

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : EEX4330 Communications
Academic Year : 2024/25
Date : 07th February 2026
Time : 1330-1630h
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of two parts. Part A contains ten (10) questions, and Part B consists of four (4) questions in four (4) pages.
3. Adhere to usual symbols and notations.
4. Answer **all** questions.
5. All questions carry equal marks.
6. Answer for each question should commence from a new page.
7. This is a Closed Book Test (CBT).

Section A

1. Define Network Function Virtualization (NFV) and state its main purpose.
(2 marks)
2. State two (2) factors that limit the maximum transmission distance of copper cables.
(2 marks)
3. State the reason why LiFi cannot fully replace WiFi or 5G communication systems.
(2 marks)
4. State an advantage and a disadvantage of digitization in telecommunication networks.
(2 marks)
5. A cellular system has 840 duplex channels and uses a cluster size of $K = 7$. Calculate the number of channels available per cell.
(2 marks)
6. What is the main difference between digital terrestrial television broadcasting (DTTB) and satellite TV in terms of spectrum efficiency?
(2 marks)
7. State any two key differences between double-sideband suppressed-carrier (DSB-SC) and single-sideband (SSB) modulation schemes.
(2 marks)

8. List two benefits of using optical fiber in telecommunication networks. (2 marks)
9. Why does AM radio have larger coverage than FM radio? Give two reasons. (2 marks)
10. Define sectorization in cellular networks and state its purpose. (2 marks)

Section B

Question 01

- a.
 - I. Describe the evolution of mobile communication systems from 1G to 5G by stating one key technical feature introduced in each generation. (5 marks)
 - II. Explain how 5G supports enhanced mobile broadband and low-latency applications by describing two (2) specific technical factors. (2 marks)
- b. A 5G system operates at a carrier frequency of 3.5 GHz with an available bandwidth of 100 MHz and an SNR of 20 dB.
 - I. Calculate the maximum achievable data rate using the Shannon capacity theorem. (2 marks)

$$[C = B \log_2(1 + SNR)]$$
 - II. Compute the spectral efficiency (bits/sec/Hz) and compare it to a 4G system operating at 20 MHz bandwidth with the same SNR. (3 marks)
- c. A mobile operator plans to deploy a heterogeneous cellular network (HetNet) in a metropolitan area of 900 km². The network consists of macro cells and small cells to provide both wide coverage and high capacity. The system has a total of 1500 duplex channels. Macro cells have a radius of 3 km, while small cells have a radius of 1 km. The operator chooses a cluster size $K = 9$ for macro cells to reduce co-channel interference.
 - I. Calculate the area of a single macro cell, assuming hexagonal shape: (2 marks)

$$A_{\text{cell}} = \frac{3\sqrt{3}}{2} R^2$$
 - II. Determine the minimum number of macro cells required to cover the 900 km² area. (2 marks)

- III. Calculate the number of duplex channels available per macro cell and discuss how cluster size K impacts frequency reuse. (2 marks)
- IV. Determine the number of duplex channels available per small cell, assuming macro and small cells share the total 1500 channels proportionally based on area. (2 marks)

Question 02

- a.
 - I. State and briefly explain three (3) common multiplexing techniques used in communication systems. (3 marks)
 - II. Compare QPSK and 16-QAM by describing two (2) differences related to spectral efficiency and noise performance. (4 marks)
- b. A communication system uses 16-QAM modulation over a channel of bandwidth 5 MHz
 - I. Calculate the maximum symbol rate assuming ideal Nyquist signaling. (2 marks)
 - II. Hence determine the maximum achievable data rate. (2 marks)
 - III. If four such signals are combined using FDM and each channel requires a guard band equal to 10% of its bandwidth, calculate the total bandwidth required for the four channels including guard bands. (3 marks)
- c. A sensor produces an analog signal with a bandwidth of 10 kHz. The signal is to be digitized using Pulse Code Modulation (PCM) with 64 quantization levels.
 - I. Calculate the minimum sampling rate required according to the Nyquist theorem. (2 marks)
 - II. Determine the number of bits per sample. (2 marks)
 - III. Compute the bit rate of the resulting digital signal. (2 marks)

Question 03

- a. I. Explain circuit switching and packet switching by describing two (2) operational characteristics of each method. (4 marks)
- II. State two (2) functions of signaling systems used in modern communication networks. (4 marks)
- b. A data message of size 2 MB is transmitted over a packet-switched network. The message is divided into packets of 1,000 bytes, each containing a 40-byte header.
- I. Calculate the number of packets transmitted and the total header overhead in bytes. (5 marks)
- II. Determine the percentage overhead introduced due to packetization. (3 marks)
- c. A digital telephone exchange uses time-division multiplexing (TDM). Each call requires 8 kbps, and the exchange has a total bandwidth of 2 Mbps. Calculate the maximum number of simultaneous calls the exchange can handle. (4 marks)

Question 04

- a. I. Define wireless signal propagation and state two (2) propagation models in cellular networks. (5 marks)
- II. Describe the impact of path loss, shadowing, and multipath fading by stating one (1) effect of each on received signal quality. (5 marks)
- b. A cellular base station operates at 900 MHz and serves a mobile user located 2 km away.
- I. Calculate the free-space path loss between the base station and the mobile user. (6 marks)
- II. If the transmitted power is 43 dBm and antenna gains are neglected, estimate the received power at the mobile station. (4 marks)

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