1 (10%) The Capability Maturity Model for Software (CMM or SW-CMM) was successfully developed by the Software Engineering Institute of Carnegie Mellon University in 1987. Now CMM is considered to be an industrial standard for improving software processes. It is composed of five levels in total according to the degree of maturity. What are the names of the five levels of the CMM? In your own words, briefly describe each.

2 (10%) Direct memory access (DMA) is one of the techniques for data transfer between memory and I/O peripherals.

(a) A DMA read transfers data from _____ to _____. (2%)

(b) A DMA write transfers data from _____to _____. (2%)

(c) State the difference between DMA-controlled I/O and interrupt-driven I/O. (6%)

3 (9%) In general, parameters can be classified into three modes. They can be used to: (1) pass information to a subprogram, (2) receive information from a subprogram, or (3) pass information to a subprogram where it is to be updated before being returned. Thus, what would be the effect of the *whichmode*(*a*[*element*]) when the parameters are passed by (a) by value, (b) by reference, and (c) by name?

```
....
var element: integer;
 a: array [1..2] of integer;

procedure whichmode(x: ? mode integer);
begin
 a[1] := 6;
 element := 2;
 x := x + 3
end;

begin
 a[1] := 1; a[2] := 2;
 element :=1;
 whichmode(a[element]);
 .....
```

Mechanism	Results		
	a[1]	*a*[2]	*element*
Call by value			
Call by reference			
Call by name			

4 (6%) A Software inspection is a formal verification technique in which software life-cycle work products are examined in detail by a group of peers for the explicit purpose of detecting and identifying errors. As a member of the inspection team, you could save the programmers a lot of testing time by finding the errors during the inspection. The following program has three separate errors, each of which would cause an infinite loop. Please find the errors and explain why they need to be corrected.

```
void Increment(int);
int main()
{
     int count = 1;
     while(count < 10)
          cout << " The number after " << count;  /* Function Increment
          Increment(count);                          adds 1 to count */
          cout << " is " << count << endl;
          return 0;
```

5 (8%) A wheel of fortune has the integers from 1 to 25 placed on it in a random manner. Show that regardless of how the numbers are positioned on the wheel, there are three adjacent numbers whose sum is at least 39.

6 (8%) For $n \geq 1$, show that if $n \geq 64$, then n can be written as a sum of 5's and /or 17's.

7 (8%) Validate the statement $[(p \rightarrow q) \wedge (\neg r \vee s) \wedge (p \vee r)] \rightarrow (\neg q \rightarrow s)$.

8 (8%) Let A be a set with $|A| = n$, and let R be a relation on A that is antisymmetric. What is the maximum value for $|R|$? How many antisymmetric relations can have this size?

9 (11%) This problem is about the process synchronization. In Bakery Algorithm, the process receives a *number* before entering its critical section. Is the number unique? Please explain your answer.

10 The Tower of Hanoi problem is as follows: We are given a tower of n disks, initially stacked in increasing size on the 1st peg. We have three pegs. The objective is to transfer the entire tower to the 3rd peg, moving only one disk at a time and never put a larger one onto a smaller one.

(a) (10%) Please write a recursive algorithm in pseudo code to solve the Tower of Hanoi problem. Please use the following variable: *D(i)* is the disk with size *i*. Therefore, *D(n)* is the disk with the largest size. *P(j)* is the *jth* peg. You need to move the entire tower from *P(1)* to *P(3)*.

(b) (12%) Assume that you have 4 pegs, you need to move the entire tower from *P(1)* to *P(4)*. please design a recursive algorithm in pseudo code to solve the Tower of Hanoi problem with four pegs. The total moving steps in your algorithm must be as small as possible.