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Media Engineering and Technology
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CSEN 102: Introduction to Computer Science
Winter Semester 2013-2014
Midterm Exam

Bar Code

Instructions: Read carefully before proceeding.

(a) Duration of the exam: 2 hours (120 minutes).

(b) (Non-programmable) Calculators are allowed.

(c) No books or other aids are permitted for this test.

(d) This exam booklet contains 15 pages, including this one. Three extra sheets of scratch paper are attached and have to be kept attached. **Note that if one or more pages are missing, you will lose their points. Thus, you must check that your exam booklet is complete**.

(e) Write your solutions in the space provided. If you need more space, write on the back of the sheet containing the problem or on the three extra sheets and make an arrow indicating that. **Scratch sheets will not be graded unless an arrow on the problem page indicates that the solution extends to the scratch sheets**.

(f) When you are told that time is up, stop working on the test.

Good Luck!

Don't write anything below ;-)

Exercise	1	2	3	4	5	6	7	8	9	10	$\sum$
Possible Marks	5	10	10	14	10	15	14	14	8	10	110
Final Marks											

Exercise 1 Sequential algorithms (5 Marks)

Wooden Boxes

A factory manufactures wooden boxes (a box is a cuboid with six faces). The price of the wood is 10LE/m^2. Write an algorithm that, given the three dimensions of the box in meters, calculates and prints the total surface area of the box and the price of the wood needed.

Solution:

```
get width, length, height
set area to length * width * 2 + length * height * 2 + height * width * 2
set cost to area * 10
print "The area is "
print area
print "The cost is "
print cost
```

Exercise 2 Conditional operations (10 Marks)
BMI

The body mass index (BMI) is the ratio of the weight of a person (in kilograms) to the square of the height (in meters). Write an algorithm that given the weight and height, computes the BMI, and prints out the corresponding BMI category:

- Starvation: less than 15
- Anorexic: less than 17.5
- Underweight: less than 18.5
- Ideal: greater than or equal to 18.5 but less than 25
- Overweight: greater than or equal to 25 but less than 30
- Obese: greater than or equal to 30 but less than 40
- Morbidly Obese: greater than or equal to 40

You algorithm should test the least number of conditions once it is executed.

Solution:

```
get weight
get height
set ratio to (weight/(height * height))
if (ratio >= 40)
    then print "Morbidly Obese"
    else
        if (ratio >= 30)
        then print "Obese"
        else
                if (ratio >= 25)
                then print "Overweight"
                else
                        if (ratio >= 18.5)
                        then print "Ideal"
                        else
                                if (ratio >= 17.5)
                                print "Underweight"
                                else
                                        if (ratio >= 15)
                                        then print "Anorexic"
                                        else
                                                print "Starvation"
                                        endif
                                endif
                        endif
                endif
        endif
endif
```

Exercise 3 Conditional (10 Marks)

Chinese Zodiac

Chinese tradition assigns one of twelve zodiac signs to each year. After a twelve year circle, the signs are repeated in the same order. The order is: Rat—Ox—Tiger—Rabbit—Dragon—Snake—Horse—Sheep—Monkey—Rooster—Dog—Pig. Chinese New Year is usually in the beginning of February, so a Chinese year can be approximately identified with a Western calendar year. The last year of the Rat coincided with 2008.

Write a program that, given a year after 2013, gives the zodiac sign of the coinciding Chinese year.

You are not allowed to use any else statements.

Solution:

```
1  get year
2  set year to year - 2008
3  set year to year%12
4
5  if (year = 0) then
6      print "The␣year␣of␣the␣Rat."
7  endif
8
9  if (year = 1) then
10     print "The␣year␣of␣the␣Ox."
11 endif
12
13 if (year = 2) then
14     print "The␣year␣of␣the␣Tiger."
15 endif
16
17 if (year = 3) then
18     print "The␣year␣of␣the␣Rabbit."
19 endif
20
21 if (year = 4) then
22     print "The␣year␣of␣the␣Dragon."
23 endif
24
25 if (year = 5) then
26     print "The␣year␣of␣the␣Snake."
27 endif
28
29 if (year = 6) then
30     print "The␣year␣of␣the␣Horse."
31 endif
32
33 if (year = 7) then
34     print "The␣year␣of␣the␣Sheep."
35 endif
36
37 if (year = 8) then
38     print "The␣year␣of␣the␣Monkey."
39 endif
40
41 if (year = 9) then
42     print "The␣year␣of␣the␣Rooster."
43 endif
44
45 if (year = 10) then
```

```
46      print "The year of the Dog."
47  endif
48
49  if (year = 11) then
50      print "The year of the Pig."
51  endif
```

Exercise 4 Conditional operations (4+2+8=14 Marks)

Letter Grade

Some schools use a scale like the following to determine the proper letter grade to assign to a student. The letter grade is based on a percentage representing a weighted average of all of the work for the term. Based on the following table, all percentage values must be in the range of 0.0 through 100.0:

Value of Percentage	Assigned Grade
90.0 $\leq$percentage $\leq$ 100.0	A
80.0 $\leq$ percentage $<$ 90.0	B
70.0 $\leq$ percentage $<$ 80.0	C
60.0 $\leq$ percentage $<$ 70.0	D
0.0 $\leq$ percentage $<$ 60.0	F

An algorithm to determine where the range `weightedAverage` falls into could be implemented with unnecessarily long separate if statements.

```
get weightedAverage
set result to  ""
if (weightedAverage > 100)
then set result to "The average is out of range"
endif
if (weightedAverage >= 90.0)
then set result to "A"
endif
if (weightedAverage >= 80.0 AND weightedAverage <= 90.0)
then set result to "B"
endif
if (weightedAverage >= 70.0 AND weightedAverage < 80.0)
then set result to "C"
endif
if (weightedAverage >= 60.0 AND weightedAverage < 70.0)
then set result to "D"
endif
if (weightedAverage >= 0.0 AND weightedAverage < 60.0)
then set result to "F"
endif
print result
```

(a) The algorithm has two errors/missing statements that you should find and fix.

Solution:

- There is a missing condition in the second if statement to avoid that the result `A` will be printed for number that are out of range.

  ```
  if (weightedAverage >= 90.0 AND weightedAverage <= 100)
  ```

- The second mistake is the overalp of the second and third conditions of the if statments. In case `weightedAverage` is equal to 90, the algorithm would print `A` and then `B`.

  ```
  if (weightedAverage >= 80.0 AND weightedAverage < 90.0)
  ```

(b) What is the main disadvantage of the algorithm above after fixing the two errors/missing statements?

Solution:

Independent of the value of `weightedAverage` all conditions of the if statements have to be checked once the algorithm is executed. This leads to an inefficient algorithm.

(c) Rewrite the algorithm to avoid the disadvantage you mentioned in the previous question. **You are not allowed to use compounded conditions.**

Solution:

```
Get wa
if( wa > 100 ) then
        print "out"
else
        if(wa >= 90) then
                print "A"
        else
                if(wa>=80) then
                        print "B"
                else
                        if(wa>=70) then
                                print "C"
                        else
                                if(wa>=60) then
                                        print "D"
                                else
                                        print "F"
                                endif
                        endif
                endif
        endif
endif
```

Exercise 5 Iteration (10 Marks)
Rotation

Write an algorithm that rotates the digits of a 4-digit number (`m`), `n` places to the right and displays the output.

For example

- if `m` is `9732` and `n` is `1`, the output should be `2973`.
- if `m` is `1234` and `n` is `2`, the output should be `3412`.
- if `m` is `5814` and `n` is `3`, the output should be `8145`.

Solution:

```
get m
get n

set i to 1

while(i<= n)
{
   set ones to m%10
   set num to INT(m/10)
   set m to ones*1000 + num
   set i to i+1
}

print m
```

Exercise 6 Iterative algorithms (15 Marks)

ISBN

The International Standard Book Number (ISBN) is a 10 digit code that uniquely specifies a book. The rightmost digit is a checksum digit which can be uniquely determined from the other 9 digits from the condition that $d_1 + 2d_2 + 3d_3 + \ldots + 10d_{10}$ must be a multiple of 11 (here d_i denotes the ith digit from the right).

The checksum digit d_1 can be any value from 0 to 10; the ISBN convention is to use the value X to denote 10.

Example: the checksum digit corresponding to 020131452 is 5 since it is the only value of d_1 between 0 and 10 for which $d_1 + 2 * 2 + 3 * 5 + 4 * 4 + 5 * 1 + 6 * 3 + 7 * 1 + 8 * 0 + 9 * 2 + 10 * 0$ is a multiple of 11.

Write an algorithm that takes a 9-digit integer and computes the checksum, and prints it out. Your algorithm should print `X` if the checksum digit is 10.

Solution:

```
get n
set sum to 0
set i to 2
while (i <= 10) {
        set digit to n % 10
        set sum to sum + i * digit
        set n to  INT(n / 10)
}

if (sum % 11 == 1)
then print "X"
else    if (sum % 11 == 0)
                then print "0"
        else
                print 11 - (sum % 11)
        endif
endif
```

Exercise 7 Conditional operations (4+4+6=14 Marks)
Tracing

Given the following fragment of a Java program

```
int a = 7; int b = 22; int c = 4;
if (b < a) { int t = b; b = a; a = t; }
if (c < b) { int t = c; c = b; b = t; }
if (b < a) { int t = b; b = a; a = t; }
System.out.println("" + a + " " + b + " " + c);
```

(a) Trace the algorithm above and write out what it will print.

Solution:

The algorithm prints

```
4 7 22
```

(b) What does the algorithm do for any three variables `a, b` and `c`.

Solution:

The algorithm sorts the three numbers in ascending order.

(c) Write an algorithm that will do the same for 5 variables `a, b, c, d` and `e`. The algorithm should look similar to the one above for three variables.

Solution:

```
1  public class Sorting {
2          public static void main(String[] args) {
3                  int A = 5;
4                  int B = 22;
5                  int C = 3;
6                  int D = 13;
7                  int E = 1;
8                  int t;
9
10                 if (A > B) { t = A; A = B; B = t; }
11                 if (B > C) { t = B; B = C; C = t; }
12                 if (A > B) { t = A; A = B; B = t; }
13                 if (C > D) { t = C; C = D; D = t; }
14                 if (B > C) { t = B; B = C; C = t; }
15                 if (A > B) { t = A; A = B; B = t; }
16                 if (D > E) { t = D; D = E; E = t; }
17                 if (C > D) { t = C; C = D; D = t; }
18                 if (B > C) { t = B; B = C; C = t; }
19                 if (A > B) { t = A; A = B; B = t; }
20
21         System.out.println("" + A + "␣" + B + "␣" + C + "␣" + D + "␣" + E);
22         }
23 }
```

Exercise 8 Iterative operations (6+4+4=14 Marks)
Tracing

Given the following algorithm

```
get n
set x to 1
set c to 0
while (n >= 1) {
    print x
    set c to c + 1
    set x to 2 * x
    set n to  INT(n/2)
   }
print c
```

(a) Draw the tracing table for `n=19` and write out what the algorithm will print.

Solution:

The algorithm prints the following sequence

```
1 2 4 8 16
```

and prints then `5` which is the length of the sequence.

(b) What is the sequence printed by the algorithm for any `n`?

Solution:

The algorithm prints the power of 2 from 1 to `n`.

(c) What is the value of `c` in terms of `n`?

Solution:

$c = \lfloor log_2(n) \rfloor + 1$ where $\lfloor \ \rfloor$ corresponds to the floor function.

Exercise 9 Java (2+2+2+2+4(Bonus)=8 Marks)

(a) What does the compiler do if you try to write the following expression:

```
double x;
System.out.println(x);
```

Solution:

It is a compile error since the variable is not initialized with a value.

(b) Suppose that a and b are `int` values. What does the following sequence of statements do?

```
int t = a;
b = t;
a = b;
```

Solution:

The variables `a` and `b` will be assigned to the initial value of `a`.

(c) What does the following statement do where `grade` is a variable of type `int`?

```
boolean isA = (90 <= grade <= 100);
```

Solution:

It is a compile error. It has to be written with a compounded condition.

```
boolean isA = (grade >= 90 && garde <= 100);
```

(d) What is wrong with the following if statement?

```
boolean done = false;
if (done = false) {
    ...
}
```

Solution:

A comparison should be done with ==.

(e) Write the **shortest** Java program you can that takes an integer N and print true if $(1 + 2 + \ldots + N)^2$ is equal to $(1^3 + 2^3 + \ldots + N^3)$.

Solution:

```
public static void main(String[] args) {
      System.out.println(true);
}
```

Exercise 10 Iterative operations (6+4=10 Marks)
Tracing

Given the following Java program

```
public static void main(String[] args) {
        int N = 5;
        String s = "";
        int i = 1;
      while (i <= N)  {
             if (i % 2 == 0)
             {
                s = s + i + s;
             }
             else
             {
                s = i + s + i;
           }
             i = i + 1;
        }
        System.out.println(s);
    }
```

(a) Draw the tracing table for `N=5` and mention what will be printed at the end of the execution of the Java program.

Solution:

The algorithm will print `53112113431121135`.

(b) The algorithm prints for any `N` a string with a specific feature. Mention the feature of this string.

Solution:

The string is a palindrome, i.e. a word that reads the same forward as backward.