Roll No.: .....

**National Institute of Technology, Delhi**
**Name of the Examination: B.Tech**

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|---|---|---|---|
| **Branch** | **: ECE** | **Semester** | **:VI** |
| **Title of the Course** | **: Digital Communication** | **Course Code** | **: EC 351** |

**Time: 3 Hours** **Maximum Marks: 50**

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**Note:**

- **Questions are printed on BOTH sides. Answers should be CLEAR, TO THE POINT AND LEGIBLE.**
- **In total there are NINE(9) questions with their marks shown individually. All questions are compulsory.**
- **All parts of a single question must be answered together and in the same sequence as given in question paper. ELSE QUESTION SHALL NOT BE EVALUATED.**
- **NOTE: ALL QUESTIONS ARE COMPULSORY.**

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**Section A ( 10 Marks )**

**Q.1** Answer the following questions to the point . No need to write the details. Just the important points you need to write.

(a) Arrange PSK,FSK,ASK in increasing order of Error Probability.
(b) What is Quadrature Null Effect? In which modulation Schemes it is present.
(c) What is the difference between bandpass signal and baseband signal? Draw their spectrum.
(d) What is the difference between baseband modulation and bandpass modulation? Name some of these modulation schemes.
(e)What is white Noise? What is the shape of its Probability density function and Power spectral density.
(f)What do you understand by the terms Information and Entropy?
(g) What are the main differences between Analog Communication and Digital Communication?
(h)What is Matched Filter and why it is used?
(i) What is the main difference between PCM ,DM ,DPCM in terms of quantization noise?
(j) A source is generating 4 symbols with probability 1/8,1/8,1/4,1/2. Find Entropy and Information rate if the source is generating 1 symbol in 1 mille second. **( 10×1)**

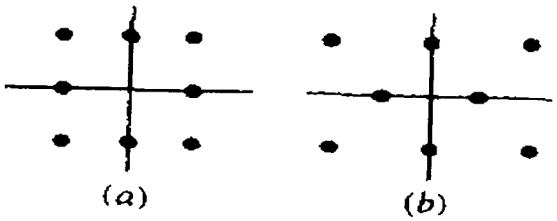
**Section B ( 16 Marks )**

**Q. 2** Find Nyquist rate of the following :
**(a)** Sinc[400t].Sinc[600t]
**(b)** $\mathrm{Sin}(8\pi\times10^3 t)$ .$\mathrm{Cos}(6\pi\times10^3 t)$
**(c)** $5\mathrm{Sin}(8\pi\times10^3 t)$ $+6\mathrm{Cos}(6\pi\times10^3 t)$
**(d)** Sinc[400t]*Sinc[600t] **(4)**

**Q.3** Ten Signals each band limited to 5 Khz are multiplexed using TDM. Sampling rate is 5 times NR. $Q_e$ should be at most of 0.2 % of peak to peak amplitude of m(t). 5 Number of synchronization bits are added at the end of each frame. Find Bit rate and Transmission bandwidth. **(4)**

**Q.4**
**(a)** Draw block diagram of a PCM system and briefly explain basic elements of it.
**(b)** What is the difference between Source Coding and Channel Coding? Explain your answer with suitable example. **(4)**

**Q5**. Consider the two 8- point QAM signal constellation as shown in the figure. The minimum distance between adjacent points is 2A . Determine the average transmitted power for each constellation, assuming that the signal points are equally probable. Which constellation is more power- efficient?




(4)

**Section C ( 24 Marks )**

**Q.6**

**(a)** Draw the 4-PSK and 8- PSK signal constellation. (2)

**(b)** For the constraint that the minimum distance between pairs of signal points be "d" for both constellations. Then what are the radii r1 ( for 4 PSK), and r2( for 8PSK) of the circles in terms of "d". (2)

**(c)** Assuming high SNR and that all signals are equally probable, then what additional average transmitted signal energy is required by the 8-PSK signal to achieve the same error probability as the 4-PSK signal. (2)

**Q7.** Suppose that binary PSK is used for transmitting information over an AWGN with a power spectral density of $\frac{1}{2}N_0 = 10^{-10}$W/Hz. The transmitted signal energy is $E_b = \frac{1}{2}A^2T$,where T is the bit interval and A is the signal amplitude. Determine the signal amplitude required to achieve an error probability of $10^{-6}$ when the data rate is (a) 10kbits/sec, (b) 100kbits/s , and (c) 1 Mbits/sec.

Use the following information:

(1) Error probability in case of BPSK is $P_e = Q\left[\sqrt{\frac{2E_b}{N_0}}\right]$.

(2) Moreover $P_e$ is $10^{-6}$ when the argument of Q is 4.74. (6)

**Q8**. A matched filter has the frequency response

$$H(f)=\frac{1-e^{-j2\pi fT}}{j2\pi f}$$

(a) Determine the impulse response h(t) corresponding to H(f). (3)

(b) Determine the signal waveform in time domain to which the filter characteristic is matched. (3)

**Q.9**

**(a)** Consider a digital source X that produces three symbols with following probabilities:

P(X = A) = 2/3 , P(X = B) = 1/6 , P(X = B) = 1/6

Generate Huffman Code for the above digital source and find the efficiency of the code. (2)

**(b)** In an extended version of above digital source, we combine two symbols and send them together. Therefore, we have 9 symbols from $S_1$ to $S_9$ as follows:

$S_1$ = AA, $S_2$ = AB, $S_3$ = AC, $S_4$ = BA, $S_5$ = BB, $S_6$ = BC, $S_7$ = CA, $S_8$ = CB, $S_9$ = CC

Assuming symbol A,B and C are mutually independent, generate the Huffman Code for the above symbol set S. (3)

**(c)** Which efficiency is higher between part A and part B? (1)