

b) Show that the unambiguous range (R_u) of a pulse radar system is equal to $\frac{cT_p}{2}$ where c is the velocity of light and T_p is the pulse repetition interval.

[2.0 Marks]

c) A pulse radar operating at 10 GHz frequency has an antenna with a gain of 28 dB and a transmitted power of 2 kW. It is desired to detect a target of cross section 12 m^2 with a minimum detectable signal of -90 dBm. What is the maximum range of the radar system?

[2.5 Marks]

d) Estimate the required peak transmits power for a Bistatic radar to achieve a minimum Signal-to-Noise Ratio (SNR) of 6 dB for a target with a Radar Cross Section (RCS) of 1 m^2. The target is 50 km from the transmitter and 75 km from the receiver. The radar operating frequency is 10 GHz and the pulse duration is 10 μs. The transmitter and receiver gains are 40 dB and 20 dB respectively.

[3.5 Marks]

Q5 a) What is the main purpose of having Polar Orbit satellite?

[1.0 Mark]

b) Explain the difference between the Broadcast Satellite Network and the Interactive Satellite Network using examples.

[2.0 Marks]

c) In satellite receiver station, the Low Noise Amplifier (LNA) and the Down Converter (DC) are placed in a single module called Low-Noise Block down converter (LNB). Give two reasons for this arrangement.

[2.0 Marks]

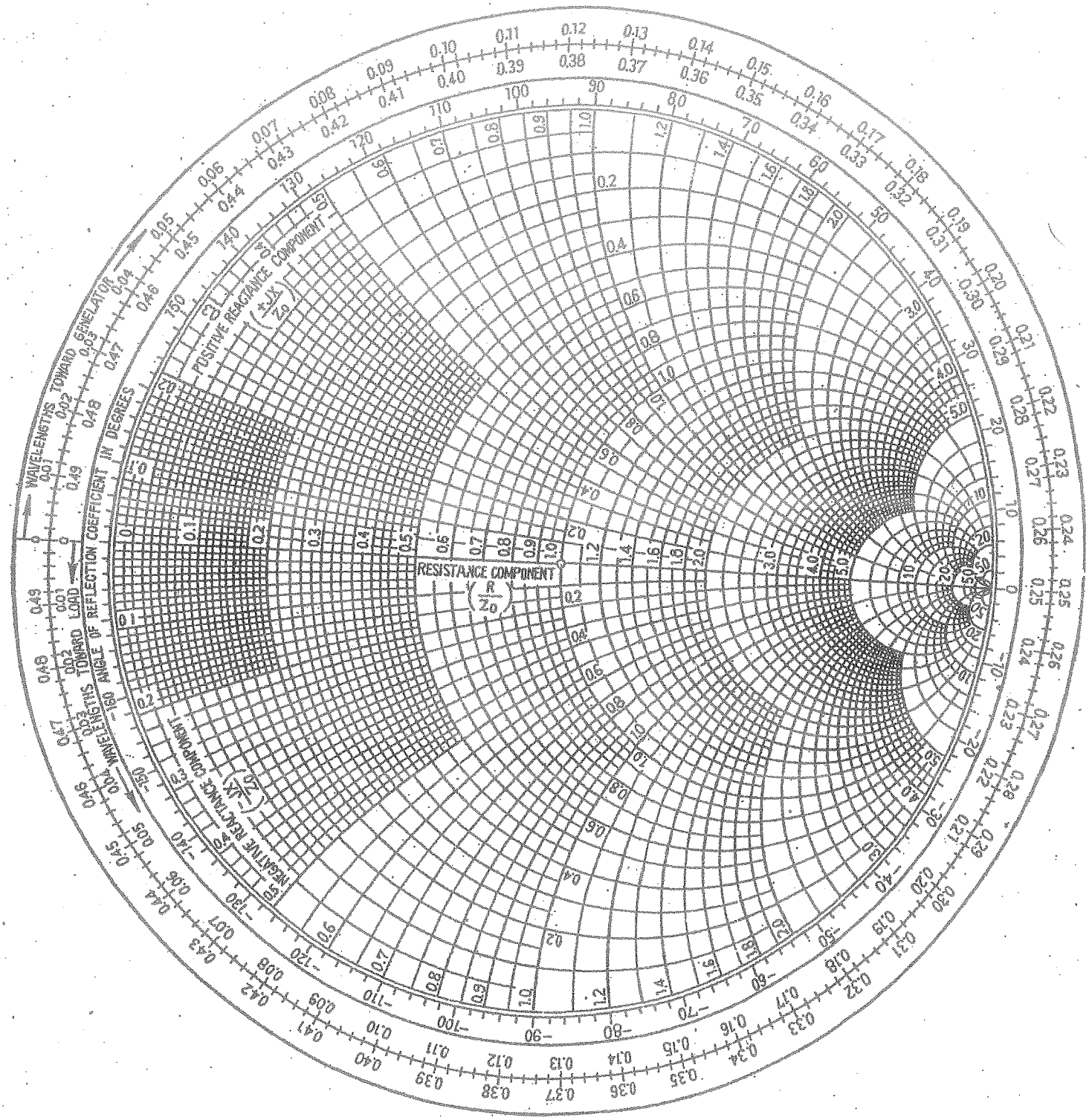
d) A geostationary satellite carries a transponder with 20 W transmitter at 4 GHz. The transmitter is operated at output power of 10 W and drives an antenna with a gain of 30 dB. The earth station is located at the center of the coverage zone of the satellite at a range of 38,500 km.

i) Calculate the transmit power density at the earth station in dBW/m^2.

ii) Determine the power received in dBW by an antenna with a gain of 39 dB.

iii) Calculate the Equivalent Isotropically Radiated Power (EIRP) of the transponder in dBW.

[5.0 Marks]



The Smith Chart