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INTERNAL ASSESSMENT TEST II

Sub:	DIGITAL COMMUNICATION							Code:	18/17/15EC61
Date:	22/06/2021	Duration:	90 mins	Max Marks:	50	Sem:	VI	Branch:	ECE/TCE

<u>Answer five full questions. Question #1 is compulsory.</u>

	Questions	Marks	CO	RBT
1(a)	Sketch the waveforms for the binary sequence "**10101010**" using the following line coding schemes. i) NRZ Bipolar ii) RZ Polar iii) NRZ Unipolar ii) Manchester	[04]	CO1	L2
1(b)	Sketch the waveforms for the binary sequence "**1000000001**" using the following line coding schemes. i) HDB3 ii) B3ZS iii) B6ZS	[06]	CO1	L2
2	Explain binary pulse amplitude modulation (PAM) system with a neat block diagram. Derive Nyquist criterion for zero ISI.	[10]	CO3	L2,L3
3(a)	Derive ideal solution to ISI. What are the practical limitations of the ideal solution?	[05]	CO3	L3
3(b)	With necessary equations, explain the practical solution to ISI. Plot the raised cosine spectrum for roll-off factor equal to 0.75.	[05]	CO3	L2
4	With a neat block diagram and necessary equations, explain modified duobinary coder. Derive the impulse response of modified duobinary coder and plot the same.	[10]	CO3	L2,L3
5(a)	Binary sequence "**1100101011**" is applied to a duobinary coder. Obtain the output of duobinary coder. Obtain the receiver output assuming that amplitude due to second bit reduces to **0**.	[05]	CO3	L3
5(b)	Binary sequence "**1100101011**" is applied to a duobinary coder with precoder. Obtain the precoded output, transmitted amplitudes and receiver output.	[05]	CO3	L3
6(a)	Binary sequence "**1100101011**" is applied to a modified duobinary coder. Obtain the output of modified duobinary coder. Obtain the decoded bits assuming that amplitude due to third bit becomes **0**.	[05]	CO3	L3
6(b)	Binary sequence "**1100101011**" is applied to a modified duobinary coder with precoder. Obtain the output of precoder and transmitted amplitudes and decoded bits.	[05]	CO3	L3

Scheme Of Evaluation
Internal Assessment Test II – June 2021

Sub:	DIGITAL COMMUNICATION							Code:	18EC61
Date:	22/06/2021	Duration:	90 mins	Max Marks:	50	Sem:	VI	Branch:	ECE,TCE

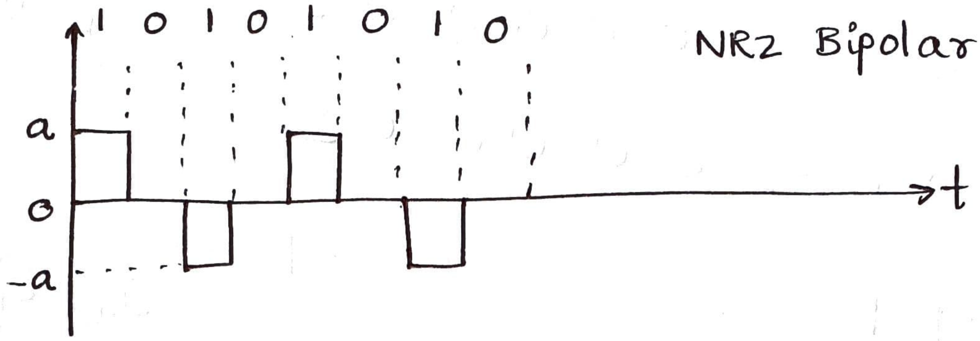
Note: Answer 5 Questions

Question #		Description	Marks Distribution		Max Marks
1	a	Sketch the waveforms for the binary sequence "**10101010**" using the following line coding schemes. i) NRZ Bipolar ii) RZ Polar iii) NRZ Unipolar ii) Manchester		4	10
		• NRZ Bipolar • RZ Polar • NRZ Unipolar • Manchester	1 1 1 1		
	b	Sketch the waveforms for the binary sequence "**1000000001**" using the following line coding schemes. i) HDB3 ii) B3ZS iii) B6ZS		6	
		• HDB3 • B3ZS • B6ZS	2 2 2		
2		Explain binary pulse amplitude modulation (PAM) system with a neat block diagram. Derive Nyquist criterion for zero ISI.		10	10
		• Block diagram • Explanation • Derivation	2 2 6		
3	a	Derive ideal solution to ISI. What are the practical limitations of the ideal solution?		5	10
		• Derivation • Practical Limitation	3 2		
	b	With necessary equations, explain the practical solution to ISI. Plot the raised cosine spectrum for roll-off factor equal to 0.75.		5	10
		• Equation • Plot	3 2		

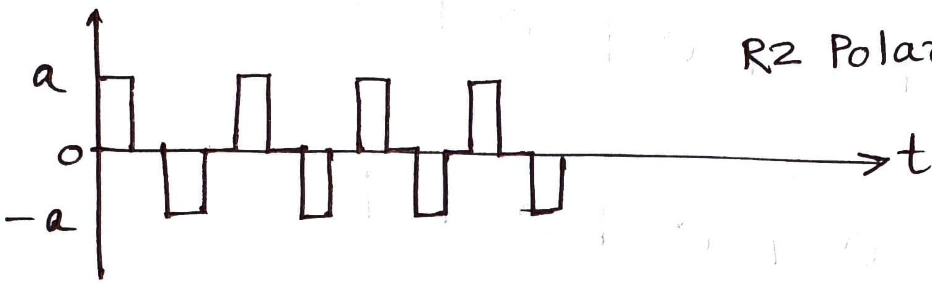
4		With a neat block diagram and necessary equations, explain modified duobinary coder. Derive the impulse response of modified duobinary coder and plot the same.		10	10
		• Block diagram • Explanation • Derivation	2 2 6		
5	a	Binary sequence "**1100101011**" is applied to a duobinary coder. Obtain the output of duobinary coder. Obtain the receiver output assuming that amplitude due to second bit reduces to **0**.		5	10
		• Transmitter Output • Receiver Output	3 2		
	b	Binary sequence "**1100101011**" is applied to a duobinary coder with precoder. Obtain the precoded output, transmitted amplitudes and receiver output.		5	
		• Transmitter Output • Receiver Output	3 2		
6	a	Binary sequence "**1100101011**" is applied to a modified duobinary coder. Obtain the output of modified duobinary coder. Obtain the decoded bits assuming that amplitude due to third bit becomes **0**.		5	10
		• Transmitter Output • Receiver Output	3 2		
	b	Binary sequence "**1100101011**" is applied to a modified duobinary coder with precoder. Obtain the output of precoder and transmitted amplitudes and decoded bits.		5	
		• Transmitter Output • Receiver Output	3 2		

Solutions

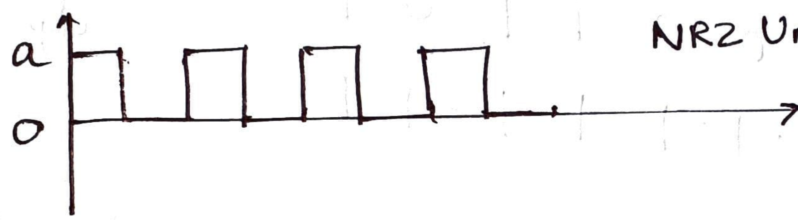
1a)



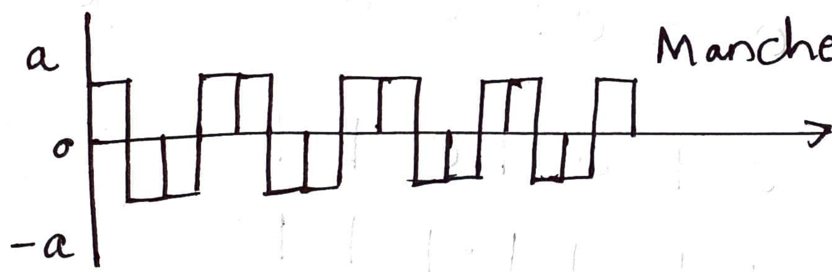
NRZ Bipolar.



RZ Polar

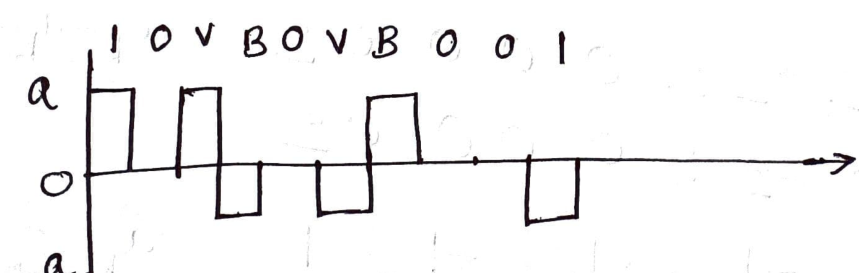


NRZ Unipolar



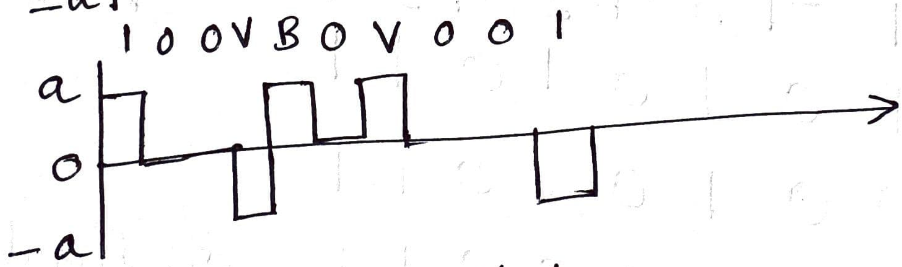
Manchester.

1b)

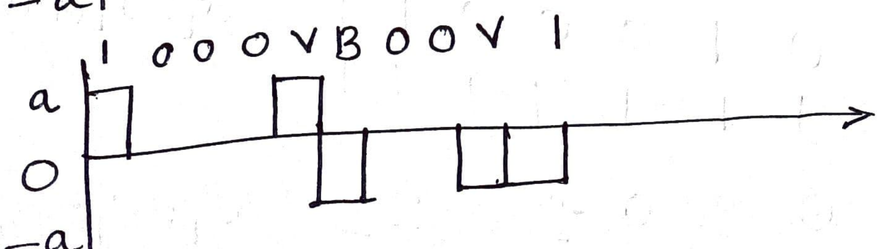


B6ZS

~~HDB3~~



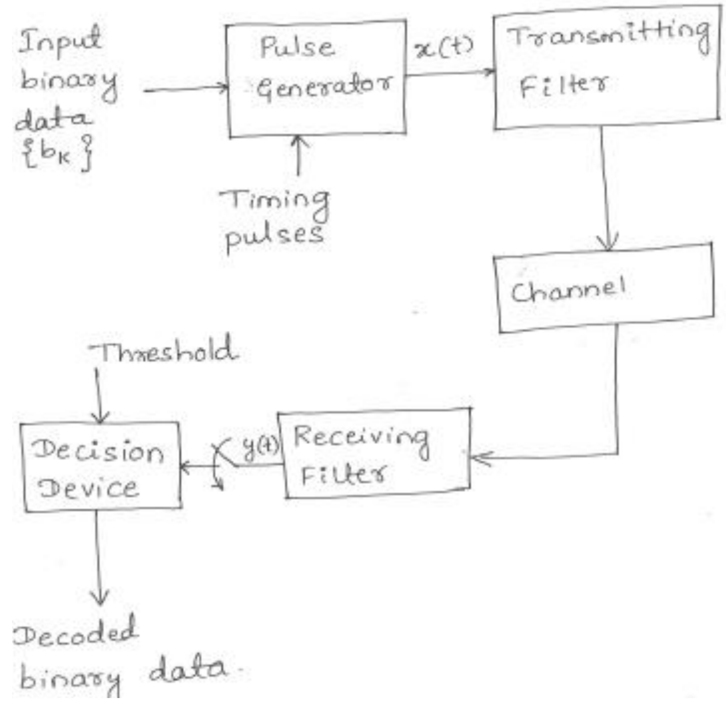
B3ZS



~~B6ZS~~

HDB3

2)



$$x(t) = \sum_{k=-\infty}^{\infty} a_k v(t - kT_b) \quad \dots (1)$$

$$y(t) = \mu \sum_{k=-\infty}^{\infty} a_k p(t - kT_b) \quad \dots (2)$$

$$y(iT_b) = \mu \sum_{k=-\infty}^{\infty} a_k p(iT_b - kT_b)$$

$$= \mu p(0) a_i + \mu \sum_{\substack{k=-\infty \\ k \neq i}}^{\infty} a_k p(iT_b - kT_b) \quad \dots (3)$$

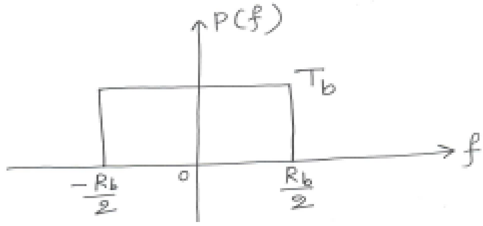
(when $k=i$)

$$p(iT_b - kT_b) = \begin{cases} 1 & \text{when } i = k \\ 0 & \text{when } i \neq k \end{cases} \quad \dots (4)$$

$$1 = \frac{1}{T_b} \sum_{k=-\infty}^{\infty} P(f - kR_b)$$

$$\sum_{k=-\infty}^{\infty} P(f - kR_b) = T_b \quad \dots (11)$$

3a)



$$p(t) = \int_{-\frac{R_b}{2}}^{\frac{R_b}{2}} P(f)\, e^{j2\pi f t}\, df$$

$$= \int_{-\frac{R_b}{2}}^{\frac{R_b}{2}} T_b\, e^{j2\pi f t}\, df$$

$$= T_b \left. \frac{e^{j2\pi f t}}{j2\pi t} \right|_{-\frac{R_b}{2}}^{\frac{R_b}{2}}$$

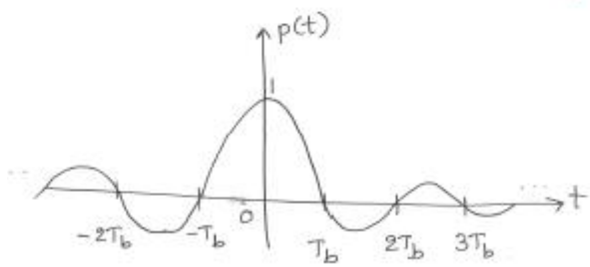
$$= \frac{T_b}{j2\pi t}\left[e^{j\pi R_b t} - e^{-j\pi R_b t} \right]$$

$$= \frac{T_b}{j2\pi t}\left[2j \sin(\pi R_b t) \right]$$

$$= \frac{\sin(\pi R_b t)}{\pi R_b t}$$ (9)

$$= \operatorname{sinc}(R_b t) \quad \ldots \quad (2)$$ ← This is the signal that produces zero ISI.

t us plot $p(t) = \operatorname{sinc}(R_b t)$



Practical difficulties in realizing the ideal solution to ISI.

i. $P(f)$ has abrupt transition at $f = \pm \frac{R_b}{2}$, which cannot be physically realized.

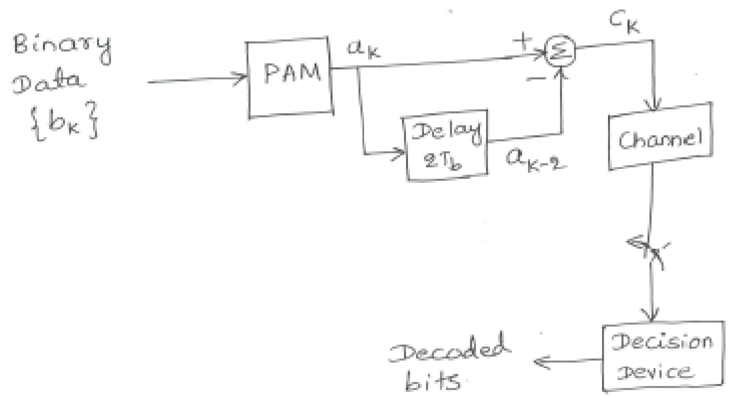
ii. Instead of sampling the received signal at $t = iT_b$, $i = 0, \pm 1, \pm 2, \ldots$ if we sample at $t = iT_b + \Delta t$, there will be a large amount of ISI. Accordingly, there is practically no margin for error in determining sampling instants at the receiver.

3b)

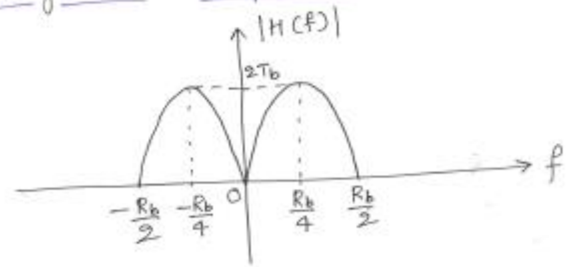
$$P(f) = \begin{cases} T_b & \text{for } |f| < f_1 \\ \frac{T_b}{2}\left\{1 + \cos\left[\frac{\pi}{2}\frac{|f| - f_1}{B_0 - f_1}\right]\right\} & \text{for } f_1 \le |f| < 2B_0 - f_1 \\ 0 & \text{for } |f| \geq 2B_0 - f_1 \end{cases}$$

4)

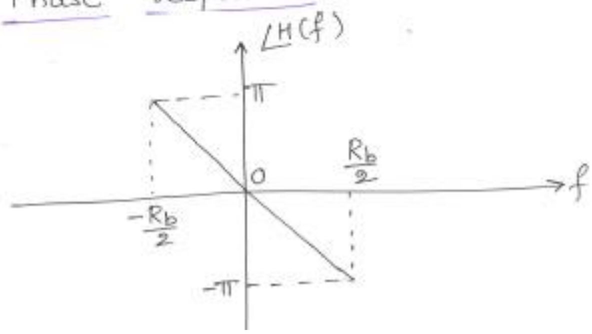
Block diagram of modified duobinary coder without precoder.



Magnitude response



Phase response



$$\therefore h(t) = \int_{-\infty}^{\infty} H(f)\, e^{j2\pi f t}\, df$$

$$= \int_{-\frac{R_b}{2}}^{\frac{R_b}{2}} \left[1 - e^{-j2\pi f 2T_b}\right] T_b\, e^{j2\pi f t}\, df$$

$$= T_b \int_{-\frac{R_b}{2}}^{\frac{R_b}{2}} e^{j2\pi f t}\, df - T_b \int_{-\frac{R_b}{2}}^{\frac{R_b}{2}} e^{j2\pi f (t-2T_b)}\, df$$

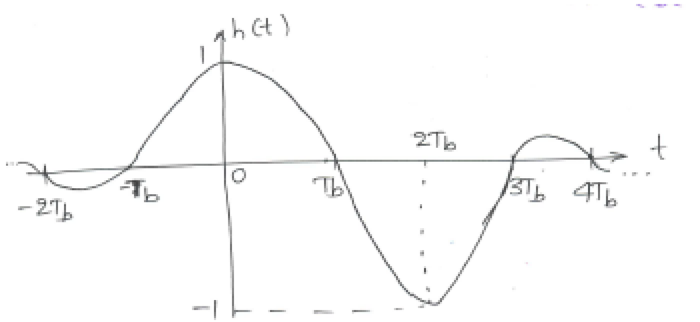
$$= T_b \left.\frac{e^{j2\pi f t}}{j2\pi t}\right|_{-\frac{R_b}{2}}^{\frac{R_b}{2}} - T_b \left.\frac{e^{j2\pi f (t-2T_b)}}{j2\pi (t-2T_b)}\right|_{-\frac{R_b}{2}}^{\frac{R_b}{2}}$$

$$= \frac{T_b}{j2\pi t}\left[e^{j\pi R_b t} - e^{-j\pi R_b t}\right] - \frac{T_b}{j2\pi (t-2T_b)}\left[e^{j\pi R_b (t-2T_b)} - e^{-j\pi R_b (t-2T_b)}\right]$$

$$= \frac{T_b}{j2\pi t}\, 2j \sin(\pi R_b t) - \frac{T_b}{j2\pi (t-2T_b)}\, 2j \sin(\pi R_b (t-2T_b))$$

$$= \frac{\sin(\pi R_b t)}{\pi R_b t} - \frac{\sin(\pi R_b (t-2T_b))}{\pi R_b (t-2T_b)}$$

$$= \text{sinc}(R_b t) - \text{sinc}(R_b (t-2T_b)) \quad \ldots (6)$$



5a)

b_K 1 1 0 0 1 0 1 0 1 1

a_K 1 1 1 -1 -1 1 -1 1 -1 1 1

c_K 2 2 0 -2 0 0 0 0 0 2 $\qquad c_K = a_K + a_{K-1}$

$\hat{c}_K$ 2 0 0 -2 0 0 0 0 0 2

$\hat{a}_K$ 1 1 -1 1 -3 3 -3 3 -3 3 -1 $\qquad \hat{a}_K = \hat{c}_K - \hat{a}_{K-1}$

$\hat{b}_K$ 1 1 0 1 0 1 0 1 0 1 0

5b)

b_K 1 1 0 0 1 0 1 0 1 1

d_K 1 0 1 1 1 0 0 1 1 0 1 $\qquad d_K = b_K \oplus d_{K-1}$

a_K 1 -1 1 1 1 -1 -1 1 1 -1 1

c_K 0 0 2 2 0 -2 0 2 0 0 $\qquad c_K = a_K + a_{K-1}$

6a)

b_K 1 1 0 0 1 0 1 0 1 1

a_K 1 1 1 1 -1 -1 1 -1 1 -1 1 1

c_K 0 0 -2 -2 2 0 0 0 0 2 $\qquad c_K = a_K - a_{K-2}$

$\hat{c}_K$ 0 0 0 -2 2 0 0 0 0 2

$\hat{a}_K$ 1 1 1 1 1 -1 3 -1 3 -1 3 1 $\qquad \hat{a}_K = \hat{c}_K + \hat{a}_{K-2}$

$\hat{b}_K$ 1 1 1 0 1 0 1 0 1 1

6b)

b_K 1 1 0 0 1 0 1 0 1 1

d_K 1 1 0 0 0 0 1 0 0 0 1 1 $\qquad d_K = b_K \oplus d_{K-2}$

a_K 1 1 -1 -1 -1 -1 1 -1 -1 -1 1 1

c_K -2 -2 0 0 2 0 -2 0 2 2 $\qquad c_K = a_K - a_{K-2}$