Menoufia University
Faculty of Electronic Eng.
Department of Electronics
and Electrical Communications
Engineering

جامعة المنوفية
كلية الهندسة الألكترونية
قسم هندسة الألكترونيات والأتصالات الكهربية

Course Title: (Information Theory and Coding), ECE-413 **Year: B.Sc. Students**

Date: 2-1-2019 **1st Semester Exam** **Time Allowed: 3 Hours**

----------Answer the following FOUR questions----------

Q.1 If a repeating four bit input pattern **011011**...is applied to the scrambler given in Fig.1, find the starting state for this input sequence for which the scrambler does not randomize the data.

Q.2 Design an encoder for the (7, 4) binary cyclic code generated by the polynomial $\mathbf{11}_{10}$ and Verify its operation using the message vector $\mathbf{12}_{10}$, (MSB on the left). Assume the error Polynomial $\mathbf{e(x)} = \mathbf{x}^6$, discuss the synthesis of a code capable of correcting this single error showing the content of the register at the successive steps.

Q.3 A convolutional coder of rate ½, constraint length =**3**, and with generator polynomials $g_0=\mathbf{5}_{10}$ and $g_1=\mathbf{7}_{10}$ has been used to encode the data 100111. What is the output of the encoder.(assuming the first input bit is the left most bit) and the coder starts with 0 in both stages If two errors occurred in the **4th** and **9th** bit of the transmitted data. Explain how to decode the received data using Viterbi algorithm.

Q.4 A turbo encoder consists of two symmetrical recursive systematic coders ENC1 and ENC2 with generator polynomials $g=\{7;5\}_{10}$. The interleaver matrix α is represented by α=[2 5 4 1 3].Assuming the padding block adds the tails (01) to the input data U_k =101.Write the outputs words after multiplexing of padding block, output of ENC1 and the output of ENC2.

Answer ONE of the following questions:

Q.5 (a) Consider a binary memoryless source X with two symbols x1 and x2. Show that H(X) is a maximum when both x1 and x2 are equiprobable.

(b) Compute the capacity of the binary symmetric channel (BSC) which defined by the channel diagram shown in Fig.2: Considering the binary source has the input: X ={x_1, x_2} with probabilities {p_1, p_2}, and the output symbols {y1, y2} with probabilities {q1, q2}, respectively. The channel matrix is given by

$$\left[P_{BSC}(Y|\ X)\right]=\begin{bmatrix}1-P & P\\ P & 1-P\end{bmatrix}$$

Q.6 (a). Define the type of the channels and the corresponding channel matrix for the special channels given in Fig.3. **(b)** The input symbols are emitted at the input of a binary transmission channel (fig.4). Statistical measurements show that, because of channel noise, both symbols are 10% erroneous, the process being time invariant. Knowing that the symbols 0 and 1 are

transmitted in a ratio of 3/7, the transmission of a symbol is independent of the previously transmitted symbols and that 1000 symbols per second are being emitted (the duration of each symbol is the same), find:

(i) Joint probability matrix P(X,Y) ,(ii) Input probabilities P(X), and

(iii) The output probabilities P(Y). (iv) The quantity of information I (x_1) obtained when 0 is emitted and the source average quantity of information H(X).

Q.7 **(a)** Some students who are late in joining elective courses in the Communications Department wanted to choose one of the two elective courses (Course A: ECE462-D3) and (Course B: ECE426-F3). 55% of students joining course (A) while 45 % joining course (B). They asked their former colleagues were consulted for their consultation. They reached the following results:

(i)- The probability of the students enrolled in course (A) after the initial lecture is 70% (ii). The probability of converting students from course (A) to course (B) after the initial lecture is 30% (iii) - the probability of survival of students in decision (B) after the initial lecture is 90% (iv). The probability of converting students from course (B) to course (A) after the initial lecture is 10%

(1) Draw the Markov diagram for our case. (2) Calculate the probability of students' presence in the two courses after the first lecture and after the second lecture assuming the transition matrix does not change with time. In case of steady state, calculate the final probabilities of joining the students in the two courses.

(b) Encode the character stream: **w a b b a w a b b a** using LZW encoding algorithm?

---*GOOD LUCK*---

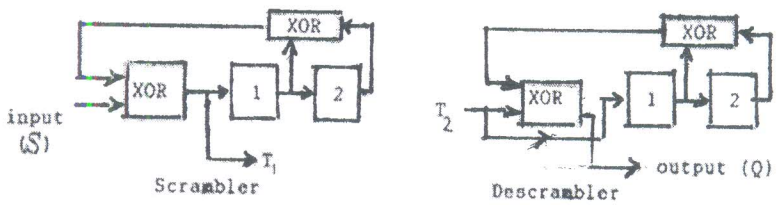
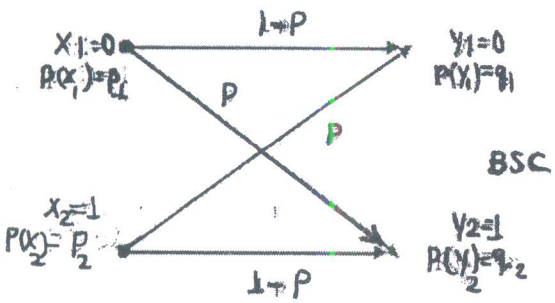


Fig.1 (Q.1)

The capacity of a BSC can be computed starting from:



$$I(X;Y)=H(Y)-H(Y|X)$$

$$H(Y|X)=-\sum_{j=1}^{n}\sum_{i=1}^{m}P(x_i,y_j)\log_2 P(y_j|x_i)$$

$$[P(X,Y)]=[P(X)][P(Y|X)]$$

Fi.g2 BSC Channel (Q.5)

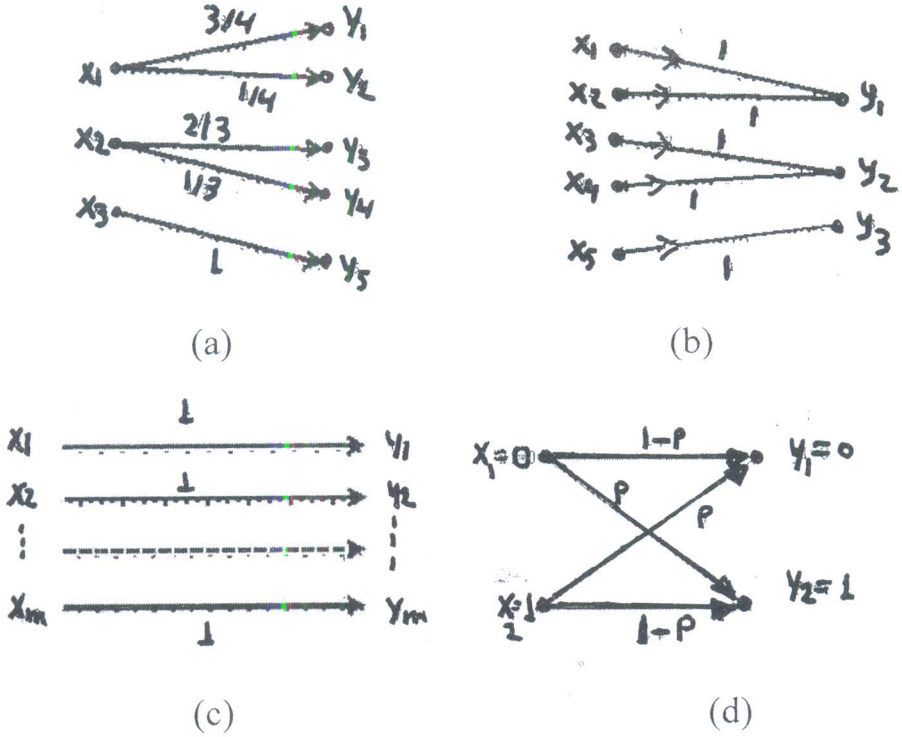


Fig.3(Q.6a)

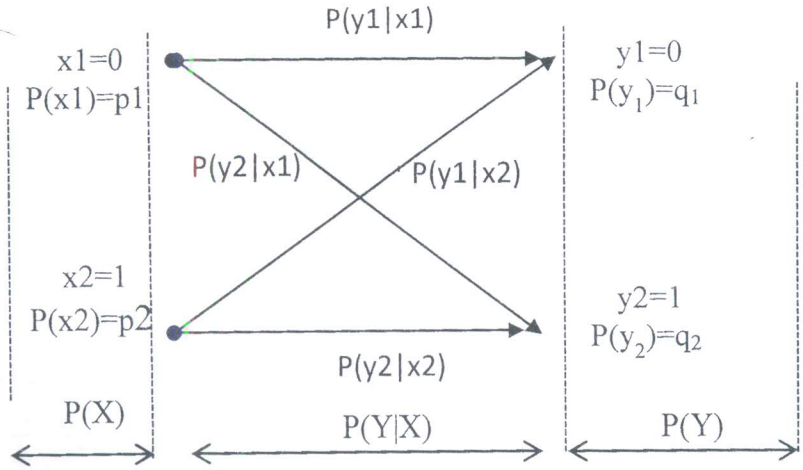


Fig.4 Q.6(b)