JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

BONDO MAIN CAMPUS

END SEMESTER EXAMINATION

BSC IN COMPUTER SECURITY & FORENSICS [YR 1 SEM 2]

PAPER:IIT 3121 DATA COMMUNICATION PRINCIPLES

INSTRUCTIONS

1. This paper contains FIVE questions. Question One is 30 Marks and the rest are 20 Marks each.
2. Answer question one which is COMPULSORY and ANY OTHER TWO
3. Be precise and clear in your answers.

QUESTION ONE [30 MARKS]

(a) Explain your understanding of *data communications*. [2 Marks]

(b) Define the following terms and concepts as applies to Data Communications [4 Marks]

(i) Protocol

(ii) Bandwidth

(iii) Isochronous

(iv) Full-duplex

(c) Using an OSI Reference Model, identify common data communications standards in each network layer. [4 Marks]

(d) A nonperiodic composite signal has a bandwidth of 200 kHz, with a middle frequency of 140 kHz and peak amplitude of 20 V. The two extreme frequencies have amplitude of 0. Draw the frequency domain of the signal. [2 Marks]

(e) Does the Nyquist theorem bit rate agree with the intuitive bit rate described in baseband transmission? Suppose we need to send 265 kbps over a noiseless channel with a bandwidth of 20 kHz, how many signal levels do we need? [4 Marks]

(f) What is the difference between propagation speed and transmission speed? Calculate the propagation time and the transmission time for a 2.5-kbyte message (an e-mail) if the bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4×10^8 m/s. [4 Marks]

(g) What are the considerations for choosing a good signal element? Consider a digital transmission where the receiver clock is 0.1 percent faster than the sender clock. How many extra bits per second does the receiver receive if the data rate is 1 kbps? How many if the data rate is 1 Mbps? [4 Marks]

(h) A complex bandpass signal has a bandwidth of 200 kHz. Comment on the minimum sampling rate for this signal. [2 Marks]

(i) A 100 KHz carrier $\cos(2\pi \cdot 100 \cdot 10^3 \cdot t)$ is *amplitude modulated* by a signal s(t) given as

$$s(t) = 10\cos(2\pi \cdot 10^3 \cdot t) + 8\cos(4\pi \cdot 10^3 \cdot t) + 6\cos(10\pi \cdot 10^3 \cdot t)$$

What frequencies are contained in the modulated carrier? *Sketch* its amplitude spectrum. [4 Marks]

QUESTION TWO [20 MARKS]

(a) Identify the similarities and differences between Shannon Theorem and Nyquist Theorem as applied in data communications. [4 Marks]

(b) Shannon's formula for the ultimate capacity of a transmission link with bandwidth W is $C = W \log_2 (1+SNR)$ bps, where SNR is the ratio of signal power to noise power at the receiver input. What is the minimum signal-to-noise ratio *in decibels* required at the receiver to allow in principle a bandwidth efficiency of 10 that is a data rate of 10 bps for each Hz of bandwidth? Do you know of any practical scheme that achieves approximately this efficiency? [6 Marks]

(c) Name the FOUR fundamental characteristics of data communications. [2 Marks]

(d) A Go-Back-N ARQ scheme using ACKs and NAKs is implemented on a full-duplex link with the following parameters:

Transmit window size K=3, transmitter (P) re-uses a *minimum set of sequence numbers*

ACK and NAK frames are of *negligible duration*

I-frames are of fixed time-duration T_{ix}

One-way *propagation delay = one I-frame duration*

Processing times for I-frames, ACK and NAK frames = *half of I-frame duration*

(Note that the I-frame duration is the unit of time measurement in this description). Draw the *frame sequence diagram* for the case where the *third I-frame from P is lost* in transit and the *very first ACK frame from S is lost* in transit; all other frames are propagated without error. Indicate when frames are accepted and delivered to its higher protocol layer by the receiver (S). (Extend your diagram to 13 I-frame durations from start of transmission). [8 Marks]

QUESTION THREE [20 MARKS]

(a) "If composite signal is nonperiodic, the decomposition gives a combination of sine waves with continuous frequencies"

(i) Use a diagram to support the above statement. [4 Marks]

(ii) How does nonperiodic signal compare periodic one? Consider a periodic signal that has a bandwidth of 20 Hz. Its highest frequency is 60 Hz. What is the lowest frequency? Draw the spectrum if the signal contains all frequencies of the same amplitude. [4 Marks]

(b) Give a reason why Fourier transform is important in data communications. [2 Marks]

(c) Suppose we want to transmit user data at 14400 bits/sec, using baseband signaling pulses at a rate of Rs baud (pulses/second).

(i) What is the absolutely minimum bandwidth needed for Rs=2400 baud? [2 Marks]

(ii) In a telephone modem, the baseband pulses are modulated using QAM at a carrier frequency fc. The available frequency band is between 300 and 3300 Hz. What maximum baud rate is achievable? What fc should we use for this? (Justify answers). [4 Marks]

(iii) At Rs=2400 baud, what is the size of the QAM constellation? How does your answer change if we also transmit one error control bit for every 6 user data bits? [4 Marks]

QUESTION FOUR [20 MARKS]

(a) Distinguish between; [4 Marks]

(i) Error Detection and Error Correction

(ii) Data Encryption and Data Compression

(b) Using a well labeled diagram, explain the structure of encoder and decoder in error correction. [6 Marks]

(c) An application has the following bit pattern to transmit over a Stop and Wait communications link:

1 0 0 1 0 0 1 1 0 1 1 0

i. What would be the data bits sent over the communication channel if the data link used a cyclic redundancy check with a generator polynomial of the form:

P(x) = x3 + 1 [6 Marks]

ii. If the bits that arrived at the receiver for the above transmission had the following bit pattern:

1 0 0 1 0 0 1 1 0 1 1 1 0 0 1

What would be the response of the receiver? [4 Marks]

QUESTION FIVE [20 MARKS]

(a) Using well labeled diagram, explain the FIVE components of data communication system [6 Marks]

(b) Define the following terms and concepts; [4 Marks]

(i) Modulation

(ii) Multiple Access

(iii) Multiplexing

(iv) Synchronization

(c) Explain TWO techniques that can be used to secure data during transmission.[4 Marks]

(d) Identify TWO global organizations that regulate data communications standards [2 Marks]

(e) Compare the frame structure for 10BaseT, 100BaseT and Gigabit Ethernet explaining how they differ? [4 Marks]

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