Communications Test I

Number of Questions: 35 **Time: 90 min.**

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. In a digital communication system FSK signal used to transmit 0 and 1, with the help of two sine waves having frequency 25KHz & 50KHz respectively. The minimum bit duration for these waveforms to be orthogonal is
   (A) .04ms (B) .08ms
   (C) 0.12ms (D) 0.06ms
2. For the modulated carrier $x(t) = 400\cos(\omega_c + 100\pi)t + 2000\cos\omega_c t + 400\cos(\omega_c - 100\pi)t$ where $2000\cos\omega_c t$ is the unmodulated carrier, the complex envelope is ________.
   (A) $400\cos(100\pi t)$
   (B) $2000 + 400\cos(100\pi t)$
   (C) $2000 - 800\cos(100\pi t)$
   (D) $2000 + 800\cos(100\pi t)$
3. Match List – I (operations) with List – II (functions) and select the correct answer using the codes given below the lists:

List-I	List-II
p. companding	1. Improving image rejection ration
q. pre emphasis	2. muting the receiver
r. squelch	3. non-uniform quantization
s.Double conversion	4. Boosting of higher modulating frequencies at the transmitter

Codes:
(A) $p-1$ $q-3$ $r-1$ $s-2$
(B) $p-3$ $q-2$ $r-4$ $s-1$
(C) $p-2$ $q-4$ $r-1$ $s-3$
(D) $p-3$ $q-4$ $r-2$ $s-1$

4. Match the following

(i)	PSK	1	Matched filter
(ii)	FM	2	PLL
(iii)	AM	3	Synchronous detector
(iv)	DSB	4	Envelope Detector

(A) (i) – 4 (ii) – 2 (iii) –3 (iv) – 1
(B) (i) – 1 (ii) – 2 (iii) – 4 (iv) – 3
(C) (i) – 2 (ii) – 1 (iii) – 4 (iv) – 3
(D) (i) – 4 (ii) – 2 (iii) – 1 (iv) – 3

5. The message signal $m(t) = \text{sinc}^2(4000t)$ modulates a carrier $\cos(2\pi fct)$ and generate a SSB-SC signal. The $B.W$ of SSB – SC is
   (A) 4 KHz (B) 5 KHz
   (C) 2 KHz (D) 1 KHz
6. A binary sequence of bits 1101100 is differentially encoded and phase shift keyed and producing a transmitted phase for the first bit 1 as π. The transmitted phase for the following bits (101100) are ________.
   (A) (π, 0, 0, 0, π, 0) (B) (π, π, 0 0 0 π)
   (C) (0, π, π, π, 0, π) (D) (0, 0, π, π, π 0)
7. Consider following statements about PCM
   (1) Bandwidth depends on the sampling rate
   (2) Cross – talk occurs in PCM
   (3) Band width depends on the quantization error
   (4) Quantization error depends upon the step size.
   True statements are _____
   (A) 1 and 2 (B) 2 and 3
   (C) 3 and 4 (D) 4 and 1
8. Match the list – I & List – II

	List-I		List-II
P	AMI	1	Pusle stuffing
Q	Asynchronous TDM	2	Voice channels
R	T4 carrier system	3	Clock recovery
S	RZ code	4	Scrambling

(A) $P-3, Q-2, R-4, S-1$
(B) $P-4, Q-1, R-2, S-3$
(C) $P-4, Q-1, R-3, S-2$
(D) $P-3, Q-2, R-1, S-4$

9. In a PCM system with 4 quantization levels, the maximum quantization noise power will be __________
   (A) $\left(\frac{1}{8}\right)^{th}$ of total (amplitude range)^2
   (B) $\left(\frac{1}{192}\right)^{th}$ of total (amplitude range)^2
   (C) $\left(\frac{1}{8}\right)^{th}$ of total amplitude range
   (D) $\left(\frac{1}{192}\right)^{th}$ of total amplitude range
10. In a super heterodyne receiver double spotting phenomena occurs at 2500 KHz. If intermediate frequency is 450KHz. Then the receiver should be tuned at
    (A) 2050 KHz (B) 3400 KHz
    (C) 1600 KHz (D) 2950 KHz
11. A 50% modulated AM is diode detected having time constant 5μ sec. The message frequency for which diagonal clippling will not occur is _______.
    (A) 1 MHz (B) 55 KHz
    (C) 346 KHz (D) 28 KHz
12. A PCM system uses a uniform quantizer followed by a 10bit binary encoder. The bit rate is 80Mbps. The

maximum message bandwidth for which the system operates satisfactorily is ______.

(A) 4 KHz (B) 4 MHz
(C) 10 MHz (D) 10 KHz

13. The function

$$F_{X,Y}(x, y) = b\left[\pi + \tan^{-1}\left(\frac{x}{2}\right)\right]\left[\pi + \tan^{-1}\left(\frac{y}{3}\right)\right]$$

is a valid joint distribution function for random variables X and Y if the constant b is _______.

(A) $\frac{1}{\pi^2}$ (B) $\frac{4}{\pi^2}$
(C) $\frac{4}{9\pi^2}$ (D) $\frac{2}{3\pi^2}$

14. A joint sample space for two random variables X and Y has 3 elements (1, 2), (2, 3) and (3, 1). Probabilities of these elements are 0.2, 0.45 and 0.35 respectively.
The probability of the event $\{X \le 2.5, Y \le 5\}$ is

(A) 0.35 (B) 0.65
(C) 0.45 (D) 0.2

15. An amplitude modulated signal is represented by $\phi_{AM}(t) = 10\cos(2\pi\, 10^6 t)\,[1 + m(t)]$
where $m(t) = 0.5\cos(2\pi\, 10^3 t) + 0.2\cos(4\pi - 10^3 t)$
with regard to following which one of the following is true?

(1) Modulation index is 0.539
(2) Power of modulated signal is 57.25W
(3) Bandwidth of the modulated signal is 40 KHz
(4) Spectrum consist of 6 spectral components

(A) 1 and 2 (B) 2 and 3
(C) 2 and 4 (D) 1 and 4

16. Two random variable X and Y have the probability density function

$$f_{XY}(x, y) = \begin{cases} \frac{xy}{12} & 0 < x < 3 \text{ and } 0 < y < 2 \\ 0 & \text{elsewhere} \end{cases}$$

The X and Y are

(A) Correlated but statistically dependent.
(B) Uncorrelated but statistically independent.
(C) Correlated but statistically independent.
(D) Uncorrelated but statistically dependent.

17. Source S_1 produces 4 discrete symbols with equal probability.
Source S_2 produces discrete symbols with equal probability. If H_1 and H_2 are the entropies of sources S_1 and S_2 respectively, then which one of the following is correct?

(A) H_1 is always equal to H_2
(B) H_1 is always less then H_2
(C) H_1 is always greater than H_2
(D) H_2 is 1.5 times H_1 only

18. In a CD player, the sampling rate is 94.1 KHz and the samples are quantized using a 32 – bit/sample quantizer. The resulting number of bits for a piece of music with a duration of 60 minutes are ______.

(A) 108.4×10^{10}bits (B) 10.84×10^{10}bits
(C) 1.084×10^9 bits (D) 10.84×10^9 bits

19. A discrete memoryless source have six symbols with probabilities

$P_A = \frac{1}{4}$ $P_B = \frac{1}{2}$
$P_C = \frac{1}{8}$ $P_D = P_E = \frac{1}{20}$,
$P_F = \frac{1}{40}$

The amount of information contained in the message ABBAAB

(A) 6 bits (B) 7 bits
(C) 8 bits (D) 9 bits

20. A source delivers symbols $X_1, X_2, X_3, X_4\, X_5$ with probabilities $\frac{1}{4}\frac{1}{4}\frac{1}{4}\frac{1}{8}$ *and* $\frac{1}{8}$ respectively. The entropy of the system is ______.

(A) 3.32 bits/second (B) 2.25 bits/message
(C) 2.25 bits/second (D) 1.0 bits/message

21. A pseudo – noise sequence is generated using a feedback shift register of length $m = 5$. The chip rate is 10^6 chips/sec. The PN sequence length & chip duration is

(A) 31 and 1 μs (B) 31 and 0.1 μs
(C) 32 and 1 μs (D) 32 and 0.1 μs

22. The period of PN sequence, if $m = 6$ and chip rate is 10^7chips/sec ________.

(A) 6.4 μs (B) 6.3 μs
(C) 63 μs (D) 64 μs

23. If in IS – 95 CDMA system the base band information rate $R = 4800$ bps and total radio frequency bandwidth $\omega = 2.5$MHz & the number of users $N = 18$ then SNR at the base station receiver is ______.

(A) 30 dB (B) 14.86 dB
(C) 10 dB (D) 30.63 dB

24. An audio signal consisting of the sinusoidal term given as _______ $x(t) = 5\cos(500\pi t)$
The number of bits required to achieve signal - to - quantization noise ratio of at least 30 dB.

(A) 4 bits (B) 5 bits
(C) 6 bits (D) 3 bits

25. In a GSM system, which is a TDMA/FDD system 25 MHz frequency is used for the forward link, which can accommodate 200 KHz radio channels. If 8 speech channels are used & no guard band is assumed, then the total number of users in GSM are

(A) 125 users (B) 16 users
(C) 1000 users (D) 1600 users

26. Consider the following statements about PCM
(1) PCM requires a large bandwidth as compared to other systems.
(2) Very high noise immunity.
(3) PCM is used in space communication.
(4) Repeaters regenerate the received PCM.
(A) 1, 2 & 3 are true (B) 2, 3, & 4 are true
(C) Only 2 & 3 are true (D) Only 2 & 4 are true

27. If a signal $x(t)$ having PDF

$$f_x(x) = \begin{cases} 0 & , for\ x < -4 \\ \frac{1}{8} & , for -4 < x < 4 \\ 0 & , for\ x > 4 \end{cases}$$

is quantized into 128 levels, then the nomalized signal power & noise power is
(A) 5.33 W & 325.55 μW (B) 16 W & 3.25 mW
(C) 5.33 W & 3.25 mW (D) 1 W & 325.55 μW

28. A delta modulator system is designed to operate at 4 times the Nyquist rate for a signal with a 2 KHz bandwidth. The quantization step size is 36 mV. Maximum amplitude of a 0.5 KHz input sinusoid for which there is no slope overload is _______.
(A) 46 mV (B) 183 mV
(C) 45.8 mV (D) 184 mV

29. Matched filter output over (0, T) interval to the pulse wave form

$$x(t) = \begin{cases} e^{-2t} & , 0 \le t \le T \\ 0 & , otherwise \end{cases}$$

(A) $\frac{e^{-2T}}{2}\sin h(2t)$ (B) $\frac{e^{-2T}}{2}\sin(2t)$
(C) $e^{-2T}\sinh(2t)$ (D) $e^{-2T}\sin(2t)$

30. If in a PCM system the number of quantization levels are decreased from 2048 to 8 then the bandwidth required for the transmission of PCM signal decreases by a factor of ______.
(A) $\frac{11}{3}$ (B) $\frac{1}{4}$
(C) $\frac{3}{11}$ (D) $\frac{1}{3}$

31. If an RF pulse $x(t)$ is applied at the input of the matched filter then the maximum magnitude of the signal at the output of matched filter and the time at which it occurs are respectively.

If $x(t) = \begin{cases} 10\sin(4\pi \times 10^6)t \text{ volts} & 0.1 \text{ ms} < t < 0.5 \text{ ms} \\ 0 & \text{otherwise} \end{cases}$

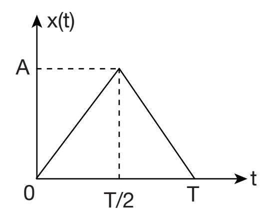
(A) 20 mV, 0.1 ms (B) 80 mV, 0.5 ms
(C) 20 mV , 0.5 ms (D) 40 mV, 0.1 ms

Statement for Common data questions: 32 and 33:
A normal GSM has 3 start bits, 3 stop bits (also called as trailing bits), 26 training bits for allowing adaptive equalization, 8.25 guard bits and 2 bursts of 58 bits of encrypted data which is transmitted at 270.833 kbps in the channel.

32. Frame rate is
(A) 1.733 frames/sec (B) 1733.28 frames/sec
(C) 216.66 frames/sec (D) 21.666 frames/sec

33. The frame efficiency is
(A) 54.24% (B) 74.24%
(C) 36.24% (D) 59.36%

Statement for linked questions 34 and 35:
Two messages are transmitted by space and mark using a simple binary pulse $x(t)$



Where $A = 5$V and $T = 10^{-3}$sec

34. The energy E of the signal $x(t)$ is
(A) 4.22 W (B) 8.33 mW
(C) 4.22 mW (D) 8.33 W

35. If the probability of $x(t)$ being present is 0.5 then the error probability of the optimum receiver is, if the channel noise is white noise with PSD $\frac{\eta}{2}$, where $\eta = 10^{-4.}$

(A) $\frac{1}{2}erfc\sqrt{\frac{250}{3}}$ (B) $\frac{1}{2}erfc\sqrt{\frac{5}{6}}$
(C) $\frac{1}{2}erfc\sqrt{\frac{125}{3}}$ (D) $\frac{1}{2}erfc\sqrt{\frac{500}{3}}$

Answer Keys

1. A	**2.** D	**3.** D	**4.** B	**5.** A	**6.** A	**7.** D	**8.** B	**9.** B	**10.** C
11. B	**12.** B	**13.** C	**14.** B	**15.** A	**16.** A	**17.** D	**18.** D	**19.** D	**20.** B
21. A	**22.** B	**23.** B	**24.** B	**25.** C	**26.** B	**27.** A	**28.** B	**29.** A	**30.** C
31. C	**32.** C	**33.** B	**34.** B	**35.** A					

Hints and Explanations

1. As we know that in FSK

$fi = \frac{n_c + i}{T_b}$, for the signals to be orthogonal.

Where T_b = bit duration
n_c = any fixed integer
$i = 1, 2$
So f_1 = 25KHz
f_2 = 50KHz
by putting $i = 1$ & 2 we get T_b = 0.04 ms Choice (A)

2. $x(t) = 400 \cos(\omega c + 100\pi)t + 400 \cos(\omega_c - 100\pi)\ t + 2000 \cos \omega_c t$
$= 800 \cos(\omega_c t) \cos(100\pi t) + 2000 \cos \omega_c t$
$= [2000 + 800\cos(100\pi t)] \cos\omega_c t$
It is in the from of $[A + f(t)] \cos\omega_c t$
Complex envelope is $(2000 + 800 \cos(100\pi t)]$
Choice (D)

3. Companding → non – uniform quantization
Squelch → muting R_x
Double conversion → Improving IRR Choice (D)

4. Choice (B)

5. $m(t) = \text{sinc}^2(4000t)$
So $m(t)$ have $B.\ W$ 4000Hz.
and SSB – SC signal having $B.\ W$ same as $m(t)$ so —
$B.\ W.$ of SSB .SC = 4KHz Choice (A)

6. 1 1 0 1 1 0 0 is differential encoded
So encoded signal is
1 1 1 0 0 0 1 0
(by taking reference 1)
So transmited phase are π, π, π, 0, 0, 0, π, 0
So for 1 0 11 00 phase are (π, 0, 0, 0, π, 0)
Choice (A)

7. ⇒ Bandwidth depends upon sampling rate
⇒ Cross – talk occurs in PAM. In PCM Inter symbol interference occurs.
⇒ Bandwidth depends upon no. of quantization levels
⇒ Quantization error = $S/2$, which depends upon step size Choice (D)

8. Choice (B)

9. As we know that

$$\text{Step size } S = \frac{\text{Amplitude Range}}{\text{No. of quantization levels}} = \frac{A}{4}$$

and Quantization noise power

$$= \frac{S^2}{12} = \frac{A^2}{12 \times 16}$$

$$= \left(\frac{1}{192}\right)^{th} \text{ of total (amplitude range)}^2$$

Choice (B)

10. Double spotting occurs at image signal so Receiver should be tuned at = 2500 – 2 × 450 = 1600 KHz
Choice (C)

11. $m_a = 0.5$

$$\frac{1}{RC} \geq \frac{\omega_m m_a}{\sqrt{1 - m_a^2}} \quad \text{where } RC = 5\mu \text{ sec}$$

$$\frac{0.2 \times 10^6 \times .86}{0.5} \geq \omega_m$$

$\omega_m = 0.346 \times 10^6$
= 55KHz Choice (B)

12. Bit rate = 80 Mbps

$$\text{So Nyquist Rate} = \frac{80 Mbps}{10 bit} = 8\text{MHz}$$

$$\text{So message bandwidth} = \frac{8}{2}\text{MHz} = 4\text{MHz}$$

Choice (B)

13. $F_{XY}(\infty, \infty) = b\left[\pi + \frac{\pi}{2}\right]\left[\pi + \frac{\pi}{2}\right]$ should be 1

$$\Rightarrow \quad b\left[\frac{3\pi}{2}\right]\left[\frac{3\pi}{2}\right] = 1$$

$$b\frac{9\pi^2}{4} = 1; \ b = \frac{4}{9\pi^2}$$

Choice (C)

14. $F_{XY}(x, y) = 0.2u(x - 1)\ u(y - 2) + 0.45\ u(x - 2)\ u(y - 3) + 0.35u(x - 3)\ u(y - 1)$
and probability that $X \leq 2.5$, $Y \leq 5$ is
= 0.2 + 0.45 = 0.65 Choice (B)

15. $\phi_{AM}(t) = 10 \cos(2\pi \times 10^6)t\ [1 + m(t)]$
$m(t) = 0.5 \cos(2\pi\ 10^3 t) + 0.2\cos(4\pi \times 10^3 t)$
$\phi_{AM}(t) = 10 \cos(2\pi \times 10^6)t\ [1 + 0.5 \cos(2\pi\ 10^3 t) + 0.2 \cos(4\pi \times 10^3 t)$
It is a multi – tone modulation
so $m_{a1} = 0.5$
$m_{a2} = 0.2$

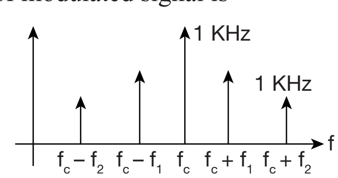
$$m_a = \sqrt{m_{a1}^2 + m_{a2}^2} = \sqrt{0.25 + 0.04} = 0.539$$

Power of modulated signal is

$$P = \frac{10^2}{2}\left(1 + \frac{m_1^2 + m_2^2}{2}\right)$$

$$= 50\left(1 + \frac{0.25 + 0.04}{2}\right) = 57.25 \text{ W}$$

Spectrum of modulated signal is



Where f_c = 1MHz
f_1 = 1 KHz
f_2 = 2KHz
So bandwidth = $2f_2$ = 4 KHz
and 5 spectral components are present. Choice (A)

16. $R_{XY} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} xy\ f_{XY}(x,y)\,dx\,dy$

$= \int_0^3\int_0^2 \frac{x^2y^2}{12}dx\,dy = 2$

$E[X] = \int_0^3\int_0^2 \frac{x^2y}{12}dx\,dy$

$= \frac{1}{12}\left[\frac{x^3}{3}\right]_0^3\left[\frac{y^2}{2}\right]_0^2 = \frac{3}{2}$

$E[Y] = \int_0^3\int_0^2 \frac{x\ y^2}{12}dx\,dy$

$= \left[\frac{x^2}{2}\right]_0^3\left[\frac{y^3}{3}\right]_0^2\frac{1}{12} = 1$

Since $R_{XY} = 2$, & $E[X]\,E[Y] = \frac{3}{2}\times 1 = \frac{3}{2}$

$R_{XY} \neq E[X]\,E[Y]$
So X and Y are in correlated form and Marginal densities are

$f_x(x) = \int_0^2 \frac{xy}{12}dy = \frac{x}{6}$, $0 < x < 3$

$f_y(y) = \int_0^3 \frac{xy}{12}dx = \frac{3y}{8}$, $0 < y < 2$

so $f_X(x)\,f_Y(y) = \frac{3xy}{48}$ $0 < x < 3$ and $0 < y < 2$

$= \frac{xy}{16}$

$f_{XY}(x, y) \neq f_x(x)\,f_Y(y)$
so X and Y are statistically dependent.

Choice (A)

17. $H(x) = \sum_{i=1}^{n} P_i.\log_2\frac{1}{P_i}$

$H_1 = 4 \times \frac{1}{4}.\log_2^4 = 2$

$H_2 = 8 \times \frac{1}{8}.\log_2^8 = 3$

$H_2 = 1.5\ H_1$ Choice (D)

18. Sampling rate is $f_s = 94.1 \times 10^3$
= 94100 samples/sec
each sample is quantized using 32 – bits
Total number of bits/ sec = 94100 × 32 = 3011200bits
For a music piece of duration 60min
The number of bits/channel is
= 94100 × 32 × 60 × 60 = 10.84×10^9 bits Choice (D)

19. $P(ABBAAB) = \frac{1}{4}\left(\frac{1}{2}\right)^2 \times \left(\frac{1}{4}\right)^2 \times \frac{1}{2} = \frac{1}{2^9}$

$I = \log_2\frac{1}{P} = \log_2 2^{9} = 9$bits. Choice (D)

20. Entropy $H(X) = -[0.25\log_2 0.25 + 0.25\log_2 0.25 + 0.25\log_2 0.25 + 0.125\log_2 0.125 + 0.125\log_2 0.125]$
= 2.25 bits/message Choice (B)

21. The PN sequence length is $N = 2^m - 1 = 2^5 - 1 = 31$

The chip duration is $T_C = \frac{1}{10^6} = 1\mu$s. Choice (A)

22. The period of the PN sequence is

$T = NT_C = (2^6 - 1)\times\frac{1}{10^7} = 6.3\ \mu$s Choice (B)

23. $\frac{E_b}{N_o} = \frac{W/R}{N-1}$

$= \frac{2.5\times 10^6/4800}{(18-1)} = 14.86$ dB Choice (B)

24. We know that

$\left(\frac{S}{N}\right)_{dB} = 1.8 + 6N$

Where N = No. of bits used to encode one sample in PCM
To get SNR at least 30 dB
$1.8 + 6N \geq 30$ dB
$6N \geq 28.2$
$N \geq 4.7 \approx 5$bits Choice (B)

25. $N = \frac{25\text{MHz}}{(200\text{KHz})/8} = 1000$ Choice (C)

26. Choice (B)

27. mean square value of a random variable X is given as

$\overline{X^2} = \int_{-\infty}^{+\infty} x^2 f_x(x)dx$

So mean square value of x will be

$\overline{x^2} = \int_{-4}^{+4} x^2.\frac{1}{8}dx = \frac{1}{8}\left[\frac{X^3}{3}\right]_{-4}^{+4} = \frac{16}{3}$

Signal power = $\frac{\overline{x^2}}{R}$

Normalized signal power = $\frac{\overline{x^2}}{1} = \frac{16}{3}$W

and We know that

Step size S = $\dfrac{2\,x_{\max}}{No.of\ \ quantization\ levels}$

$= \dfrac{2\times 4}{128} = \dfrac{1}{16}$V

Nomalized signal power = $\dfrac{S^2}{12} = \dfrac{1}{16}\times\dfrac{1}{16\times 12}$

= 325.55 μW Choice (A)

28. Sinusoid input m(t) = $A\cos\omega_m t$

Slope of the input = $\dfrac{dm(t)}{dt}$

To avoid slope overload $\dfrac{S}{T_s} \geq \left|\dfrac{dm(t)}{dt}\right|_{\max}$; $\dfrac{S}{T_s} \geq A\omega_m$

$A_{max} = \dfrac{S}{T_s\omega_m}$

Where S = 36 × 10^{-3}V

$\omega_m = 2\pi\times 0.5\times 10^3$

$T_s = \dfrac{1}{f_s} = \dfrac{1}{2\times 4\times 2\times 10^3}$

$A_{max} = \dfrac{36\times 10^{-3}}{2\pi\times 0.5\times 10^3}.4\times 2\times 2\times 10^3$

= 183 mV Choice (B)

29. The impulse response of the matched filter is $h(t) = x(T-t) = e^{-2(T-t)} = e^{-2T+2t}$

Now output $y(t) = x(t)\otimes h(t)$

$$\Rightarrow\quad y(t) = \int_{-\infty}^{+\infty} e^{-2\tau}\,.e^{-2(T-t+\tau)}d\tau$$

$$= e^{-2T}\int_{-\infty}^{+\infty} e^{-2\tau}\,.e^{(2t-2\tau)}d\tau = e^{-2t}\int_{-\infty}^{+\infty} e^{(2t-4\tau)}d\tau$$

$$= \frac{e^{-2T}}{-4}\left[e^{2t-4\tau}\right]_0^t = \frac{e^{-2T}}{-4}\left[e^{-2t}-e^{2t}\right]$$

$$= \frac{e^{-2T}}{2}\left[\frac{e^{2t}-e^{-2t}}{2}\right] = \frac{e^{-2T}}{2}\sinh(2t)$$ Choice (A)

30. For 2048 quantization levels, the number of bits required = 2048 = 2^N

So $N = 11$

for 8 quantization levels

Number of bits required to encode one sample = $8 = 2^3 = N = 3$

Bandwidth depends upon number of bits required to encode one sample.

So decresed ratio = $\dfrac{3}{11}$ Choice (C)

31. As we know that in matched filter the maximum amplitude occurs at $t = T$ and It is equal to E

So $T = 0.5$ms

Energy of $x(t) = \displaystyle\int_{-\infty}^{+\infty} x^2(t)dt = \int_{0.1}^{0.5} 10^2\sin^2(4\pi\times 10^6)tdt$

$$= \frac{10\times 10}{2}\int_{0.1}^{0.5}\left[1-\cos\left(8\pi\times 10^6\right)t\right]dt$$

$= \dfrac{10\times 10}{2}[0.5-0.1]-0$ = 20 mV Choice (C)

32. A time slot has 6 + 8.25 + 26 + 2(58) = 156.25bits

Since in GSM each frame consists of 8 time slots

So number of bits/frame = 156.25 × 8 = 1250 bits/frame

So frame rate = $\dfrac{270.833\text{kpbs}}{1250\text{bits/frame}}$ = 216.66 frame/sec

Choice (C)

33. The total number of over head bits in on frame = 8(6) + 8(8.28) + 8(26) = 322 bits

Frame efficiency = η = $1-\dfrac{322}{1250}$ = 74.24%

Choice (B)

34. $x(t) = \begin{cases} \dfrac{2A}{T}t & ,0\leq t\leq T/2 \\ 2A-\dfrac{2A}{T}t & ,T/2\leq t\leq T \end{cases}$

Energy $E = \displaystyle\int_{-\infty}^{+\infty} x^2(t)dt$

$$E = \int_0^{\frac{T}{2}}\left(\frac{2A}{T}t\right)^2 dt + \int_{\frac{T}{2}}^{T}\left(2A-\frac{2A}{T}t\right)^2 dt$$

$$= \frac{4A^2}{T^2}\int_0^{\frac{T}{2}} t^2dt + 4A^2\int_{\frac{T}{2}}^{T}\left(1-\frac{t}{T}\right)^2 dt$$

$$= \frac{4A^2}{T^2}\left[\frac{t^3}{3}\right]_0^{\frac{T}{2}} + 4A^2\left[t-\frac{2}{T}\frac{t^2}{2}+\frac{1}{T^2}\frac{t^3}{3}\right]_{\frac{T}{2}}^{T}$$

$$= \frac{A^2T}{6}+\frac{4A^2T}{24} = \frac{A^2T}{3}$$

$E = \dfrac{5\times 5\times 10^{-3}}{3}$ = 8.33 mW Choice (B)

35. Since channel noise is white noise. So the optimum filter is same as matched filter. So probability of error of matched filter is

$$P_e = \frac{1}{2}erfc\sqrt{\frac{E}{\eta}} = \frac{1}{2}erfc\sqrt{\frac{25\times 10^{-3}}{3\times 10^{-4}}}$$

$$= \frac{1}{2}erfc\sqrt{\frac{250}{3}}$$ Choice (A)