Khulna University, Khulna

Computer Science and Engineering Discipline

3rd Year, Term II, Examination 2015

Session: 2013-2014

Course No: ECE 3251

Full Title of Course: **Data Communication**

Full Marks: 60 Time: 03 Hours

- The Figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Q1. a) Define data and signal. **02**

b) Explain how data is transmitted, with the help of a digital communication system. **03**

c) What is modulation? State the conditions to retain the shape of the envelop of the modulated signal same as the modulating signal. **02**

d) Classify modulation techniques for transforming digital data into analogue signals. Give one use of each technique. **03**

Q2. a) Describe the pulse width modulation technique with the variations of its modulating signals. **03**

b) A PCM system is to carry a 20-kHz music channel. It is to have a signal-to-noise ratio of 80 dB and the peak maximum signal is 15 dB over its rms value. **03**

i. What sampling rate should be used?

ii. How many bits should be used in the sample code word?

c) Explain with necessary figure how PPM wave can be generated from a PWM signal. **04**

Q3. a) For the situation of a maximum sized sinusoidal signal input, derive the equation $\left(\frac{S}{N}\right) q = 1.5L^2$. **03**

b) Describe binary frequency shift keying method. **03**

c) Given the bit pattern, 01100 encode this data using ASK, BFSK and BPSK. **03**

d) Why carrier recovery circuit is used? **01**

Q4. a) With the help of a block diagram, describe QPSK modulation and demodulation technique. **04**

b) Why should PCM be preferable to data modulation for encoding analogue signals that represent digital data? **03**

c) What do you mean by constellation diagram and draw a constellation diagram of 16 QAM system. **03**

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Q5. a) For the bit stream 01001100011, sketch the waveforms for this sequence using: (i) NRZ-L; (ii) Bipolar AMI; (iii) Pseudoternary. **03**

b) State and prove the channel capacity theorem. **03**

c) Given a channel with an intended capacity of 20 $Mbps$ and the bandwidth of the channel is 3 MHz. What signal-to-noise ratio is required to achieve this capacity? **03**

d) What do you understand by the term mutual information? **01**

Q6. a) A discrete memoryless source has an alphabet of five symbols with their probabilities for its output, as given here: 04

Symbol	S_0	S_1	S_2	S_3	S_4
Probability	0.55	0.15	0.15	0.10	0.05

Compute Huffman code for this source and find:

i. The average code-word length

ii. Calculate the entropy of the source.

b) With the help of a Synchronous frame format, explain the synchronous transmission system. 03

c) What is multiplexing? Discuss about the time division multiplexing process. 03

Q7. a) Consider the (7, 4) Hamming code, whose parity check matrix is given by H in Figure 7 (a). 05

i. Find the minimum distance of the Hamming code.

ii. Determine the syndrome 's' of the Hamming code for single and double error patterns. From this, show that single errors are correctable and double errors are at least detectable.

$$H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$$

Figure 7(a): Matrix 'H'

b) Draw the state diagram of the convolution encoder given in Figure 7(b). Consider the input bit stream in 10011. Find the encoded bit sequence of the given data. Also draw the trellis diagram of this data sequence. 05

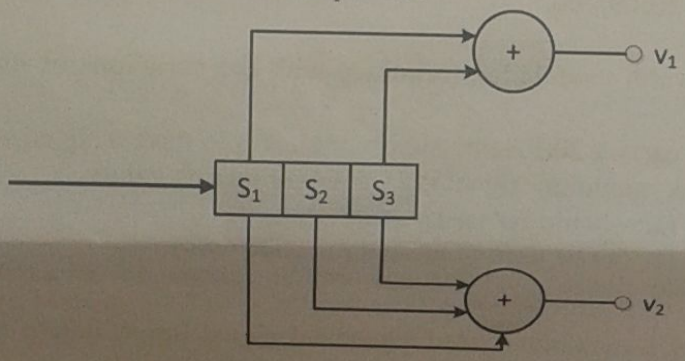


Figure 7(b): Convolution Encoder

Q8. a) How can you convert a general communication system into an optical fiber communication system? Explain with a block diagram. 03

b) A multimode step index fiber with a core diameter of 60 μm and a relative index difference of 1.5% is operating at a wavelength of 0.85μm. If the core refractive index is 1.48, then calculate: 03

i. The normalized frequency for the fiber.

ii. The number of guided modes.

c) Prove that, if the transmission times are to be the same, the bit energy for the coded signal must be reduced by a factor "r" compared to the uncoded signal. 04

KHULNA UNIVERSITY, KHULNA

Computer Science and Engineering Discipline Date: 04/06/2017

3rd Year, Term II, Examination 2017

Session: 2015-2016

Course No: ECE 3251

Full Title of Course: **Data Communication**

Full Marks: 60 Time: 03 Hours

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Define Data. Explain how data is transmitted with the help of a data communication model including specific function of each block of this model. 03
   (b) Derive the standard equation of Pulse Amplitude Modulated (PAM) wave using the concept of flat-top sampling. 03
   (c) Draw a modulator to generate a Pulse width Modulated (PWM) wave and explain its operation. Also show the corresponding waveforms after each block. 04

2. (a) Why is multiplexing of signals necessary? Name the common forms of multiplexing techniques. 02
   (b) Describe FDM system. From here, show the spectrum of the composite baseband signal and the FDM signal. 05
   (c) Three information signals are to be sent using time-division multiplexed PAM. Suppose that the maximum frequency of each of the first two signals is 5kHz and the maximum frequency of the third signal is 10kHz. Draw the block diagram of the system. 03

3. (a) A sinusoidal carrier has a peak value of 3V and frequency of 100Mhz. It is modulated with a binary digital message 101101. Draw the modulated waveforms for (i) ASK, (ii) BFSK and (iii) BPSK. 03
   (b) Explain the generation of a QPSK wave along with the modulator states. 04
   (c) Which of the four digital-to-analog conversion techniques (ASK, FSK, PSK or QAM) is most susceptible to noise? Defend your answer. 03

4. (a) What is quantizing? What is its effect? Explain the types of a quantizer with transfer characteristic of each type. 04
   (b) What is the need of sample and hold circuit? How does it help in quantization? 03
   (c) Show that, "under the assumption of no slope-overload distortion, the maximum output signal to-noise ratio of a delta modulator is proportional to the sampling rate cubed" 03

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) What is meant by intersymbol interference (ISI) in data communication? 02
   (b) Bipolar binary pulses are received with peak amplitude $A_p = 0.0015$ volt. The channel noise rms amplitude is 0.3 millivolt. Threshold detection is used, and 1 and 0 are equally likely. Find the detection-error probability. Given that $Q(x) \cong \frac{1}{x\sqrt{2\pi}}\left(1 - \frac{0.7}{x^2}\right)e^{\frac{-x^2}{2}}$. 03
   (c) A binary PSK system transmits the following two signals: 05
   $S_0(t) = 0.01\cos(2\pi \times 1000t)$
   $S_1(t) = 0.01\cos(2\pi \times 1000t + \Theta_1)$
   $T_b = 10_{msec}$ and $N_o = 2 \times 10^{-7}$
   Plot the probability of bit error of a coherent detector as a function of Θ_1

6. (a) State channel coding theorem. 02
   (b) Prove that, "the channel capacity, C varies with the probability of error, P". 03

(c) Consider a message bit be 100100 and Divisor be 1101. Find the message bit polynomial and Divisor Polynomial. What will be the polynomial of sending data after adding CRC? 05

7. (a) A code scheme has a minimum hamming distance of 4. What is the error detection and correction capability of this scheme? 02

(b) Show the structure of the encoder and decoder for a hamming code and explain its operation. 03

(c) Consider the (7,4) Hamming Code, whose parity check matrix is given by H in figure 7(c) 05

$$H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$$

Fig. 7(c) : Matrix H

(i) Find the minimum distance of the Hamming Code.

(ii) Determine the syndrome 's' of the Hamming Code for single and double error patterns. From this, show that single errors are correctable and double errors are at least detectable.

8. (a) What is line coding? List some important factors that can be used in evaluating the various line coding techniques. 02

(b) Given the bit pattern 00110011, draw the waveform for this sequence using (i) NRZ-I (ii) Manchester and (iii) MLT-3 scheme. 03

(c) What is the result of scrambling the sequence 111000000000000 using the following scrambling techniques? Assume that the last non-zero signal level has been positive. 02

(i) B8ZS

(ii) HDB3 (the number of nonzero pulses is odd after the last substitution)

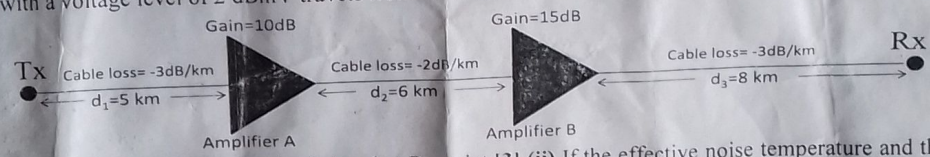
(d) We have a baseband channel with a 1-Mhz bandwidth. What is the data rate for this channel if we use the following line coding schemes? 03

(i) NRZ-L (ii) MLT-3 (iii) 2B1Q

CT-2,ECE 3251(B),FM:15, Time:30 min, Date:10-04-2017

(Q.1) What key factors affect channel capacity? Draw the spectrum of thermal noise. [1+1]

(Q.2.) A signal with a voltage level of 2 dBmV travels from Tx to Rx as shown in the following figure.



(i) Calculate the power(in dBm) of the received signal at Rx point.[3] (ii) If the effective noise temperature and the bandwidth o the receiver is 294K and 20 MHz respectively, calculate the signal to noise ratio(SNR) in dB at Rx point, taking thermal nois alone into account.[3] (iii) Determine the channel capacity of the link.[3] (iv) How many signal levels are needed to achieve a dat rate of half of the channel capacity?[2] (v) Which amplifier, A or B, will improve the SNR better and why? [1+1]

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(b) Expl ar 03
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symbols have their usual

PAM with natural sampling. 03
01

Date: 10-04-2017

CSE Discipline

ECE 3251, Class Test : 1

Marks: 30, Time: 20 min

Q1. Describe Data Communication system with its block diagram. Also show the input-output waveforms of the corresponding blocks. 10

Q2. How does a data communication system differ from the basic communication system? 04

Q3. Make a comparison among PAM, PWD and PPM. 06

Q4. Convert a PWM wave into a PPM wave. 10

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Hours

- The figures in the margin indicate
- Use separate sheet for each secti

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03

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ECE 3251(B), FM:15, Time:30 min, Date:10-04-2017

CSE Discipline, ECE 3251, Class Test : 2, Marks: 15, Time: 20 min

Q1. A sinusoidal carrier has a peak value of 3V and frequency of 100MHz. It is modulated with a binary digital message 101101. Draw the modulated waveform for (a) ASK, (b) BFSK and (c) BPSK. 06

Q2. Draw the block diagram of a QPSK modulator. Also draw the corresponding inphase component, quadrature phase component and the output waveforms of this block if the input is 101001. 07

Q3. What is Delta Modulation? 02

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- The figures in the margin ind
- Use separate sheet for each

There are **FOUR** qu ons

1. (a) Define the f 03
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   (b) Explain ar ation. 03
   (c) A carrier odulated by 04
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2. (a) Wri significance on 0
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   (b)

CSE Discipline: Data Communication: Course No.: ECE 3251

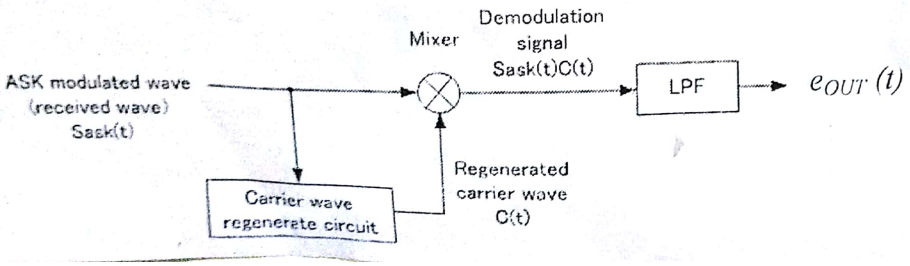
Class Test-1:Marks-15:Time 25minutes

Q1. State Sampling theorem. What is the need for sampling? 4

Q2. What is the function of a carrier? 1

Q3. Draw the waveforms for ASK, FSK and PSK of the data: 00101100 7

Q4. What is the e_{OUT} *(t)* of the following block diagram: 3



CSE Discipline: Data Communication: Course No.: ECE 3251

application Class Test-2:Marks-15:Time 20minutes

Q1. Give one example of each of PAM, PWM and PPM. 03

Q2. Define TDM. Through figure show how multiplexing of three channels is performed. 05

Q3. Graphically derive a PPM wave from a PWM wave. 07

CSE Discipline: Data Communication: Course No.: ECE 3251

Class Test-3: Marks-20: Time-25min

Q1. What do you mean by constellation diagram? What is the use of it? Draw the signal-space representation of '32-QAM'. 10

Q2. Why do we shape the baseband response of a system? Draw the waveform of the 'data: 11000000001100000101' using i) Bipolar RZ; ii) Gray Code; iii) B8ZS and iv) HDB3. 10

Date: 07/12/2017

KHULNA UNIVERSITY, KHULNA
Computer Science and Engineering Discipline

3rd Year Term: II Session: 2016 – 2017 Examination: 2017
Course No: ECE 3251 Course Title: Data Communication
Full Marks: 60 Time: 03 Hours

- The Figures in the margin indicate full Marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions. **Marks**

1. a) Explain how data is transmitted through a typical data communication system. 02

b) Make a comparison among PAM, PWM, and PPM. 03

c) Three information signals are to be sent using time-division multiplexed PAM. Draw a figure to show this multiplexing, and explain shortly. 05

2. a) What is aperture effect? How can it be minimized? 02

b) Show that "Amplitude distortion as well as a delay of T/2 is achieved using flat-top samples." 04

c) An important signal, s(t), is pulse position modulated (PPM). Find out its corresponding pulse width modulated (PWM) wave. 04

3. a) Define SNR. Explain a differential pulse-code modulation system with necessary figure. Also, find the output signal-to-quantization noise ratio of DPCM. 05

b) Explain the types of quantization noise in delta modulation. 03

c) Prove that, $(SNR)_o|_{max} = \frac{3}{8\pi^2 w f_0{}^2 T_s{}^2}$ [Symbols hold their usual meaning.] 02

4. a) What is meant by carrier recovery? Show how the carrier may be recovered from a QPSK signal. 04

b) Describe FDM. Show the spectrum of the composite baseband signal and the FDM signal. 03

c) A sinusoidal carrier has a peak value of 5v and frequency of 100MHz. It is modulated with a binary digital message 101111. Draw the modulated waveforms for: (i) ASK, (ii) FSK, and (iii) PSK. 03

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. a) Draw the waveform of the "data: 11100000000001" using the following data shaping formats. Assume that the last non-zero signal level has been positive. (i) Polar RZ, (ii) Differential encoding, (iii) B8ZS, and (iv) HDB3 (the number of non-zero pulses is odd after the last substitution). 04

b) What is the maximum possible band rate of a voice channel having bandwidth of 3100Hz? 01

c) Explain the fundamental concept of a constellation diagram. Draw the signal space representation of '32-QAM' with symbols. 05

6. a) Define error probability. 02

b) Derive the error probability for polar signal. 05

c) Polar binary pulses are received with peak amplitude, $A_p = 1mV$. The channel noise rms amplitude is 192.3μV. Threshold detection is used, and 1 and 0 are equally likely. Find the detection error probability. Adjust the amplitude of the pulse to keep the transmitted power same and find the error probability for on-off and bipolar case. 03

Table for Q(x)

x	Q(x)
3.00	0.1350×10^{-2}
3.50	0.2326×10^{-3}
3.68	0.1166×10^{-3}
4.00	0.3167×10^{-4}
5.00	0.2867×10^{-6}
5.20	0.9964×10^{-7}
5.60	0.1072×10^{-7}

7. a) Describe the asynchronous transmission mode. 03

b) We want to transmit 1000 characters with each character encoded as 8 bits. Find the number of transmitted bits for synchronous and asynchronous transmission modes. 04

c) What is the purpose of cladding in an optical fiber? Name the advantages of optical fiber over twisted-pair and co-axial cable. 03

8. a) State channel coding theorem. 02

b) Explain how the channel capacity varies with the probability of error. 03

c) Assume a message bit be 100100 and divisor be 1101. Find the message bit polynomial and divisor polynomial. What will be the polynomial of sending data after adding CRC? 05

Marks: 15 Data Communication Class Test: 01

1. Define modulation process. Write down the names of modulation techniques with an example. 03
2. Consider a sinusoidal AM wave, now derive its frequency spectrum equation where symbols have their usual meaning. 05
3. A carrier of 10 V peak and frequency 100 KHz is amplitude modulated by a sine wave of 4 V peak and frequency 1000 KHz. Determine the modulation index for the modulated wave and draw the amplitude spectrum. 05
4. Define PWM technique. 02

PAIBFUL

Date: 11-12-2016

Khulna University

Computer Science and Engineering Discipline
3rd Year Term II Final Examination 2016
Session: 2014-2015
Course No: ECE 3251
Full Title of Course: Data Communication

Full Marks: 60 Time: 03 Hours

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions

1. (a) Define the following terms: 03
Analog and Digital transmission system.
(b) Explain amplitude modulation technique with its standard equation. 03
(c) A carrier of 10V peak and frequency 100KHZ is amplitude modulated by a sine wave of 4V peak and frequency 1000HZ. Determine the modulation index for the modulated wave and draw the amplitude spectrum. 04

2. (a) Write down the sampling theorem and explain its significance on communication system. 03
(b) Prove the following statement: At 100% modulation, total power of a modulated signal is $P_T = (3/2)P_C$, where symbols have their usual meanings. 03
(c) Define PAM. Also draw the neat sketch of PAM with natural sampling. 03
(d) What do you mean by aperture effect? 01

3. (a) Define SNR. Show that, the product of two significant parameters for digital transmission system, R_b/B_T and E_b/N_0 is equal to SNR. 04
[Symbols have their usual meanings]]
(b) Explain the technique of full-duplex FSK transmission system on a voice-grade line. 03
(c) A sinusoidal signal with a maximum peak input voltage of 5V is applied to a PCM channel using a 10-bit code word. Find: 03
i. The number of quantization levels used
ii. The maximum sinusoidal signal to quantization noise ratio in Decibels.

4. (a) Draw up a table, showing how the sequence d_k = 1011001 would be encoded and decoded using DPSK technique. 04
(b) Discuss the basic stages involved in the generation of PCM. Why is compressor added in the generation of PCM? 03
(c) Explain the fundamental concept of a constellation diagram with necessary figure. 03

There are **FOUR** questions in this section. Answer any **THREE** questions

5. (a) Define numerical aperture. Prove that – $NA = n_1(2\Delta)^{1/2}$, where symbols hold their usual meanings. 04
   (b) In a fiber-optic cable, does the light energy from the source equal the light energy recovered at the destination?. Discuss this in terms of propagation mode. 03
   (c) An optical fiber made of plastic with a refractive index of 1.53 and cladded with another plastic with a refractive index of 1.51. Launching takes place from air. Now calculate the following terms: 03
      i. Relative refractive index difference between core and cladding.
      ii. Numerical aperture.
      iii. Acceptance and critical angle.

6. (a) Define multiplexing and demultiplexing process. Write down the classification of multiplexing technique. 03
   (b) Consider the TDM technique with three input signals and explain the interleaving process with the help of a diagram. 04
   (c) Five channels are to be multiplexed together shown in the following figure. Find the minimum bandwidth of the link. 03

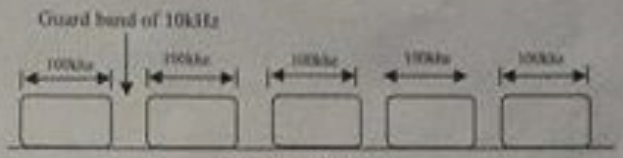


Figure Q.6 (c)

7. (a) Explain sliding-window flow control protocol with necessary diagram. 04
   (b) Consider a message of 10 bits, M = 1101011011. Pattern of 5 bits, P = 10011. For CRC error-detecting code, find the reminder R and transmitted bits in a polynomial form. 04
   (c) How is synchronization provided for synchronous transmission? 02

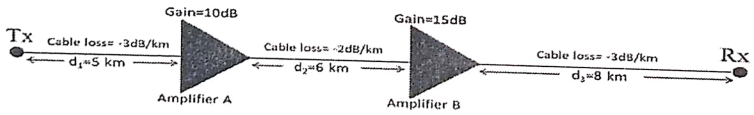
8. (a) Write down the Shannon capacity formula. What is the channel capacity for a teleprinter channel with a 300-Hz bandwidth and a signal-to-noise ratio of 3dB? 03
   (b) A discrete memoryless source has an alphabet of five symbols with their probabilities for its output, as given here: 05

Symbol	S_0	S_1	S_2	S_3	S_4
Probability	0.4	0.2	0.2	0.1	0.1

   Compute Huffman Code for this source and find:
      i. The average code-word length
      ii. Calculate the entropy of the source
   (c) What do you mean by data link control protocol? 02

CT-1, ECE 3251(B), FM:10+20, Time:30 min, Date:30-09-2018

(Q.1) (True/False?): (i) If a signal doesn't change at all its frequency is infinite. (ii) Frequency spectrum of a composite aperiodic signal is discrete.(iii) For baseband transmission of a digital signal we need a high pass channel with a very wide bandwidth (iv) The SNR of a noiseless channel is ideally zero. (v) Optical amplifier can improve the SNR of a channel. **(Q2.)** A signal with -5 dBm power travels from Tx to Rx as shown in the following figure: (i) Calculate the power (in mW) of the received signal at Rx point. (ii) At room temperature what is the signal to noise ratio in dB at Rx point if its BW is 20 MHz? Take thermal noise alone into account whose noise power density is kT Watt/Hz, k being the Boltzmann's constant and T is the absolute temperature (iii) Determine the channel capacity of the link. (iv)How many signal levels are needed to achieve a data rate of half of the channel capacity?



CT-2, ECE 3251(B), FM:30(10+5+15), Time:30 min, Date:28-10-2018

(Q.1) (True/False?): (i) For a twisted pair cable, more twist means better quality. (ii) The most common UTP connector is BNC.(iii) The attenuation is much higher in coaxial cables than in twisted-pair cables. (iv) Modal dispersion is a very common problem in single mode step index fibers. (v) Keeping the material properties same, fibers with bigger core dimension will usually have higher numerical aperture than the fibers with smaller core dimension. **(Q.2)** Suppose a light beam from an optical source is launched into an optical fiber which propagates inside the core. Sketch the scenario neatly assuming ray-optics concept and show therein the critical incident angle, critical propagation angle and acceptance angle. **(Q.3)** Suppose a surface emitting LED couples 5.88μW of optical power into a step index multimode optical fiber whose numerical aperture and core index is 0.2425 and 1.465, respectively. Determine the output power of the optical source and the refractive index of the fiber's ~~core material~~ cladding material.

Date: 22/11/2018

Khulna University, Khulna

Computer Science and Engineering Discipline
3rd Year, Term II, Examination 2018
Session: 2017-2018
Course No: ECE 3251
Full Title of Course: Data Communication

Full Marks: 60 Time: 03 Hours

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section A

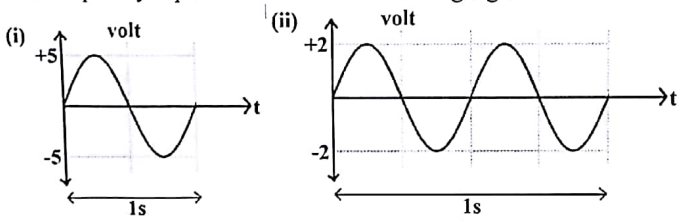
There are **FOUR** questions in this section. Answer any **THREE** questions

1 a) What do you understand by the term modulation? Why modulation is necessary in communication? 2+1

b) Calculate the antenna height for the frequency 3GHz 02

c) Consider the general expression for Amplitude-Modulated (AM) signal is $s(t) = [A + x(t)]\cos\omega_c t$; where $x(t) = V_m \cos\omega_m t$ is a single tone modulating signal. Show that the modulated signal will be $s(t) = A\cos\omega_c t\,[1 + m_a \cos\omega_m t]$. Here m_a represents the modulation index. 03

d) Draw the frequency representation of the following signals 02



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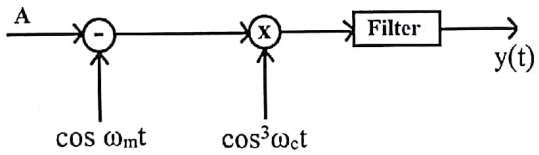
2 a) A 400 watts carrier is modulated to a depth of 75 percent. Find the total power in the amplitude-modulated wave. Assume the modulating signal to be a sinusoidal one. 03

b) Find out the output signal y(t) of the following system. Consider the filter allow to pass the frequency up-to $\left(2\pi f_c + \frac{2\pi f_m}{4}\right) Hz$. 03



Here, $\omega_c >> \omega_m$.

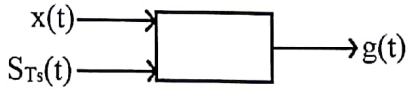
c) Why should you consider Double-Sideband-Suppressed Carrier (DSB-SC) Amplitude Modulation technique in place of Double-Side-Band-Full Carrier (DSBFC) Amplitude Modulation technique. 02

d) Do you think, for Amplitude Modulation, Upper Side Band (USB) and Lower Side Band (LSB) contain similar kind of message information? Justify your answer. 02

3 a) A single-tone Frequency Modulated (FM) signal is represented by the voltage equation as: $v(t) = A\cos(\omega_c t + m_f \sin\omega_m t)$. For this scenario find out the following terms. 4x1 =04

(i) Carrier frequency
(ii) Modulating frequency
(iii) Modulation index
(iv) Maximum frequency deviation

b) Consider a continuous time signal x(t) is multiplied by a continuous impulse train $S_{T_s}(t)$ of period T_s. This system is represented by the following figure: 04



Prove the frequency domain representation of the signal g(t) is

$$G(\omega) = \frac{1}{T_s} \sum_{n=-\infty}^{\infty} X(\omega - n\omega_s)$$

c) What do you understand by the following two terms 02
   (i) Mid-Rise Quantization
   (ii) Mid-Tread Quantization

4 a) An analog signal is expressed by the equation 03

$$x(t) = 4\cos 50\pi t + 18\cos 300\pi t - \cos 100\pi t$$

Calculate the Nyquist rate for the signal

b) What do you understand by 03
   (i) Binary Phase Shift Keying (BPSK)
   (ii) Binary Amplitude Shift Keying

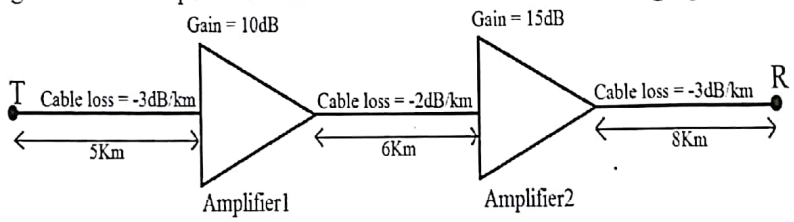
c) Describe the following terms 4x1 =04
   (i) Pulse Position Modulation (PPM)
   (ii) Pulse width Modulation (PWM)
   (iii) Pulse Amplitude Modulation (PAM)
   (iv) Quantization Noise

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions

5 a) Explain Shannon's channel capacity theorem. Prove that for an infinite bandwidth of channel, the capacity is finite. 04

b) A signal with 5dBm power travels from T to R as shown in following figure. 06



   (i) Calculate the signal power at R
   (ii) At room temperature what is the signal to noise ratio at R if its bandwidth is 30 MHz? Take thermal noise alone into account whose noise power density is kT watt/Hz, k being the Boltzmann's constant and T is the absolute temperature.
   (iii) Determine the channel capacity of the link.
   (iv) How many signal levels are needed to achieve a data rate of half of the channel capacity?

6 a) Define Line Coding. 01

b) A signal has four data levels with a phase duration of 1ms. Calculate the Pulse Rate and Bit Rate. 2+2

c) Describe following terms 2+2
   (i) Frequency Division Multiplexing
   (ii) Time Division Multiplexing

d) What do you understand by Microwave? 01

7 a) What is the Hamming distance? A code scheme has a minimum Hamming distance of 5. What is the error detection and correction capability of this scheme? 02

b) Show the possible structure of the encoder and decoder for a Hamming code and explain its operation. How can this code be used to correct burst errors? 04

c) What are the advantages of the cyclic codes? What are the characteristics of a good polynomial generator? Given the dataword 1010011110 and the divisor 1011, show the generation of the codeword at the sender side using polynomials. 03

d) For a CRC-32 polynomial, what is the probability of detecting a burst error of size 55? 01

8 a) What are the major classes of guided media? What is the significance of the twisting in twisted pair cable? 02

b) What is meant by the numerical apertures (NA) of an optical fiber? Show that $NA = \sqrt{n_1^2 - n_2^2}$, *where* n_1 *and* n_2 are the refractive indexes of core and cladding layer of an optical fiber. 03

c) Draw the basic block diagram of an optical fiber transmission link. What is WDM? Explain with necessary figure. 05