國立臺北科技大學 104 學年度碩士班招生考試

系所組別：2300 資訊工程系碩士班

第三節　程式設計　試題

注意事項：

1. 本試題共七題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Problem 1 [6%]

In both of the two recurrences shown below, it is assumed that $T(1) = d$ for some constant d. State, using the "big oh" notation, the solution to each of the two recurrences shown below. **Just state the answer - you do not need to justify them.**

(1) (3 pts) $T(n) = 10T\left(\frac{n}{3}\right) + 5n^2$

(2) (3 pts) $T(n) = 8T\left(\frac{n}{2}\right) + 5n^3$

Problem 2 [11%] Answer the following questions about priority queue:

(1) (3 pts) Please give the abstract data type (ADT) of priority queue.

(2) (3 pts) Describe how to use a priority queue to sort n elements.

(3) (5 pts) One can use a sorted list, unsorted list, and heap to implement a priority queue. Please give the definition of a minimum heap. Furthermore, please list the time complexity of all the major operations when a priority queue is implemented by the above three mentioned approaches, respectively.

Problem 3 [14%] Please answer each of the following problems shortly and concisely.

(1) (3 pts) Are there graphs for which Prim's algorithm is faster than Kruskal's algorithm?

(2) (4 pts) Give an algorithm that determines whether or not a given undirected graph $G=(V,E)$ contains a cycle. Your algorithm should run in $O(|V|)$ time, independent of $|E|$.

(3) (7 pts) Please use dynamic programming approach to find a longest common subsequence of the following two sequences: SLWOVNNDK, ALWGQVNBBK.

Problem 4 [18%, each 3%]

Consider the following C++ program that implements the exception handling of entering score. Please trace this program and answer problems 4-1~4-6 with the correct statements. The output of this program is: 0, 99, 100, input an Integer, {0..100}, {0..100}, 89.

```
#include <iostream>
#include <stdexcept>
#include <string>
using namespace std;
class RangeException: public runtime_error{
public:
   RangeException(string msg):
        runtime_error(msg){}
};
class NumberException: public runtime_error{
public:
   NumberException():
      runtime_error("input an Integer"){}
};
class Student {
public:
   int parseInt(string);
   void inputScore(string str[]);
private:
   int _____;          //----------(4-1)
};
int Student::parseInt(string str){
   int sum=0, i=0;
   if (str.at(i)=='-') {
       sum=_____;      //----------(4-2)
       i++;
   }
   for (; i<str.length(); i++) {
      if ((str.at(i)<'0')||(str.at(i)>'9'))
         throw NumberException();
      sum=sum*____+(str.at(i)-'0');//(4-3)
   }
   if (sum>100||sum<0)
      throw RangeException("{0..100}");
   return sum;
}
void      Student::inputScore(string
str[]){
   bool valid=true;
   int i=0;
   _____ {          //--------(4-4)
      valid = true;
      _____ {       //--------(4-5)
         score = parseInt(str[i++]);
      } catch (NumberException e) {
         // Java e.getMessage()
         cout<<e.what()<<",";
         valid = false;
      } catch (RangeException e){
         cout<<e.what()<<",";
         valid = false;
      }
   }while(_____);    //-----(4-6)
   cout<<score;
}
void main() {
  Student s;
  string p[]={"p1","-1","101","89"};
  cout<<s.parseInt("0")<<",";
  cout<<s.parseInt("99")<<",";
  cout<<s.parseInt("100")<<",";
  s.inputScore(str);
}
```

Problem	Answer
4-1	
4-2	
4-3	
4-4	
4-5	
4-6	

Please copy the above answer table to your answer sheet.

注意：背面尚有試題

Problem 5 [15%, each 3%]

Given two points (x1, y1) and (x2, y2) in the x-y coordination system, the slope-intercept form of the mathematical models of nonvertical straight lines is: y=(m1/m2)x+(b1/b2), where m1 = y1-y2, m2 = x1-x2, b1=x2*y1-x1*y2, and b2 = x2-x1. Consider the following C program that implements the slope-intercept form. Please trace this program and answer problems 5-1~5-5 with the correct statements. The output of this program is: ERROR, x -1, y = -x + 1, y = x, y = 3 x -2, y = x + 1, y = 2/3 x + 1, y = 1/4 x + 3/4.

```
#include <stdio.h>
#include <math.h>
void equation(int x1, int y1, int x2, int
y2) {
  int m, b, m1, m2, b1, b2;
  if ((x1==x2) &&(y1==y2))
    printf("ERROR,");
  if (x1==_____) {          //------(5-1)
      printf("x=%d,", x1);
  }
  else if (y1==y2) printf("y=%d,");
  else {
    m1 = y1-y2;          m2 = x1-x2;
    b1 = x2*y1-x1*y2; b2 = x2-x1;
    printf("y = ");
    if ((m1<0)&&(m2<0))
        {m1=-m1; m2=-m2;}
    if (m1==m2) {}
    else if (m1==(_____))    //---(5-2)
        printf("-");
    else if (m1%m2==_____) { //---(5-3)
        m=m1/m2;
        printf("%d ", m);
    }
    else {printf("%d/%d ", m1, m2);}
    printf ("_____");      //----(5-4)
    if (b1*b2>0)
        printf("_____"); //-----(5-5)
    if (b1==0) { printf(",");}
    else if (b1%b2==0) {
       b=b1/b2;
       printf("%d,", b);
    }
    else {printf("%d/%d,", b1, b2);}
  }
}
int main() {
    equation(1, 0, 1, 0);
    equation(1, 0, 0, -1);
    equation(1, 0, 0, 1);
    equation(1, 1, 2, 2);
    equation(1, 1, 2, 4);
    equation(2, 3, 4, 5);
    equation(0, 1, 3, 3);
    equation(1, 1, 5, 2);
    return 0;
}
```

Problem	Answer
5-1	
5-2	
5-3	
5-4	
5-5	

Please copy the above answer table to your answer sheet.

Problem 6 [18%, each 3%]

Given the program below in C. Please trace the program and fill the **6-1~6-6** blanks with the printf output of each statement.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

enum COLOR {RED, YELLOW, GREEN=10, BLUE};
typedef struct item {
        int data;
        struct item *link;
} ITEM_t;

void test01(int a, int b, int c) {
    printf("%d\n", a&b|c);                    /*    Problem 6-1    */
}

void test02(int a[], int size){
    int x;
    if (a[0]==0 && a[1]==a[2])      x=a[0];
    else if (!a[0] || a[1]==a[2])   x=a[1];
    else    x=a[2];
    printf("%d\n", x);                        /*    Problem 6-2    */
}

void test03(int a[], int size){
    int x=0, i, j;
    for (i=0; i<size; i++){
        for (j=i; j<size; j++)
            x+=a[j];
    }
    printf("%d\n", x);                        /*    Problem 6-3    */
}

void test04(int *p, int *q, int *r) {
    int **a=&p, **b=&q, **c=&r;
    a = &q;  b = c;
    printf("%d\n", **a + **b + **c);          /*    Problem 6-4    */
}

char* test05(enum COLOR x) {
    char *str;
    str = (char *)malloc(10);
    switch (x) {
      case RED: strcpy(str,"red");
           break;
      case YELLOW: strcpy(str,"yellow");
           break;
```

```
        case GREEN: strcpy(str,"green");
        case BLUE: strcpy(str,"blue");
             break;
        default: strcpy(str,"error");
             break;
    }
    return str;
}

void test06(int y, ITEM_t **top) {
    ITEM_t *x;
    x = (ITEM_t *) malloc(sizeof(ITEM_t));
    x->data = y;
    x->link = (*top);
    (*top) = x;
}

int main() {
    int a=2, b=3, c=4, i, array[]={0,1,2,3,4};
    char *str1, *str2;
    ITEM_t *top=NULL;
    test01(a, b, c);
    test02(array, 3);
    test03(array, 3);
    test04(&array[0], &array[1], &array[2]);
    str1=test05(2);
    str2=test05(10);
    printf("%s %s\n", str1, str2);              /* Problem 6-5     */
    for(i=0;i<5; i++)
        test06(array[i], &top);
    printf("%d\n", top->link->data);            /* Problem 6-6     */
    return 0;
}
```

Problem	Answer
6-1	
6-2	
6-3	
6-4	
6-5	
6-6	

Please copy the above answer table to your answer sheet.

Problem 7 [18%, each 3%]

Please trace the following C++ program and provide the results of the cout statements.

```
#include <iostream>
using namespace std;
class Polygon {
    protected:
        int width, height;
    public:
        virtual void setup (int w, int h) { width=w; height=h; }
        void name() { cout << "Polygon" <<endl; }
        virtual int area() = 0;
};
class Rectangle: public Polygon {
    public:
        void name(){ cout << "Rectangle" <<endl; }
        virtual int area() { return (width * height); }
};
class Triangle: public Polygon {
    public:
        void name() { cout << "Triangle" <<endl; }
        int area() { return (width*height/2); }
};
class Square : public Rectangle {
    protected:
        int width;
    public:
        void setup (int w) { width=w; }
        void name(){ cout << "Square" <<endl; }
        int area() { return (width * width); }
        Square(){ width=3; }
};
void main(){
    Rectangle *rectangle = new Rectangle;
    Triangle *triangle = new Triangle;
    Square *square = new Square;
    Rectangle * ptr_polygon1 = rectangle;
    Triangle * ptr_polygon2 = triangle;
    Square  * ptr_polygon3 = square;
    ptr_polygon1->setup(2,2);
    cout << ptr_polygon1->area() << endl;   // problem 7-1
    cout << ptr_polygon3->area() << endl;   // problem 7-2
    Rectangle * ptr_polygon4 = ptr_polygon3;   ptr_polygon4->setup(4,4);
    cout << ptr_polygon4->area() << endl;   // problem 7-3
    ptr_polygon2->name();                   // problem 7-4
    ptr_polygon3->name();                   // problem 7-5
    ptr_polygon4->name();                   // problem 7-6
}
```

Problem	Answer
7-1	
7-2	
7-3	
7-4	
7-5	
7-6	

Please copy the above answer table to your answer sheet.