MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

Fourth year SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO405: COMPRESSION TECHNIQUES

DATE: **TIME:**

INSTRUCTIONS: Answer Question ONE and Any Other TWO Questions.

QUESTION 1 (30 MARKS) [COMPULSORY]

a) Contrast between lossy and lossless compression methods. (4 marks)

b) Using a detailed diagram, describe the various stages of the compressor. (5 marks)

c) Describe the steps involved in the Huffman algorithm. (5 marks)

d) Specifically, if the value of one pixel is known, it is highly likely that the adjacent pixel value is similar. By finding a mapping equation that de-correlates the data, this type of data redundancy can be removed. Expound on the THREE ways in which this can be done. (6 marks)

e) Below is a set of tokens;

BABACACADADABBCBABEBEDDABEEEBB

i. Show how you would use Huffman coding to encode the above set of tokens; (4 marks)

ii. Explain how this message is transmitted when encoded. (6 marks)

f) Highlight the main differences that exist between JPEG and MPEG compression standards. (4 marks)

QUESTION TWO (20 MARKS)

a) Explain TWO reasons why data compression is highly desirable in most multimedia applications. (4 marks)

b) Calculate the time that it will take to transmit a digitized color 35mm slide scanned at 000x3000 pixels, and 24-bits, at 3Gbps. (4 marks)

c) You are invited for a conference on Multimedia compression techniques, you topic is How Lempel-Ziv algorithm work." Based on this topic illustrate how the technique works in regard to compression of multi-media applications. (6 marks)

d) Consider the simple encoding scheme which simply repeats every bit of the input 3 times, and decoded by taking the majority vote.

i. Calculate the rate of this encoding scheme. (2 marks)

ii. Suppose a message of length k is encoded and sent through a binary symmetric channel which flips each bit with probability p. Determine the probability that a message sent using this encoding scheme is decoded correctly. (2 marks)

iii. Suppose $p = 0{:}125$. Is it true that for k (the message length) large enough, there exists an encoding scheme with the same rate as the above simple encoding scheme and which decodes correctly with a probability of at least 99%? Explain why or why not. (2 marks)

QUESTION THREE (20 MARKS)

a) There are various applications across the globe that requires image compression. Explain FOUR of these applications. (4 marks)

b) Using a simple example in each case identify THREE differences between entropy coding and transform coding techniques in data compression (6 marks)

c) Lorna wants to send a large file to her friend in the U.S.A. She has realized that it is not possible to send the file as it is and she has to compress it. Advise her on some of the examples of file compression tools that are available at her disposal for use and how they can be used. (4 marks)

d) Let S_1 be a source which outputs independent letters from the alphabet $A = \{a, b, c, d, e\}$ with probabilities $p_a = 1/8$, $p_b = 1/16$ $p_c = 1/2$ $p_d = 1/4$ and $p_e = 1/16$. Let S_2 be a source which outputs independent letters from the alphabet $Z = \{w, x, y, z\}$ with probabilities $p_w = 1/4$, $p_x = 1/4$, $p_y = 1/4$ $p_z = 1/4$. Suppose one wants to compress the random sequence coming out of these sources. Calculate the source that can be compressed to shorter code in average among the codes. (6 marks)

QUESTION FOUR (20 MARKS)

a) Explain the four primary types of redundancy that can be found in images. (4 marks)

b) By use of a simple diagram, explain the stages involved in the de-compressor. (6 marks)

c) Given the below sequence; construct Lempel-Ziv parsing and explain how the code will be encoded by Lempel_Ziv code. (6 marks)

01011010111011011110111

d) Examine TWO main differences in encoding and decoding speeds of the LZ77 and Burrows-Wheeler transform techniques. (4 marks)

QUESTION FIVE (20 MARKS)

a) Outline THREE main characteristics of the Vector Quantization compression technique. (3 marks)

a) Briefly describe FIVE major factors that affect the quality of service for multimedia application. (5 marks)

b) Using a suitable diagram explain the steps involved in the MPEG coding algorithm. (6 marks)

c) Consider a source which outputs independent random letters from the alphabet $A = \{a, b, c, d, e\}$ with probabilities $p_a = 1/4$, $p_b = 1/4$, $p_c = 1/6$, $p_d = 1/6$ and $p_e = 1/6$. Evaluate the Huffman code for this source. (6 marks)