Indian Institute of Technology, Kharagpur
Mid-Autumn Semester 2018-19

Date of Examination: 26-09-2018 Session: FN (9-11 am) Duration: 2 hrs
Subject No.: IT30037 Subject: INTRODUCTION TO INTERNET
Department/Center/School: Computer Science and Engineering
Specific charts, graph paper, log book etc., required: NO
Special instructions (if any): NO

1. Match the following: **[$0.5 \times 24 = 12$M]**
   In the middle column of the table mark appropriate match through (a) or (b) or (c) or ..

(1) Physical layer	(q)	(a) Data link control layer
(2) Transport layer	(h)	(b) Frequency division multiplexing
(3) Presentation layer	(u)	(c) Received code vector is a valid code vector other than transmitted one
(4) Spectrum of a non-periodic signal	(y)	(d) Address of each source need to be included
(5) Signal distortion	(v)	(e) Error correction is not possible
(6) Scrambling	(s)	(f) Only one bit is sufficient for frame sequence number
(7) Pulse code modulation	(m)	(g) Block codes
(8) Analog transmission	(t)	(h) Virtual link for end-to-end messages
(9) Amplitude shift keying	(z)	(i) All single-bit errors can be corrected
(10) Multiple AM and FM radio transmissions	(b)	(j) Avoids the flags inside the data bits
(11) Sampling frequency $= 2 \times f_m$	(x)	(k) Each transmission utilizes the entire bandwidth of the channel
(12) Wave length division multiplexing	(w)	(l) Error detection capability + 1
(13) Single parity check code	(e)	(m) Analog to digital conversion
(14) Horizontal and vertical parity code	(i)	(n) Contains all odd harmonics
(15) Minimum distance of a code	(l)	(o) Discrete
(16) Undetectable error	(c)	(p) ARP and RARP
(17) Bit-stuffing	(j)	(q) Modem
(18) Statistical TDM	(d)	(r) Accept the frames out of order
(19) Frequency hopped spread spectrum	(k)	(s) Avoids long sequence of zeros during signal coding for digital transmission
(20) Stop-and-Wait ARQ	(f)	(t) Allow the data transmission through band-pass channels
(21) Number of signal patterns are more than data patterns	(g)	(u) Secure transmission of messages
(22) Node to node flow control	(a)	(v) Addition of various frequency components of signal with phase mismatch
(23) Square wave signal	(n)	(w) Prisms
(24) Selective repeat ARQ	(r)	(x) Nyquist rate
		(y) Continuous
		(z) Sensitive to noise

2. The given waveforms (signals) shown in figures are encoded by five different Line coding techniques. For each signal, mark the bit periods and comment on (i) the line coding scheme used for its generation, (ii) Data sequence, (iii) DC component, (iv) Synchronization, (v) Bandwidth and (vi) Complexity. **(5M)**

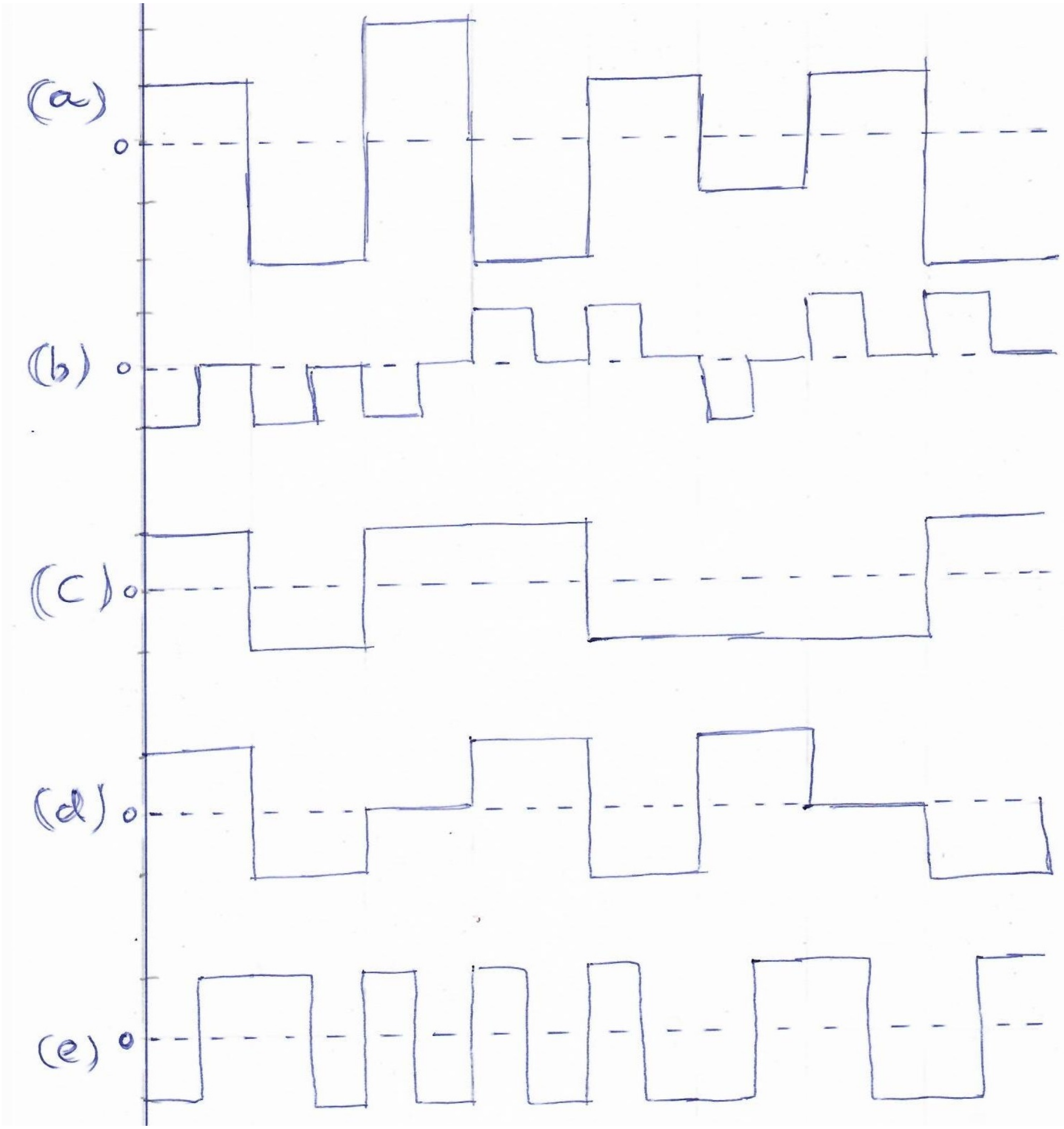

Figure 1: Signals generated by line coding schemes for various data-sequences

Figure 1(a)	
Line coding scheme	2B1Q
Data sequence	0111001101100111 1011001110011011 0100110001100100 1000110010011000
DC component	Present
Synchronization	No builtin synchronization
Bandwidth	N/4 (optimal)
Complexity	More
Figure 1(b)	
Line coding scheme	RZ (return to zero)
Data sequence	00011011 11100100
DC component	Not present
Synchronization	Builtin synchronization
Bandwidth	N (high)
Complexity	More
Figure 1(c)	
Line coding scheme	NRZ-L (OR) NRZ-I
Data sequence	NRZ-L: 01001110 10110001 NRZ-I: 01101001 10010110
DC component	Present
Synchronization	No builtin synchronization
Bandwidth	N/2 (moderate)
Complexity	Simple

Figure 1(d)	
Line coding scheme	AMI
Data sequence	11011101
DC component	Not present
Synchronization	No builtin synchronization for long seq of zeros
Bandwidth	N/2 (Moderate)
Complexity	Simple
Figure 1(e)	
Line coding scheme	Differential Manchester (OR) Manchester
Data sequence	DM: 11000111 00111000 M: 01111010 10000101
DC component	Not present
Synchronization	Builtin synchronization
Bandwidth	N (high)
Complexity	More

3. Consider a voice signal has prominent frequencies up to 8 KHz, and having the amplitude ranging from -10 V to +10 V. Choose an uniform quantizer with a step size of 0.5 V. An even parity check scheme is employed for error detection of each block of 4 samples. Twenty such voice channels are mixed using synchronous TDM (sync-TDM). The output frame of the synchronous TDM consists of four samples from each voice signal. For frame synchronization, four bytes of control information will be placed at the beginning of each frame. **(0.5+1+1+1+0.5+1 = 5M)**

   (a) Determine the maximum quantization error that will occur in the digitization process.
   Maximum quantization error = step size/2 = 0.25 V

   (b) What will be the data rate for encoding the voice channel, with and without error detection?
   With error detection = Number of samples per second $\times$ Number of bits per sample + Number parity bits per second = 16000 $\times$ 6 + 4000 = 100 kbps
   Without error detection = Number of samples per second $\times$ Number of bits per sample = 16000 $\times$ 6 = 96 kbps

   (c) What will be the output Sync-TDM frame length in micro seconds ?
   Length of output Sync-TDM frame in micro seconds = 1/Number of frames per second = 1/4000 = 250 microseconds

   (d) Determine the number of bits present in the output sync-TDM frame.
   Number of bits present in the output sync-TDM frame = Number of voice channels $\times$ bits required for encoding 4 samples with even parity error detection + frame synchronization bits = 20 $\times$ 25 + 32 = 532 bits.

   (e) Determine the output data rate of the sync-TDM.
   Output data rate of the sync-TDM = Number of frames $\times$ frmae length in bits = 4000 $\times$ 532 = 2128 kbps

   (f) What will be the effective channel utilization, if all channels have enough data for transmission?
   Effective channel utilization = (Effective number of bits in a frame) $\times$ 100/(Total number of bits in a frmae) = (480 $\times$ 100)/532 = 90.23%

4. The following code vectors (1001011, 0101101 and 0011110) are generated from a (7,3) parity check code. Assume the pattern of the code vector is ($C_i = m_2m_1m_0p_3p_2p_1p_0$). **(1$\times$4=4M)**

   (a) Find the rule for generating each of the parity checks.

$$p_0 = m_1 + m_2$$
$$p_1 = m_0 + m_2$$
$$p_2 = m_0 + m_1$$
$$p_3 = m_0 + m_1 + m_2$$

   (b) Determine all valid code vectors.

$$C_0 = 0000000$$
$$C_1 = 0011110$$
$$C_2 = 0101101$$
$$C_3 = 0110011$$
$$C_4 = 1001011$$

$C_5 = 1010101$
$C_6 = 1100110$
$C_7 = 1111000$

(c) What is the minimum distance of this code?
Minimum distance of the code $= d_{min} = 4$.

(d) What is the error detection and correction capability of this code?
Error detection capability $= d_{min} - 1 = 3$.
Error correction capability $= \frac{(d_{min}-1)}{2} = 1$.

5. Answer the following: **(1+1.5+1.5=4M)**

(a) What is the sender and receiver window sizes in case of (i) stop and wait, (ii) go-back-16 ARQ protocols?
Sender window size for stop and wait = 1
Receiver window size for stop and wait = 1
Sender window size for go-back-16 = 16
Receiver window size for go-back-16 = 1

(b) A channel has a bit rate of 8 kbps and a propagation delay of 10 msec. Find what range of frame sizes does stop-and-wait ARQ give an efficiency of at least 70 percent?
$\frac{Frametransmissiontime}{Frametransmissiontime+2\times propagationdelay} > 0.7$
$\frac{T_{ft}}{T_{ft}+2\times T_{pd}} > 0.7$
$T_{ft} = 0.7 \times T_{ft} + 1.4 \times T_{pd}$
$T_{ft} = \frac{1.4\times T_{pd}}{0.3}$
$T_{ft} = 46.7ms$
Minimum Frame size = 46.7 ×8 = 374
Assumptions: (i) No reverse data traffic, (ii) Negligible frame transmission time in reverse direction and (iii) Negligible processing delay.

(c) Discuss the remedies to the following problems in view of go-back-n ARQ: (i) Errors in data frames, (ii) Errors/delays in acknowledgements and (iii) Short data frames and long ack frames.

Remedy for errors in data frames = By sending ack related to erroneous frames immediately and employing timers for each transmission frame so that frame retransmission can be done immediately upon knowing about the erroneous transmission.

Remedy for Errors/delays in acknowledgements = Long sender window will take care of errors in ack frames.

Remedy for Short data frames and long ack frames = Long sender window will take care of long ack frames.