1. (5%) It is known that a musical CD is sampled with 44,100 samples/sec. The data obtained for each sample is represented in 16 bits for each channel.　The stereo CD music requires two channels.
   (a) How many bits/sec for one second of a stereo CD music?
   (b) Suppose that the stereo CD music is compressed with MP3 with a compression ratio 12 to 1. What is the bit rate for the MP3 music?

2. (5%) What is the Hamming distance between (a) 100110 and 010100 (b) 000000 and 010100 (c) 111010 and 010100.

3. (10%) (a) Draw a conceptual diagram of DMA (direct memory access) and explain how it works.
   (b) Draw a conceptual diagram of memory mapped I/O for a peripheral device and explains how it works.

4. (5%) Give the original form in English for the following abbreviated terms. For example, ANSI is the abbreviated from American National Standards Institute.
   a. DVD
   b. CD
   c. CD-DA
   d. MP3
   e. DSL

5. (10%) A sequential file contains the following 6 test records.

   Beginning of the file

 | Record # | student's name | score |
   |----------|----------------|-------|
   | R1 | Tom | 85 |
   | R2 | Wendy | 35 |
   | R3 | Ive | 91 |
   | R4 | Nora | 88 |
   | R5 | Sally | 43 |
   | R6 | York | 19 |

   End of the file

   (a) (5%) Let S1 and S2 be two stacks. S1 stores the name of the students whose scores are greater than or equal to 60, and S2 stores those with scores less than 60. Show the content of each of the stacks after the sequential file is read and data are stored, using the form shown below:

   Bottom　　　　　　　　　　　　　Top

(b) (5%) Let Q1 and Q2 be two queues. Q1 stores the name of the students whose scores are greater than or equal to 60, and Q2 stores those with scores less than 60. Show the content of each of the stacks after the sequential file is read and data are stored, using the form shown below: (**Rear** represents a pointer used for insertion and **Front** for deletion.)

Rear   Front
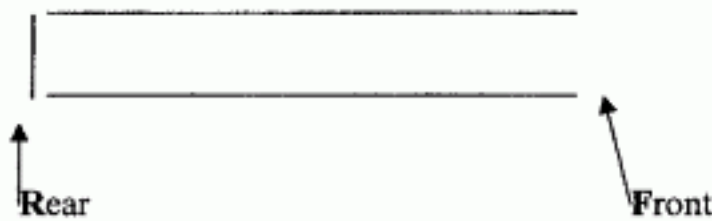
6. (7%) Based on the relations shown below, what is the appearance of the relation **RESULT** after executing each of the following instructions:

X relation				Y relation		
U	V	W		R	S	← —— Column name
a	z	5		3	j	← ——— Tuples
b	d	3		4	k	.
c	q	5				.

(a) (3%) **RESULT** ← PROJECT W from X
(b) (2%) **RESULT** ← SELECT from X where W = 5
(c) (2%) **RESULT** ← JOIN X and Y where X.W = Y.R

7. (8%) A typical operating system has the following components: *Device drivers, Dispatcher, File manager, Memory manager, Scheduler,* and *Shell* (listed in alphabetical order). The appropriate function for each component can be found from one of the following phrases:

 (1) Communicates with the machine's environments

 (2) Controls the assignment of processes to CPU time.

 (3) Coordinates the use of the machine's mass storage

 (4) Coordinates the use of the machine's main memory

 (5) Coordinates the process in the system

 (6) Handles communication with the machine's peripheral devices.

 For instance, the appropriate phrase describing the function for the component *Shell* is (1), and (5) for the component *Scheduler*.

Labeling the following four components with the **appropriate number**. (Notice that you will be deduct **two points** for the answer of each component, if you **do not** label the answer with the appropriate number.)

Component's name	Suitable number
Shell	1
Scheduler	5
Device drivers	?
Dispatcher	?
File manager	?
Memory manager	?

8. (5%) In chaining, all the elements that hash to the same slot are put in a linked list. Suppose that a hash table in which collisions are resolved by chaining has m slots that store n elements. Under the assumption of simple uniform hashing, what is the expected time an unsuccessful search takes in the given hash table?

9. (10%) Describe a Turing machine that decrements the value on the tape if it is greater than zero or leaves the value unaltered if it is zero.

10. (10%) Which are correct in the following statements? (2 points per each statement. You need not prove or disprove it.)

   (a) $3n^3/\log n + n^{2.999} = \Theta(n^{2.999})$

   (b) $n^3 2^n + 3^n/\log n = \Omega(2.5^n)$

   (c) $6n! + 100\, n^2 2^n = O(n^2 2^n)$

   (d) $600 n^3 \log n = \Theta(n^3 \log n)$

   (e) $n \log n = O(n^2)$

11. (25%) Suppose we want to write a program to manage information such as the followings:

```
John teaches Henry Chinese.
Henry teaches Mary English.
John teaches Mary French.
Henry speaks Spanish and Chinese and English.
Mary speaks French.
```

   (a) (5%) From the above, we can identify two entities: "PERSON" and "LANGUAGE", and two relations: "teaches" and "speaks". Draw the entity-relationship diagram for the above information.

(b) (5%) Given two persons X and Y, we want to find out what language(s) X teaches Y. We could implement the "teaches" relation as a procedure:

```
teaches(X, Y, Z)     // X teaches Y the language Z
```

Which parameters will you pass by value and which by reference? GIVE YOUR REASONS TO GET POINTS.

(c) (3%) Can the "speaks" relation be implemented as a function, such as L = speaks(X), where L is a variable of type language and X is variable of type person? GIVE YOUR REASON TO GET POINTS.

(d) (6%) Give the syntax diagram of the "speaks" sentences, using speaks and and as keywords.

(e) (6%) Draw the parse tree of the sentence: Henry speaks Spanish and Chinese and English.