Exam 3 Learning Objectives

Chapter 16 – Identification Numbers

➢ Understand the purpose of a check digit.
➢ Know what $a \equiv b \bmod m$ means and be able to calculate $x \bmod y$.
➢ Know the most common types of errors that can occur when dealing with identification numbers.
➢ When given the scheme to determine a check digit, be able to
  o find the check digit,
  o determine if a code is valid
  o find a missing value in the code if the check digit is given.
➢ Show how a check digit scheme can or cannot find different errors in identification numbers.
➢ Given an identification number and the scheme, use it to code or decipher the information such as birth date and gender.

Chapter 17 – Information Science

- ➢ Know what a binary code is.
- ➢ Know how to convert from binary numbers to decimals and decimals to binary.
- ➢ Use error checking to determine or verify a code word, given the message and the error checking method.
- ➢ Be able to compute check digits for code words given the parity-check sums for the code.
- ➢ Be able to determine the distance between two binary codes.
- ➢ Be able to determine the weight of a code and use the weight to determine the error detecting/correcting abilities of the code.
- ➢ Know what nearest-neighbor decoding is and be able to use it for decoding messages
- ➢ Be able to encode and decode messages that have symbols (such as letters of the alphabet) expressed in binary form.
- ➢ Use delta encoding to compress or expand data.
- ➢ Be able to decode using a Huffman code and be able to create a Huffman code given a table of probabilities.
- ➢ Be able to encrypt and decrypt messages using the Caesar, decimation, and Vigenère ciphers.
- ➢ Be able to add binary strings.

Practice Questions

1. Find the following values:

    $6 \mod 13 =$ _____

    $42 \mod 7 =$ _____

    $30 \mod 4 =$ _____

2. Decide if the following are true or false:

    $12 \equiv 2 \mod 10$ is _____

    $53 \equiv 2 \mod 13$ is _____

3. A code is given by $a_1 a_2 a_3 a_4$ where a_4 is the check digit. Given that $a_4 = 3a_1 + a_2 + 7a_3 \bmod 10$,

(a) Find the check digit for the code 123.

(b) Determine the value of x in the code $34x7$ given that the check digit is valid.

(c) Will this code find the error of transposing the first two digits?

(d) Will this code find a single digit error in the 3rd position?

4. A ZIP+4 code has a check digit in the 10th position that is found by summing the first 9 digits and the check digit will bring the sum of all the digits to a multiple of 10. What is the check digit for a ZIP+4 of 77845-8738?

5. An ID number has 5 digits where the first two digits are the last two digits of the person's zip code, the 3rd digit is the person's birth month mod 10 and the last two digits are the person's birth day. What is the ID number of a person who lives in the zip code 77840 and is born on November 28, 1983?

6. Convert the binary number 10101 to a decimal number.

What is decimal number 97 expressed as a binary number?

Add the binary numbers 11111 and 10101.

7. What is the code word for the message 11001 if the code word is the message appended with two check digits found using the parity-check sums $a_1 + 2a_2 + a_3$ and $3a_1 + a_3 + a_5$.

8. A code C = {11111111, 11110000, 00001111, 00000000} can send 4 different messages.

(a) What is the weight of this code?

(b) How many errors can this code detect?

(c) Use nearest neighbor decoding to decode, if possible, the message 11100111.

9. Data was compressed using the encoding
    e → 0, s → 10, t → 110 and a → 111.
Decode the message

   111110010110

10. Decode the information that used delta encoding:
    29 9 -4 0 -3 -3 10.

Encode the values 107 102 103 105 100 using delta encoding.

In each case, how much compression was there?

11. Use Huffman encoding to create a binary code for the directions that occur with the following frequencies:

East	West	North	South	Up	Down
0.10	0.11	0.13	0.15	0.25	0.26

12. Use the Caesar cipher with a shift of 16 to encrypt the message

D I P L O M A

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

13. Use a decimation cipher with key 3 to encrypt the message
    N E W Y E A R.

14. Use the Vigenere cipher with the key word HANK to encrypt the message

H O M E R U N.

15. Given that TROUT was used as the key word to encrypt ZFBY YBJVCGZ with the Vigenere cipher, decrypt the message.