# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION SUMMER SEMESTER, 2022-2023

DURATION: 3 HOURS FULL MARKS: 200

## CSE 4405: Data and Telecommunications

**Programmable calculators are not allowed. Do not write anything on the question paper.**

Answer **all 6 (six)** questions. Figures in the right margin indicate full marks of questions with corresponding COs and POs in parentheses.

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1. a) "In data communications, we commonly use periodic analog signals and non-periodic digital signals" - justify the statement. Explain the concept of a digital signal as a composite analog signal. Name different approaches to transmit a digital signal from one point to another. 12 (CO2) (PO1)

   b) In the NRZ encoding scheme, a positive voltage defines bit 1, and a zero voltage defines bit 0. In NRZ-L, the level of the voltage determines the value of a bit. On the other hand, in NRZ-I, a change or a lack of change in the level of the voltage determines the value of a bit. If there is a change, the bit is 1 and it is 0 otherwise. The ideas of RZ (transition at the middle of a bit) and NRZ-L are combined into the Manchester scheme. Differential Manchester, in contrast, combines the ideas of RZ and NRZ-I. There is always a transition in the middle of a bit, but the bit values are determined at the beginning of the bit. Now, explain the following pitfalls and explain in which scenarios of the input signals (a long string of 0 or a long string of 1), the above-mentioned schemes will face these pitfalls: 10 (CO2) (PO1)

      i. DC Component
      ii. Self-Synchronization
      iii. Baseline Wandering

   c) MLT-3 is a differential coding scheme with more than two transition rules that maps one bit to one signal element (similar to NRZ-I). Explain the MLT-3 scheme with a suitable example and a corresponding state transition diagram. Justify the rationale of the greater complexity (three levels and complex transition rules) at MLT-3. 10 (CO2) (PO1)

   d) Give the taxonomy of digital-to-analog conversion techniques. Which of the techniques are most susceptible to noise? Justify your answer. Briefly explain the bandwidth requirements of different analog-to-analog conversion techniques. 10 (CO2) (PO1)

2. a) Find the minimum Hamming distance for the detection of 6 errors and correction of 2 errors. Illustrate how burst error correction can be performed with the Hamming code. 7 (CO3) (PO2)

   b) Define a cyclic code. How does a cyclic code differ from a linear block code? Given the dataword 101001111 and the divisor 10111, show the generation of the CRC codeword at the sender side (using both binary division and polynomials). 10 (CO3) (PO2)

   c) Design a half-rate convolution encoder consisting of a shift registrar and XOR gates which generate two output bits for each input bit. Represent the state transition diagram and Trellis diagram of the designed encoder. Assume a suitable example and demonstrate how a convolution decoder corrects a single-bit error. 15 (CO3) (PO2)

3. a) We know that both Datagram, and Virtual-circuit need a routing or switching table to find the output port from which the information belonging to a destination should be sent out, but a circuit-switched network does not need such a table. **Give the reason for this difference**. An entry in the switching table of a Virtual-circuit network is normally created during the setup phase and deleted during the teardown phase. In other words, the entries in this type of network reflect the current connections and the activity in the network. In contrast, the entries in a routing table of a Datagram network do not depend on the current connections; they show the configuration of the network and how any packet should be routed to a final destination. The entries may remain the same even if there is no activity in the network. The routing tables, however, are updated if there are changes in the network. **Explain the reason for these two different characteristics**. Compare the packet-delay and efficiency of a Datagram network and a Virtual-circuit network. 10 (CO3) (PO2)

b) With necessary examples and flow diagrams, demonstrate the evolution process of different link control protocols for the noisy channels. Your answer should include the window size, and acknowledgement type along with other parameters. 15 (CO3) (PO2)

c) A sender sends a series of packets to the same destination using the *Go-Back-N ARQ*. If the header of the frame allows a 5-bit sequence number that starts with 0, what is the sequence number after sending 100 packets? If the sender uses the *Stop-and-Wait ARQ* protocol for flow control, then what should be the sequence number after sending 100 packets? 6 (CO3) (PO2)

4. a) What is CDMA? How does CDMA differ from other channelization protocols? Generate the chip sequences for a CDMA network with 17 stations. 10 (CO3) (PO2)

b) Briefly explain the persistent methods used by CSMA protocol. Considering the P-persistent method, draw the flowchart of CSMA/CD protocol. 10 (CO3) (PO2)

c) What is vulnerable time? Explain why the vulnerable time in ALOHA depends on frame transmission time ($T_{Fr}$) but in CSMA depends on propagation time ($T_p$). 10 (CO3) (PO2)

5. a) Neatly sketch the GSM system architecture. Suppose, a new mobile communication standard (GSM-3500) is specified as an alternative to GSM-1800 with the following frequency specifications:
Uplink: 3400-3600 MHz
Downlink: 3800-4000 MHz
The new standard also specifies that two carrier frequencies would be working at 400 KHz distance for a better voice quality. As a telecommunication engineer, calculate the following specifications of the new standard. 10 (CO4) (PO2)

   i. Wavelength
   ii. Bandwidth
   iii. Duplex Distance
   iv. Number of Radio Channels

b) Give the taxonomy of all logical channels available in GSM. Present the tasks of each of the Common Control Channels (CCCHs). Name the logical channels involved in the handoff process. 10 (CO4) (PO2)

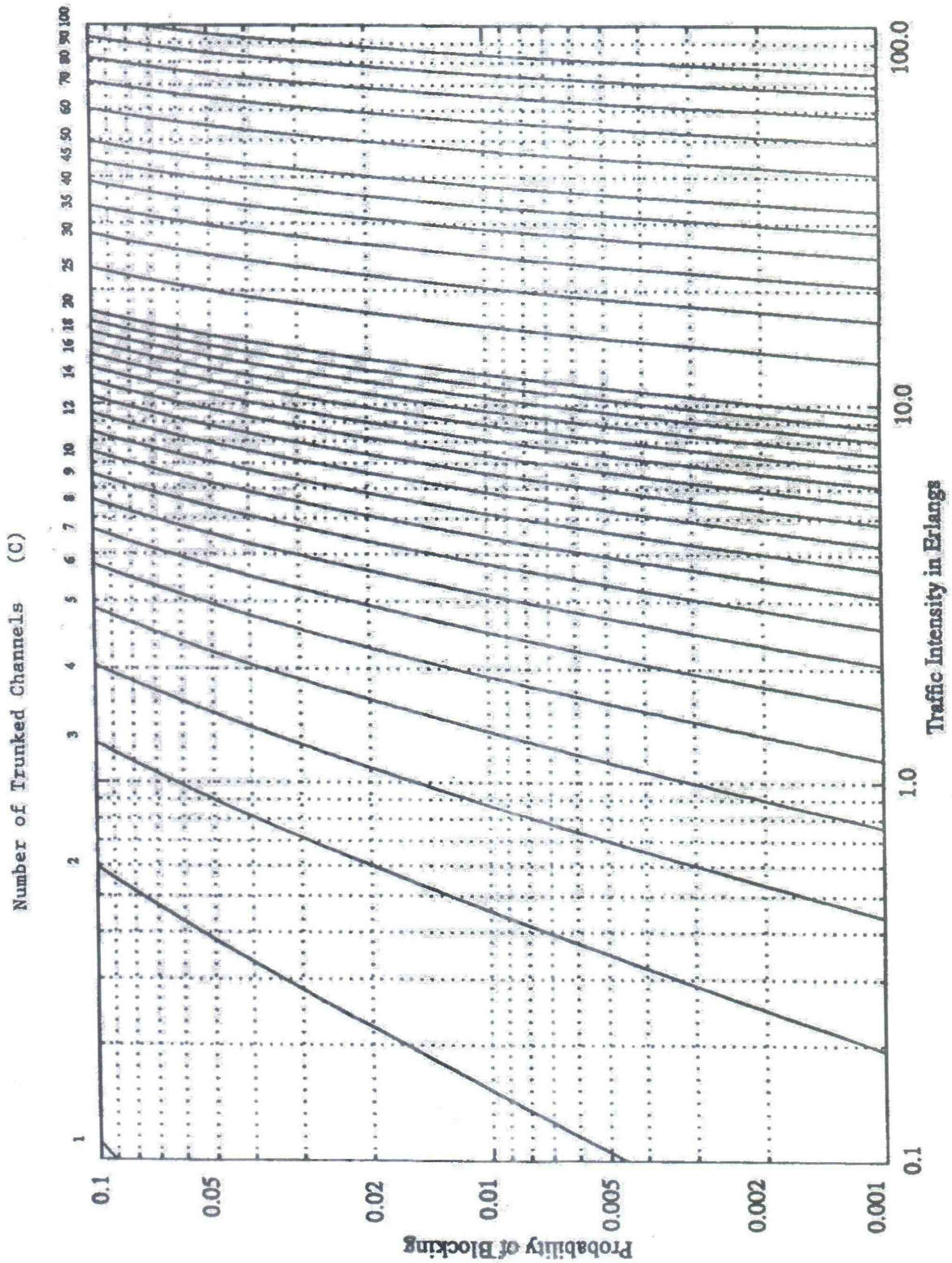
c) Draw a normal burst used in GSM. What is the significance of using the Training sequence (T) in a GSM burst? Demonstrate how four GSM bursts (each of 156.25 bits) are constructed from a 20 milliseconds voice signal following the steps of the GSM transmission process. 15 (CO4) (PO2)

6. a) What are the rationales for hexagonal cell geometry for cellular communications? Explain the co-channel interference and system capacity of a cellular network with appropriate figure and equation. 10 (CO4) (PO2)

b) With necessary diagrams, explain the handoff scenario at a cell boundary. Briefly explain different practical handoff considerations. 10 (CO4) (PO2)

c) Briefly explain the concepts of Trunking Theory and Grade of Service (GoS). A cellular system has 1000 cells with 25 traffic channels available where a minimum SIR of 15dB must be maintained. Consider that there are 6 channels in the first tier. Find the minimum cluster size for a path loss exponent 3. If the average call initiation rate of a user is two calls per hour and the average call duration is 3 minutes, how many subscribers can this system support for a 1% GoS ? 10 (CO4) (PO2)

# Appendix




The Erlang B chart showing the probability of blocking as functions of the number of channels and traffic intensity in Erlangs.