[This question paper contains 6 printed pages.]

Your Roll No. .....

3220 **J**

MEE

Paper—EE.657

COMMUNICATION THEORY

Time : 3 *Hours* *Maximum Marks* : 100

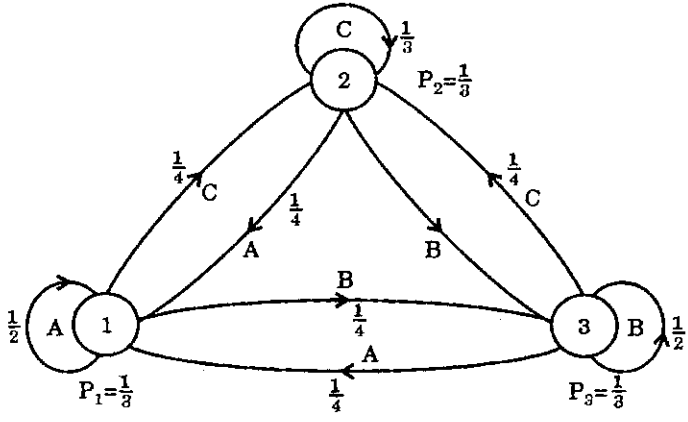
(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any ***five*** *questions.*

All *questions carry equal marks.*

Make assumptions where necessary.

1. (a) The state diagram of a stationary Markov source is as shown below :



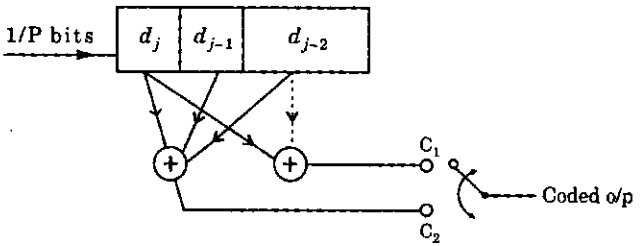
[P. T. O.

(i) Find the entropy of each state H_i (i = 1, 2, 3).

(ii) Find entropy of the source H.

(iii) Find the average information content per symbol in messages containing one, two and three symbols, that is G_1, G_2 and G_3 and verify that $G_1 \geq G_2 \geq G_3 \geq H$. 2+2+6=10

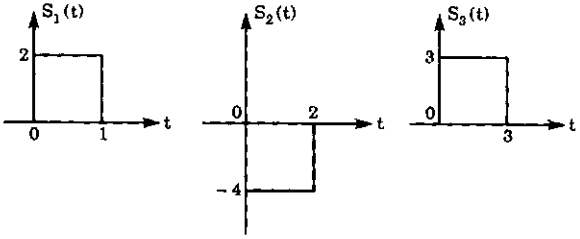
(b) Construct the code trellis and trellis diagram for the convolutional coder as shown below :



Assume length of message sequence and received code word to be '5' and 01 01 01 00 10 11 00 00, respectively, using the viterbi algorithim, detect and correct the errors in received code word. If two paths arriving at a given node have equal running metrics, arbitrarily keep the upper path. 10

2. (a) (i) Using Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the 3 signals $S_1(t)$, $S_2(t)$ & $S_3(t)$ as shown below,

(ii) Express each of these signals in terms of the sef of basis function found in part (i).



7+3=10

(b) How is the output S/N maximized in the matched filter receiver? Explain with the help of the diagram of detector. 10

3. (a) Consider a pulse S(t) defined by :

$$S(t)=\begin{cases} 1 \; ; & 0\le t\le T \\ 0 \; ; & \text{else} \end{cases}$$

It is proposed to approximate the matched filter for this pulse by a LPF RC filter defined by :

$$H(f)=\frac{1}{\left[1+j\dfrac{f}{f_0}\right]}$$

where $f_0=\dfrac{1}{2\pi RC}$ is the 3 dB BW of filter.

(i) Determine the optimum value of 'f_0' for which the RC filter provides the best approximation to the matched filter.

(ii) Assuming an additive white noise of zero mean and PSD of $N_0/2$, what is peak o/p S/N?

5+5=10

[P. T. O.

(b) For a (6, 3) systematic linear block code, the 3 parity check bits C_4, C_5 and C_6 are formed from the following equations :

$C_4 = d_1 \oplus d_3$, $C_5 = d_1 \oplus d_2 \oplus d_3$

$C_6 = d_1 \oplus d_2$.

(i) Write down the genertor matrix (G).

(ii) Construct all possible code words.

(iii) Suppose the received word is 010111.

Decode this received word by finding location of error and x-mitted data bits. 4+3+3=10

4. (a) The binary sequence 1100100010 is applied to the DPSK x-mitter.

(i) Sketch the resulting waveform at the x-mitter output.

(ii) Apply the waveform in part (i) to DPSK receiver, show that, in the absence of noise, the original binary sequence is reconstructed of the receiver output. 4+6=10

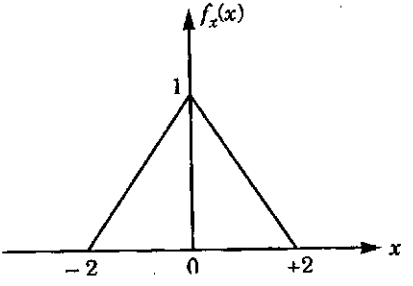
(b) An FSK system x-mits binary data at the rate of 2.5×10^6 bits/s. During the x-mission, white Gaussian noise of zero mean and PSD of 10^{-20} watt/Hz is added to signal. In the absence of noise, the amplitude of the received sinusoidal wave for digit 1 or 0 is 1 micro-volt. Determine the average

probability of symbol error for the following system configurations :

(i) Coherent BFSK.

(ii) Coherent MSK. 5+5=10

5. (a) The probability density function of the sampled values of an analog signal is as shown below. Design a four-level uniform quantizer and calculate the S/N_q. 10



(b) Discuss the following Non-coherent receivers along with block diagrams :

(i) Quadrature receiver using correlators.

(ii) Quadrature receiver using matched fiters.

(iii) Non-coherent matched filter.

4+4+2=10

6. (a) Discuss the differential quantizing scheme with the help of block diagrams. 10

(b) Derive the following expression of output S/N_q power ratio in DM system :

$$\left(\frac{S}{N_q}\right)_0 = \left(\frac{3}{8\pi^2}\right)\left(\frac{f_s'}{f_x}\right)^3$$ 10

where f_x = $1/p$ 'signal freq. $[x(t) = A \cos 2\pi f_x t]$

f_s' = Sampling freq.

7. (a) Discuss the operation of a M-Ary Q AM x-mitter and receiver system with block diagrams. 10

(b) Binary data is to be x-mitted over a microwave channel at a rate of 3×10^6 bits/s. Assume, the channel noise to be white Gaussian with a PSD of $\frac{N_0}{2} = 10^{-14}$ watt/Hz, find the power and BW requirements of four phase PSK and 16-tone FSK signalling schemes to maintain an error probability of 10^{-4}. 10