OLLSCOIL NA hÉIREANN
THE NATIONAL UNIVERSITY OF IRELAND

COLÁISTE NA hOLLSCOILE, CORCAIGH
UNIVERSITY COLLEGE, CORK

SUMMER EXAMINATIONS, 2000

B.E. DEGREE (ELECTRICAL)

TELECOMMUNICATIONS
EE4004

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[The use of *non-programmable* calculators is permitted.]

Time allowed; *3 hours*

Answer *six* questions.

Please use separate answer books for each section

SECTION A

1. Derive the relationship between quantisation noise and the number of quantisation levels in pulse code modulation.
A microwave link using 64 QAM modulation is used to carry three signals of 5 MHz, 10 MHz and 15 MHz bandwidth respectively, which have been encoded using standard PCM. If the carrier modulation rate is 6×10^7 phase changes per second, what is the maximum possible signal to quantisation noise ratio in dB?

2. (a) Discuss the implementation of a *virtual channel* and a *virtual path* in an ATM network.

   (b) Describe the three `picture types' defined in MPEG-2 video coding

3. (a) Contrast the operation of time division multiple access (TDMA) techniques in satellite and mobile communications systems.

What do you understand by *primary rate access* in the context of ISDN telephony systems?

SECTION B

Q.4. Consider a Binary Symmetric Channel (BSC) with $P[x_1] = \alpha$, as illustrated below.

(a) Show that the mutual information $I(X;Y)$ is given by: -

$$I(X;Y) = H(Y) + p\,Log_2[p] + (1-p)Log_2[1-p].$$

(b) Calculate $I(X;Y)$ for $\alpha = 0.5$ and $p = 0.1$.

(c) Repeat (b) for $\alpha = 0.5$ and $p = 0.5$ and comment on the result.

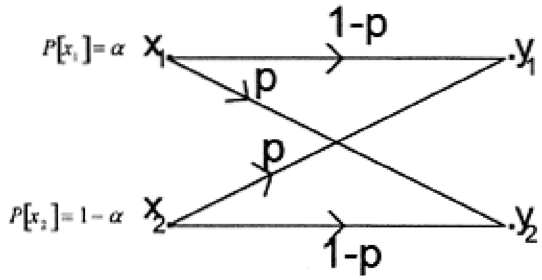

Figure : BSC.

Q.5. (a) Three binary symbols emerging from three different sources, respectively denoted x_1, x_2 and x_3, have the following probabilities of taking the value of "binary 1": -

$$P(x_1 = 1) = 0.6$$
$$P(x_2 = 1) = 0.4$$
$$P(x_3 = 1) = 0.7.$$

If a Hamming encoder produces an even parity Hamming codeword for each sequence $\{x_1, x_2, x_3$ supplied to it, calculate the efficiency of the resulting code.

(b) Determine the maximum achievable efficiency for a code similar to that of part (a) above and identify the corresponding values of $P(x_i), 1 \le i \le 3$.

Q.6. (a) Assuming the register of the convolutional encoder shown below is initially zeroed, develop its Trellis diagram.

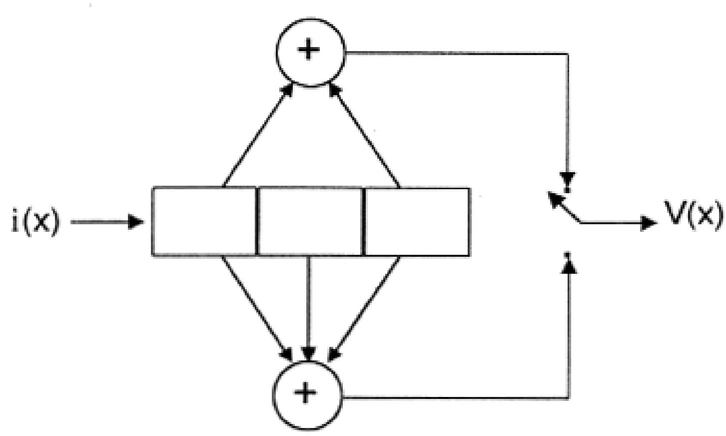

Figure : Convolutional encoder.

(b) For the information sequence: -

$$i(x) = 1 \quad 0 \quad 1 \quad 1 \quad 0 \quad 0$$

↑

First bit into encoder

determine the output from the encoder.

(c) (c) If the third and seventh bits <u>emerging</u> from the encoder are received in error, determine if the decoder will correct them.

Q.7. (a) Show that if a binary transmission system is based upon phase shift keying where: -

$$s_i(t) = \begin{cases} s_1(t) = A\cos[\omega_c t] & 0 \le t \le T \\ s_2(t) = -A\cos[\omega_c t] & 0 \le t \le T \end{cases}$$

and T is an integer times $1/f_c$ then the probability of error is given by: -

$$P_e = Q\left[\sqrt{\frac{A^2 T}{\eta}}\right]$$

where $\eta/2$ is the power spectral density of the additive white Gaussian noise.

(b) If the source symbols for the system described in (a) above are equiprobable, determine the capacity C of the transmission system (in bits/sec) as a function of the amplitude A.

(c) If amplitude were unconstrained, what is the theoretical limit on the capacity of the system described in (b)?