EE535 Communication Systems (Fall 24-25)
Department of Electrical and Electronic Engineering
Faculty of Engineering
University of Misurata

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Date: 04/01/2025 Final Exam Time: 3 Hours

Q1(20 points).

(a) Create a block diagram of a Pulse Code Modulation (PCM) system. (2 points)
(b) Explain how the number of quantization levels influences the amount of quantization noise. (2 points)
(c) Classify digital multiplexers, providing a brief definition for each type. (3 points)
(d) Explain the basic SONET frame structure (STS-1), indicating its bit rate and the transport overhead (TOH) bit rate. (2 points)
(e) The bandwidth of the input signal to the pulse code modulator is limited to 4 kHz. The input signal ranges from -3.8 volts to 3.8 volts and has an average power of 30 mW. The required signal-to-quantization noise power ratio is 20 dB. Assuming uniform quantization, calculate the number of bits required per sample. (5 points)
(f) 24 voice signals are sampled uniformly and then time division multiplexed. The sampling operation uses flat top samples with 1 $\mu$sec duration. The multiplexing operation provides a synchronization by adding an extra pulse of appropriate amplitude and 1 $\mu$sec duration. Each voice signal is band-limited to 3.4 KHz.
(1) Assuming a sampling rate of 8 KHz, calculate the spacing between successive pulses of the multiplexed signal.
(2) Repeat (1) using the Nyquist sampling rate. (6 points)

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Q2 (12 points).

(a) Discuss in brief time availability. How to improve the time availability of a LOS link ?
(b) A 35-km LOS microwave link operating at 4 GHz employs two towers of heights 70 m each (above MSL). Check if these towers height are sufficient to give the required clearance to a LOS radio beam through a path of trees and two obstacles of heights 20 m and 40 m (above MSL) at 10 km and 30 km, respectively, from one site. Assume K = 4/3.
(c) What is the EIRP in dBm out of an LOS microwave antenna if the transmit power is 2 W, the transmission line losses are 3.5 dB, and the antenna gain is 36 dB?
(d) What is the distance to a geostationary satellite if the elevation angle for a particular earth station is 27° ?

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Q3 (14 points).

(a) Explain what GPS is, its segments and applications. (3 points)
(b) Name the drawbacks of satellite communication. (2 points)
(c) Illustrate the configuration types of VSAT networks. (3 points)
(d) Consider a radar with antenna gain of 5000 and radiated power 100 MW. The wavelength of the transmitted energy is 0.02 m and the target has a radar cross-section of 1.2 $m^2$. If the minimum detectable signal of the radar is $10^{-8}$ mW and the overall system loss is 10 dB, determine (1) The maximum range at which the radar can detect the target (2) The effective area of the radar antenna (3) The new radar range if the antenna gain is doubled while keeping the antenna effective aperture constant (4) The new radar range if the antenna gain is doubled while the wavelength remains constant. ( 6 points)

**Q4 (14 points).**

(a) List the main parts of the radar system and show via a block diagram, the components of a pulse radar system. **(3 points)**

(b) Explain in brief how the radar system operates. **(2 points)**

(c) Indicate the applications of the radar system. **(2 points)**

(d) Calculate the transmitted power needed at the earth station for the antenna 10 m. Assume that:

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|---|---|
| G/T satellite | -6 dB/°K |
| Distance to satellite | 38,000 km |
| RSL/T | -153 dBm/°K |

**(7 points)**

Good Luck