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جامعة المنوفية
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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