UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2016

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

[Three Hours]

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

Q1 a) Briefly explain the importance of using the Smith chart for transmission line analysis.

[1.5 Marks]

b) A lossless transmission line is terminated by a load impedance $(60+j60)\Omega$. The characteristic impedance of the transmission line is $60\,\Omega$. Determine the followings without using the Smith chart.

i) Voltage reflection coefficient at the load

ii) Voltage Standing Wave Ratio (VSWR)

iii) Distance between the load and the generator in terms of wavelength, if the input impedance of the transmission line is $(120-j60)\Omega$.

[4.5 Marks]

c) Solve the problem in part b) using the provided Smith chart.

[4.0 Marks]

Q2 a) "Different Transverse-Magnetic (TM_{nm}) and Transverse-Electric (TE_{nm}) modes are available for a rectangular waveguide based on integer values defined for variables n and m." Discuss the validity of the aforesaid statement.

[2.0 Marks]

b) The cutoff frequency of TE_{10} mode of an air-filled rectangular waveguide is 5 GHz. The cutoff frequency of the same waveguide for TE_{01} mode is 12 GHz. Determine the

i) dimensions of the rectangular waveguide.

ii) cutoff frequencies of next three higher TE modes.

[6.0 Marks]

c) If multimode operations among five TE modes considered in part b) are to be avoided, select an appropriate operating frequency band for the rectangular waveguide.

[2.0 Marks]

Q3 a) Briefly explain how the diffraction effect is minimized when designing space wave communication systems.

[2.0 Marks]

b) The refractive index profile of the troposphere does not have a constant value. Therefore, this incident has to be accounted in space wave propagation analysis.

i) Explain briefly the two parameters that are introduced to reflect the above effect.

ii) Derive the expressions to determine those parameters by stating the assumptions clearly.

[3.0 Marks]

c) i) Explain the terms 'Skip Distance' and 'Maximum Usable Frequency' in Ionospheric wave propagation.

ii) Obtain expressions for the minimum and maximum operating frequencies for Ionospheric wave propagation, if the transmitter and receiver stations are fixed.

[5.0 Marks]

Q4 a) Explain the difference between the pulse radar and continuous wave radar in terms of duty cycle.

[1.5 Marks]

b) Define Pulse width (PW), Pulse Repetition Interval (PRI), Pulse Repetition Frequency (PRF) and carrier wave in pulse radar systems.

[1.5 Marks]

c) Explain why the Frequency Modulated Continuous Wave (FMCW) radar is used for concealed weapon detection.

[1.5 Marks]

d) Radar parameters for a radar system are shown in Table Q4. Estimate the output SNR (Signal-to-Noise Ratio) for a target with a Radar Cross Section (RCS) of 3.98 m^2 at a range of 60 km.

Table Q4: Radar system parameters

Radar System Parameters	Value
Peak Transmit Power at Power Tube, P_T	1 MW
Transmit Losses, L_t	2 dB
Pulse Width, τ_p	0.4 μs
Antenna Gain, G_T, G_R	38 dB
Operating Frequency, f_c	8 GHz
Receive Losses, L_R	3 dB
Receiver Noise Factor, F_n	8 dB
Other Losses, L_{other}	2 dB
Effective Noise Temperature , T	290 K

[3.5 Marks]

e) For the same target in part d), calculate the maximum range that can be obtained from the radar system in Table Q4 with a SNR threshold of 13 dB.

[2.0 Marks]

Q5 a) Briefly describe the functionality of each subsystem of a satellite.

[2.0 Marks]

b) i) State two types of satellite transponders.
ii) Explain the functionality of the pre-amplifier in a satellite transponder.

[2.0 Marks]

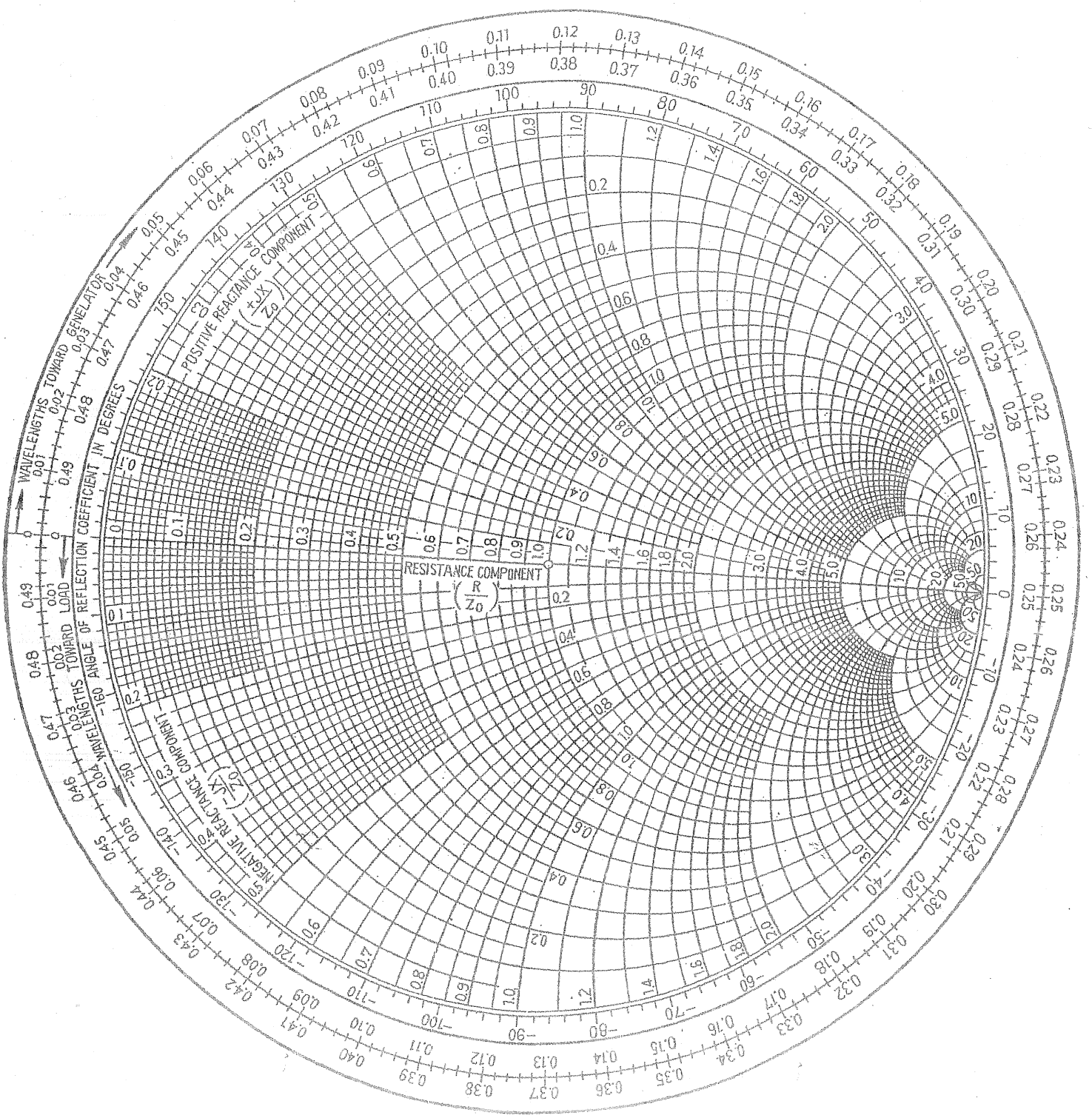
c) In the receiver station of a satellite communication system, the Low Noise Amplifier (LNA) and the Down-converter are placed close to each other. What are the advantages that can be obtained by this arrangement?

[2.0 Marks]

d) An earth station operated on C-band has an antenna with a transmit gain 54 dB. The transmitter output power is 100 W at a frequency 6100 MHz. The signal is received by satellite at a distance 37,500 km by an antenna with a gain 26 dB. The signal is then routed to a transponder with a noise temperature 500 K, a bandwidth 36 MHz and a gain 110 dB. The Boltzmann constant is 1.374×10^{-23} J/K. Determine the

i) power at the output port of the satellite antenna in dBW.
ii) noise power at the transponder input in dBW.
iii) Carrier-to-Noise power ratio (C/N) of the transponder in dB.
iv) carrier power at the transponder output in dBW and in watts.

[4.0 Marks]



The Smith Chart