ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2021-2022**

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 whereas corresponding CO and PO are written within parentheses.

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1. a) Briefly explain the necessity of layering in designing a communication system. Match the following to one or more layers of the OSI model: 5+5 (CO1) (PO1)
   i. Transmission mode ii. Flow control iii. Encryption iv. Addressing v. Access control

   b) Multiplexing and Spreading are two ways of bandwidth utilization. How do they differ from each other? With necessary diagrams, explain the Frequency Hopping Spread Spectrum (FHSS) technique. How does FHSS differ from Direct Sequence Spread Spectrum (DSSS)? 10 (CO2) (PO1)

   c) Scrambling techniques are used along with line coding schemes to provide synchronization. These techniques insert pulses to break the long sequences of zeros. Briefly explain two common scrambling techniques with the scrambling rules. Consider a bit stream: 11000010000000000 and draw the corresponding digital signals by applying the scrambling techniques. How does block coding differ from scrambling? 13.33 (CO2) (PO1)

2. a) Transmission of information in any network involves end-to-end addressing and sometimes local addressing (such as VCI). Table 1 shows the types of networks and the addressing mechanism used in each of them. 4+4+7.34 (CO2) (PO1)

Table 1: Type of networks with their addressing mechanism for Question 2.a)

Network	Setup	Data Transfer	Teardown
Circuit-switched	End-to-End		End-to-end
Datagram		End-to-end	
Virtual-circuit	End-to-end	Local	End-to-end

Answer the following questions with necessary examples and diagrams:

i. Why does a circuit-switched network need end-to-end addressing during the setup and teardown phases? Why is no address needed during the data transfer phase for this type of network?

ii. Why does a datagram network need only end-to-end addressing during the data transfer phase, but no addressing during the setup and teardown phases?

iii. Why does a virtual-circuit network need addresses during all three phases?

b) You need to design a three-stage space-division switch with $N = 100$. Use 10 crossbars at the first and third stages and 4 crossbars at the middle stage. 4+6 (CO2) (PO1)

i. Draw the configuration diagram of this system and comment on the blocking factor.

ii. State the Clos criteria and redesign the above configuration using it.

c) Comment on the bandwidth requirements of the following modulation schemes:
i. BFSK ii. BASK iii. Frequency Modulation (FM) iv. Phase Modulation (PM)

3. a) Design a half-rate convolution encoder consisting of a shift registrar having three stages and EXOR gates which generate two output bits for each input bit. Draw the state transition diagram and Trellis diagram of the convolution encoder.

b) Transport Protocol standardized by ISO and CCITT in IS 8072 and X.224 use a powerful method of checksum generation. In this method, two checksum bytes are generated instead of the usual one. The procedure for generating these bytes involves the following steps:

i. Assume checksum bytes X and Y are 00000000.
ii. Define variables P_i and Q_i such that
$P_i = P_{i-1} + B_i$; where B_i= the i^{th} byte
$Q_i = Q_{i-1} + P_i$; Initial values $P_0 = Q_0 = 0$
iii. P_i and Q_i are calculated for *all the data bytes in the message* and for *initial values of the checksum bytes X and Y*.
iv. From the resulting value of P_i and Q_i variables, calculate the final values of the checksum bytes X and Y as below:
$X = P_l - Q_l$; where l = Number of data bytes +2
$Y = Q_l - 2P_l$

Generate the checksum bytes as per the transport protocol for the following data bytes:

10100101 00100110 11100010 01010101

Regenerate variables P_i and Q_i in the receiving end and show that they are zero if there is no error.

c) What do you mean by minimum Hamming distance? With the aid of block diagrams, illustrate the structure of the encoder and decoder for a Hamming code $C\ (7, 4)$. 9.33 (CO3) (PO1)

4. a) Give the taxonomy of different multiple access techniques. With the aid of a flow diagram, explain the ALOHA protocol. What are the advancements of CSMA protocol over ALOHA protocol? 4+8+5 (CO3) (PO1)

OR

Compare and contrast the 'Stop-and-Wait' protocol with the 'Stop-and-Wait ARQ' protocol. Explain the reason for moving from the 'Stop-and-Wait ARQ' protocol to the 'Go-Back-N ARQ' protocol. With necessary examples, prove that the send window size for 'Selective Repeat ARQ' protocol can be at best 2^{m-1}, where m is the size of sequence number. 5+4+8 (CO3) (PO1)

b) A sender sends a series of packets to the same destination using 'Go-Back-N ARQ'. If the header of the frame allows 5-bit sequence number that starts with 0, what is the sequence number after sending 100 packets? If the sender uses 'Stop-and-Wait ARQ' protocol for flow control then what should be the sequence number after sending 100 packets. 6.33 (CO3) (PO1)

c) What is vulnerable time? Compare the vulnerable time of different random access protocols. 3+7 (CO3) (PO1)

5. a) What are the rationales behind hexagonal cell geometry for cellular communication? For a hexagonal cell geometry, prove that the co-channel reuse ratio is given by $Q = \frac{R}{D} = \sqrt{3N}$, where the cluster size, $N = i^2 + ij + j^2$. 3.34+10 (CO4) (PO1)

b) Explain the following concepts in terms of cellular communication:
i. Trunking ii. Traffic intensity iii. Cell dragging 3×3 (CO4) (PO1)

A system has 800 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. 5+6 (CO4) (PO1)

i. Find the minimum cluster size with path loss exponent 3.

ii. If each user averages two calls per hour at an average call duration of 2 minutes, how many subscribers can this system support for a 2% GOS?

OR

A small city of 150000 residents has two competing mobile network companies named G and R that provide cellular service to the users. Company G has 50 cells, each with 40 channels and company R has 100 cells, each with 20 channels. Find the number of users that can be supported at 10% blocking probability if each user averages 4 calls per hour at an average call duration of 5 minutes. Compute the percentage market penetration of each company assuming that both the companies are operated at maximum capacity. 11 (CO4) (PO1)

6. a) Neatly sketch the GSM system architecture. Give the taxonomy of GSM logical channels. Briefly explain the authentication process of GSM. 4+4+5 (CO4) (PO1)

b) Draw the normal burst used in GSM. 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. 12.33 (CO4) (PO1)

OR

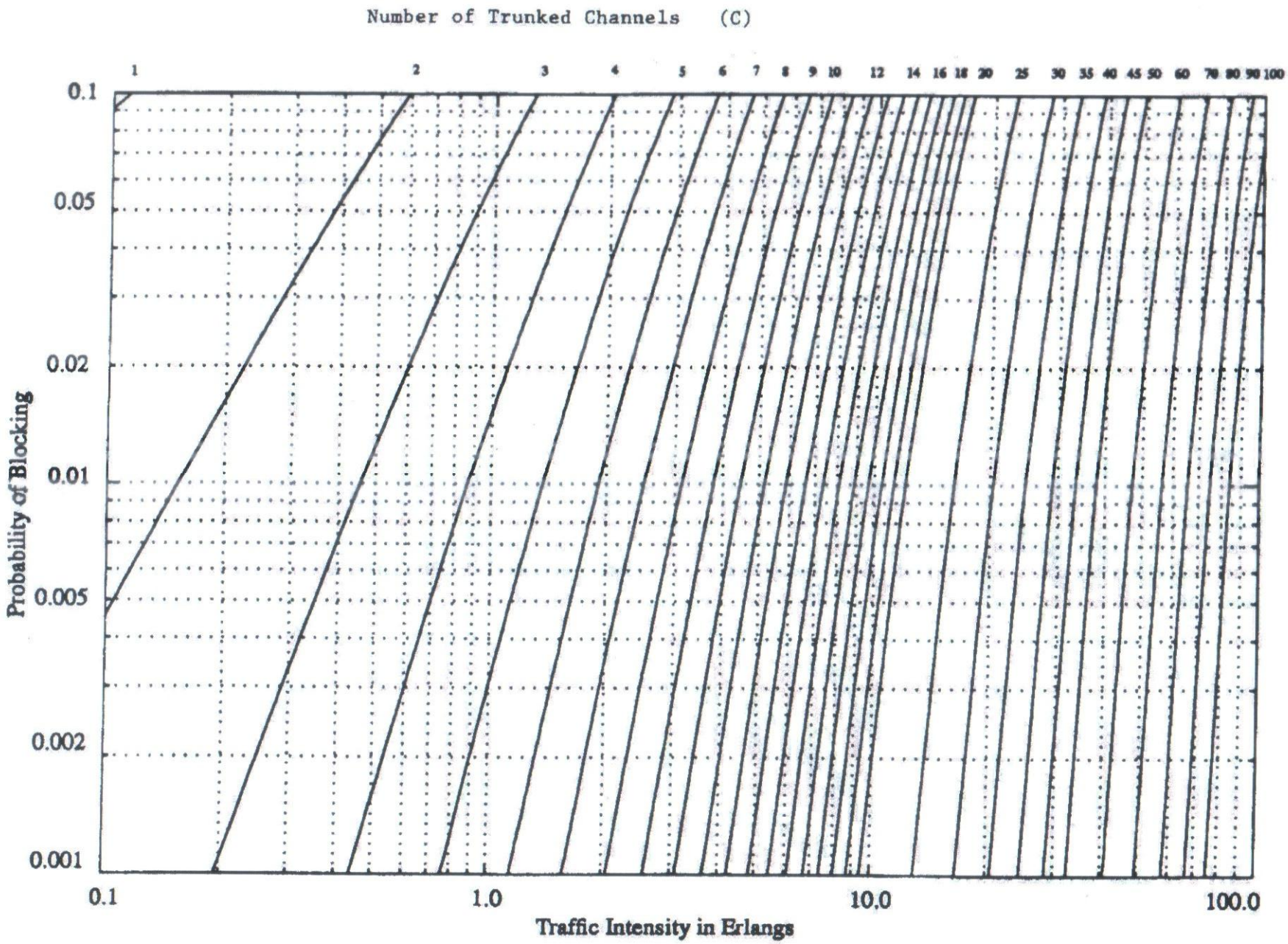
With the aid of necessary diagram, explain how a call to a mobile user initiated by a PSTN subscriber is established. Mention the name of different logical channels used in different stages of call establishment. 12.33 (CO4) (PO1)

c) Suppose a new mobile communication standard is specified as an alternative to GSM with the following frequency specifications: 8 (CO4) (PO1)

Uplink: 1400-1550 MHz **Downlink**: 1600-1750 MHz

The new standard also specifies that two carrier frequencies would be working at 400 KHz distance for better voice quality. As a telecommunication engineer, calculate the following specification of the new standard.

i. Wavelength ii. Bandwidth iii. Duplex distance iv. Number of radio channels



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