University of Ghana
(All Rights Reserved)
Bachelor of Science in Engineering
Second Semester Examinations 2015/2016
Department of Computer Engineering
CPEN 308: Fundamentals of Information Transmission
2 Credits

Time Allowed: 2 Hours

INSTRUCTION: Answer All Questions

1. (a) Imagine that a bicycle messenger is given six (6) USB memory sticks, each of which contains 8 gigabytes of data. Given that the courier can travel at 30 km per hour through traffic, for what range of distance does the courier have a higher data rate than a transmission line whose data rate (excluding overhead) is 150 Mbps?

    [4 marks]

   (b) Distinguish between circuit switching and packet switching in communication systems.

    [4 marks]

   (c) What is a virtual circuit? Given it is "virtual", how does it compare to a "real" circuit? [4 marks]

   (d) Explain the significance of the Shannon-Hartley theorem.

    [2 marks]

2. (a) Give three(3) advantages that digital transmission has over analog transmission?

    [6 marks]

   (b) With the aid of well-labelled diagrams, show how binary information is represented in ASK and FSK? [4 marks]

   (c) Consider a communication channel with bandwidth 1 MHz which is used by a financial institution for transmission of banking services information.

i. Suppose the channel is noiseless, what is the maximum number of bits that can be transmitted reliably if you use 2-ASK for modulation? What if you use 8-ASK?

[4 marks]

ii. Suppose the channel suffers from noise with a signal to noise ratio (SNR) of 10 dB. What is the maximum number of bits that can be transmitted reliably? What if the channel SNR is 30 dB?

[4 marks]

(d) An audio CD has a maximum frequency of 22,000 Hz. What is the sample rate?

[2 marks]

(e) If the audio CD uses 12 bits per sample, what would the bit rate from the CD to the codec (which is used to convert the bit stream to an analog signal) be?

[2 marks]

(f) How does this rate compares to the bit rate of a telephone channel given that the telephone channel has a bandwidth of 4 KHz?

[2 marks]

(g) How many telephone channels can you fit into a single CD Audio bit stream?

[2 marks]

3. (a) Name two (2) common techniques on which error correction is based on and explain how they are actually implemented.

[4 marks]

(b) Decompose the signal $(1 + 0.1\cos 5t)\cos 100t$ into a linear combination of sinusoidal functions, and find the amplitude, frequency, and phase of each component. Hint: Use the identity for $\cos a \cos b$.

[6 marks]

(c) Given the periodic signal $x(t) = 2 - 5\cos 100t - 10\sin 200t$

  i. Express $x(t)$ as a compact Fourier Series.

[5 marks]

 ii. Express $x(t)$ as an exponential Fourier Series, and

[5 marks]

  iii. Sketch the two-sided magnitude and phase spectra.

[3 marks]

4. (a) Suppose that a digitized TV picture is to be transmitted from a source that uses a matrix of 480 × 500 picture elements (pixels), where each pixel can take on one of 32 intensity values. Assume that 30 pictures are sent per second. (This digital source is roughly equivalent to broadcast TV standards that have been adopted). Find the source rate R (bps).

[4 marks]
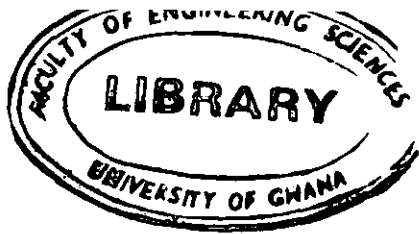
(b) Assume that the TV picture is to be transmitted over a channel with 4.5-MHz bandwidth and a 35-dB signal-to-noise ratio. Find the capacity of the channel (bps). [4 marks]

(c) Discuss how the parameters given in part (a) could be modified to allow transmission of color TV signals without increasing the required value for R. [4 marks]

5. A microwave transmitter has an output power of 0.1 W at 2 GHz. Assume that this transmitter is used in a microwave communication system where the transmitting and receiving antennas are parabolas, each 1.2 m in diameter.

(a) What is the gain of each antenna in decibels?

[3 marks]

(b) What is the effective radiated power of the transmitted signal, taking into account the antenna gain above?

[3 marks]

(c) If the receiving antenna is located 24 km from the transmitting antenna over a free space path, find the available signal power output of the receiving antenna in dBm units.

[3 marks]

6. (a) What do you understand by the term 'signal modulation' in communication systems?

[2 marks]

(b) Give two advantages and two disadvantages of analog and digital modulation schemes.

[8 marks]

(c) Explain the following modulation techniques as used in communication systems with their corresponding mathematical relations namely:
   i. Amplitude modulation (AM),

[2 marks]

   ii. Phase modulation (PM) and

[2 marks]

   iii. Frequency modulation (FM)

[2 marks]

(d) Let $m_1(t)$ and $m_2(t)$ be message signals and let $s_1(t)$ and $s_2(t)$ be the corresponding modulated signals using a carrier frequency of f_c
   i. Show that if simple AM modulation is used, then $m_1(t) + m_2(t)$ produces a modulated signal equal that is a linear combination of $s_1(t)$ and $s_2(t)$.

[5 marks]

   ii. Show that if simple PM modulation is used, then $m_1(t) + m_2(t)$ produces a modulated signal that is not a linear combination of $s_1(t)$ and $s_2(t)$.

[5 marks]