Strathmore UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF SCIENCE IN COMPUTER NETWORKS AND CYBERSECURITY
END OF SEMESTER EXAMINATION
CNS2105: DATA AND VOICE COMMUNICATION

DATE: 25th July 2023 **Time: 10:30-12:30**

Instructions

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.
3. Note down any assumptions you make in your answers.

QUESTION 1 [30MARKS]

a. Data and voice communications have evolved over the years due various challenges faced by businesses. Discuss any 3 strategic capabilities that voice and data communications aim to achieve (6 marks)
b. Using scenarios where it occurs, discuss the TCP 4-way handshake as it takes place in client-server communications (4 marks)
c. Voice communication has been one of the most commonly used forms of communication in the last century.
   i. Discuss the sequential steps to a telephone call setup (3)
   ii. There are two types of the last step in (i) above. Mention the two variants and highlight the flags that are used to represent them in TCP based connections (3)
d. Differentiate between VoIP gateways and exchanges in voice communication (2 marks)
e. A TCP connection is established between two hosts connected by a dedicated 8 Mbps path with a one-way delay of 100ms. Both hosts advertise the maximum window size of 65,535 bytes. Calculate the channel utilization as a percentage:
   i. By the time the sender pauses to receive acknowledgements (3 marks).
   ii. By the time the first acknowledgment gets back to the sender (3 marks)
f. Standards organizations have mandates over different technologies. Cellular telephony and IP telephony are handled by different organizations. Mention the respective organizations and why the difference in their control and administration (3 marks).
g. Using well labelled diagrams, compare VoIP infrastructure to the traditional (PSTN) voice networks (3 marks)

QUESTION 2 [15 MARKS]

a. Discuss any three principles to guarantee QoS in Voice communication (6marks)
b. Using examples, discuss telephone numbering plans for fixed networks (PSTN) or cellular networks. Further discuss call routing in fixed voice networks (4 marks)
c. Considering the following data frames. Calculate the checksum and indicate what is transmitted towards the receiver (5 marks).

1000 0110 0101 1110
1010 1100 0110 0000
0111 0001 0010 1010
1000 0001 1011 0101

QUESTION 3 [15 MARKS]

a. Consider a normal voice baseband signal whose highest frequency is 4Khz that needs to be digitized.
   i. What is the recommended minimum sampling rate for the process (1 mark)
   ii. Assuming an amplitude range defined by V_{min}=-20V and V_{max}=+20V, and 16 levels, what is the quantization zone width (1 mark)
   iii. List any 4 of the quantization zones that result from the process (2 marks)
   iv. Determine the number of bits that need to be used to encode the quantization levels that we have (1 marks)
   v. Indicate the 1^{st}, 4^{th}, 8^{th} and 16^{th} level codes (1 mark)
   vi. Assuming the sampled points are [-6.2,7.4, 16.2, 19.8, 11.3, -5.7, -11.3, -9.4, -5.9] determine their normalized quantized values (3 marks)
   vii. What is the bitstream based on the encoded words for each sample (2 marks)
   viii. Using the pseudo ternary scheme, perform the digital data to digital signal conversion for the first 5 sample points (2 marks)
   ix. Is there a DC component and how can it be fixed (2 marks)

QUESTION 4 [15 MARKS]

a. Assuming a SIP proxy server as the intermediary, represent the signaling information flow when setting up a channel between the calling and called party for a VOIP session (7 marks)
b. Discuss the 3 parameters considered in traffic flow management especially in converged data and voice networks (3 marks)
c. Protocol flags provide important metadata for data exchange or traffic flow control. Discuss the roles of the URG and PSH flags in TCP and their roles in priority traffic routing (3 marks)
d. Differentiate between switching and signaling in voice communication (2 marks)

QUESTION 5 [15 MARKS]

a. Discuss any 3 goals to consider when designing a transmission system for data and voice communication (3 marks)
b. Consider a channel with a 1 MHz capacity and an SNR of 63.
   i. What is the upper limit to the data rate that the channel can carry? (2)
   ii. The result of part (a) is the upper limit. However, as a practical matter, better error performance will be achieved at a lower data rate. Assume we choose a data rate of 2/3 of the maximum theoretical limit. How many signal levels are needed to achieve this data rate? (3)
c. Digital conversion allows for easier computations on data streams. This makes it easier to introduce error detection and correction codes for segments before transmission. If the data generating function is $X^9+X^8+X^6+X^4+X^3+X+1$ and the system divisor is X^4+X+1.
   i. Calculate the CRC that should be appended to the data before transmission (3)
   ii. If what is received is 11010110110110, confirm if there was an error during transmission (4)