April, 2008

Fundamental IT Engineer Examination (Afternoon)

Questions must be answered in accordance with the following:

Question Nos.	Q1 – Q5	Q6 , Q7	Q8 , Q9
Question Selection	Compulsory	Select 1 of 2	Select 1 of 2
Examination Time	13:30 – 16:00 (150 minutes)		

Instructions:

1. Use a pencil.　If you need to change an answer, erase your previous answer completely and neatly.　Wipe away any eraser debris.

2. Mark your examinee information and test answers in accordance with the instructions below.　Your answer will not be graded if you do not mark properly.　Do not mark or write on the answer sheet outside of the prescribed places.

 (1) **Examinee Number**

   Write your examinee number in the space provided, and mark the appropriate space below each digit.

 (2) **Date of Birth**

   Write your date of birth (in numbers) exactly as it is printed on your examination admission card, and mark the appropriate space below each digit.

 (3) **Question Selection**（**Q6-Q7** and **Q8-Q9**）

   Mark the Ⓢ of the question you select to answer in the "Selection Column" on your answer sheet.

 (4) **Answers**

   Mark your answers as shown in the following sample question.

 [Sample Question]

   In which month is the spring Fundamental IT Engineer Examination conducted?
   Answer group:

   a) March   b) April   c) May   d) June

   Since the correct answer is "b)" (April), mark your answer sheet as follows:

 [Sample Reply]

SQ	a	b	c	d
1	Ⓐ	●	Ⓒ	Ⓓ

Do not open the exam booklet until instructed to do so.

Q1. Read the following description and then answer the Subquestions 1 through 3.

Project Plan for "ITPEC" question bank is just finished. You may require to present ITPEC council members about the project for their approval about project plan. According to the initial project plan, time frame of the project is 45 days with resource allocated for the project. Estimated Cost of the project is $9,000.

The following table describes the data about the planning of the projects.

No.	Activity	Predecessor	Duration	Std. Deviation
1	Requirement Study	-	7	0.82
2	Architecture Design	1	5	0.58
3	HardwareSelection	2	5	0.82
4	System Design	1	5	0.58
5	Program Development	4	18	1.41
6	Integration Testing	5	5	0.58
7	System Testing	6	5	0.82
8	Hardware Installation	3	10	1.41
9	Hardware Testing	8	7	0.82
10	Implementation	7,9	5	1.00

There is possibility that ITPEC council members would ask to reduce the project time as question preparation for next exam is very near. Followings are some additional information regarding the reducing of project time.

1. Requirement Study can be reduced by 2 days if you use one more software engineers. Extra cost of the engineers will cost $1,200

2. Program development activities can be reduced to 15 days if additional 5 programmers are allocated for the projects. Usage cost of the 5 programmers is $1,500

3. Integration Testing can be reduced by 1 day at the cost of $1000

4. System Testing can be reduced by 2 days at the cost fo $2,000

5. Hardware Installation can be reduced to 5 day with extra cost of $500

6. Hardware Testing time can be reduced 3 days with extra cost of $600

Subquestion 1

What are the important activities you need to emphasis to meet schedule?

Answer group
    a) 1, 2, 4, 5, 7, 10
    b) 1, 3, 7, 8, 9, 10
    c) 1, 4, 5, 6, 7, 10
    d) 1, 5, 6, 8, 9, 10

Subquestion 2

Duration of each task is average value estimated using $(a + 4m + b)/6$ formula. The Standard Deviation measures how spread the estimation from Duration. The higher the value of standard deviation, the lesser the possibility to be finished in time.

Which activity has the highest risk level to finish project as per plan?

Answer group
    a) Hardware Installation
    b) Implementation
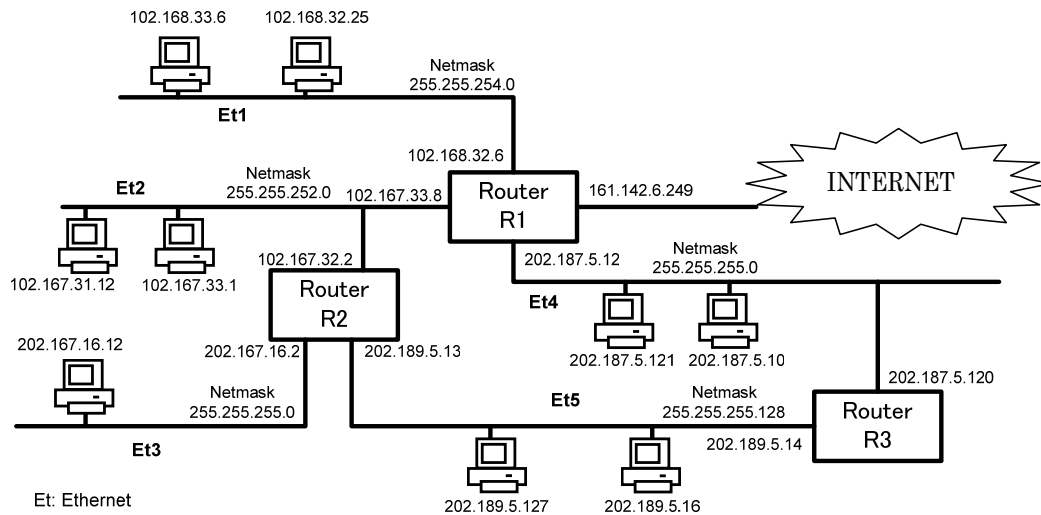   c) Program Development
    d) Requirement Study

Subquestion 3

ITPEC Council Member asked to reduce project time but Budget for reducing of project time is limited to $3,000. Maximum, how many days can you reduced project time?

Answer group
    a) 3 days
    b) 5 days
    c) 9 days
    d) 11 days

Q2. Read the following description and then answer the Subquestions 1 through 3.

We have several segments of networks which are connected using several routers as in Figure below.   Each segment may have tens PCs depending on the given netmask. Here, the given netmask and the IP address of each connection to the router are correct.

102.168.33.6   102.168.32.25

Netmask
255.255.254.0

Et1

102.168.32.6

Netmask   INTERNET
Et2   255.255.252.0   102.167.33.8   Router   161.142.6.249
                                        R1

102.167.31.12   102.167.33.1   102.167.32.2   Router   202.187.5.12   Netmask
                                              R2   255.255.255.0

202.167.16.12   202.167.16.2   202.189.5.13   Et4

202.187.5.121   202.187.5.10

Netmask   Netmask   202.187.5.120
255.255.255.0   Et5   255.255.255.128   Router
                                                  R3
Et3   202.189.5.14

Et: Ethernet   202.189.5.127   202.189.5.16

Figure

Subquestion 1

Identify two PCs in which the IP address are wrongly configured.

Answer group

```
a. 102.167.31.12
b. 102.167.33.1
c. 102.168.32.25
d. 102.168.33.6
e. 202.167.16.12
f. 202.187.5.10
g. 202.187.5.121
h. 202.189.5.127
i. 202.189.5.16
```

Subquestion 2

What is the range of IP addresses that can be used in LAN **Et2**?

Answer group

Q 2.1

   From:

   a. 102.167.31.1

   b. 102.167.32.1

   c. 102.167.33.1

   d. 102.167.34.1

   e. 102.167.35.1

Q 2.2

   To:

   a. 102.167.31.254

   b. 102.167.32.254

   c. 102.167.33.254

   d. 102.167.34.254

   e. 102.167.35.254

Subquestion 3

Other than the default routing entry and the two entries shown below, what are the other three routing entries for the routing table of router R2?　Here, the other routers are correctly and optimally configured.

Two entries in the routing table of router R2:

```
Nw 202.187.5.0 nm 255.255.255.0 gw 102.167.33.8
Nw 202.189.5.0 nm 255.255.255.128 gw 202.189.5.13
```

Answer group

Q 3.1

   a. Nw 102.168.32.0 nm 255.255.254.0 gw 102.167.33.8
   b. Nw 102.168.32.0 nm 255.255.254.0 gw 102.168.32.6
   c. Nw 102.168.32.0 nm 255.255.255.0 gw 102.168.33.8
   d. Nw 102.168.32.0 nm 255.255.255.0 gw 102.168.32.6

Q 3.2

   a. Nw 102.167.31.0 nm 255.255.252.0 gw 102.167.33.8
   b. Nw 102.167.32.0 nm 255.255.252.0 gw 102.167.33.8
   c. Nw 102.167.33.0 nm 255.255.252.0 gw 202.167.32.2
   d. Nw 102.167.32.0 nm 255.255.252.0 gw 202.167.32.2

Q3.3

   a. Nw 202.167.16.0 nm 255.255.255.0 gw 202.167.16.12
   b. Nw 202.167.16.0 nm 255.255.255.0 gw 202.167.32.2
   c. Nw 202.167.16.0 nm 255.255.255.0 gw 202.167.16.2
   d. Nw 202.167.16.0 nm 255.255.255.0 gw 202.189.5.1

Q3. Read the following description and then answer the Subquestions 1 through 4.

In cryptography, RSA is an algorithm for public-key cryptography. RSA involves a public key and a private key. The public key can be known to everyone and is used for encrypting messages. Messages encrypted with the public key can only be decrypted using the private key. The RSA algorithm is as follows:

1) **Set up**
   1.1 First, select two prime numbers: **p** and **q**
   1.2 Compute **n** value i.e. $n = p \times q$
   1.3 Compute **totient function of n** ($\phi(n)$) i.e. $\phi(n) = (p-1) \times (q-1)$
   1.4 Find **e** which meets the followings:
       $1 < e < \phi(n)$,
       e and $\phi(n)$ has the greatest common divisor as 1.

2) **Public-key** is (**n**, **e**)

3) **Private key** is **d**, that is computed from
   $d \times e = 1 \bmod \phi(n)$
   i.e., find the number **d** so that the remainder of ($d \times e$) divided by $\phi(n)$ to be 1.

4) **Encrypt** message (M) to cipher text (C) by $C = M^e \bmod n$

5) **Decrypt** cipher text (C) to message (M) by $M = C^d \bmod n$

Alice is going to send number "7" (=message M) to Bob using RSA for encrypting her data.

Assume that the initial prime numbers **p** and **q** for this algorithm is "2" and "5", respectively.

Subquestion 1

What is the possible public key that Alice sends to Bob?

Answer group

a)   (4, 3)

b)   (4, 6)

c)   (10,3)

d)   (10,6)

Subquestion 2

From the public key in Subquestion 1, what is the cipher text that Alice sends to Bob?

Answer group

a)   2

b)   3

c)   7

d)   8

Subquestion 3

From the public key in Subquestion 1, what is the private key that Bob uses to decrypt data?
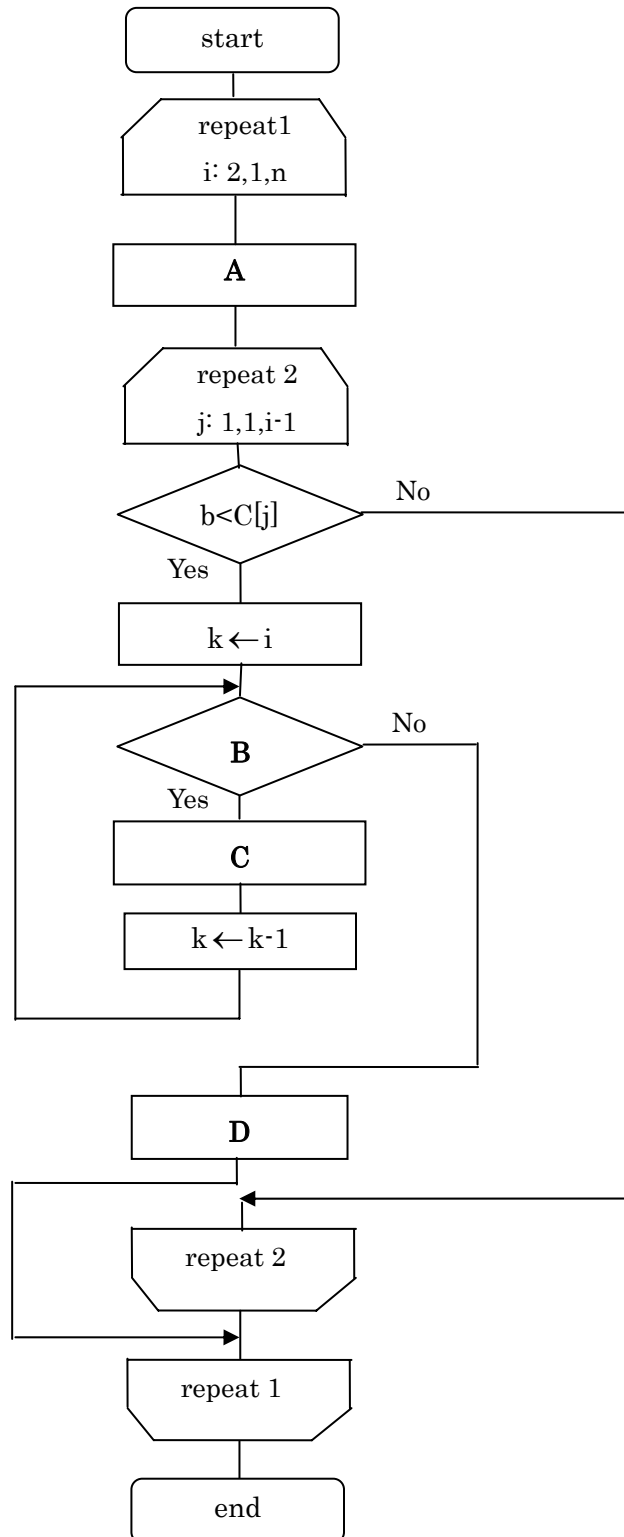
Answer group

a)   3

b)   4

c)   5

d)   6

Subquestion 4

Which one in the following cannot be a cipher text when public key and private key in the previous are used?

Answer group

a)   7

b)   8

c)   9

d)   10

Q4. Read the following description and then answer the Subquestions 1 through 3.

The idea of Insertion sort is to insert an element in unsorted sub-array into sorted sub-array. At first, the sorted sub-array has one element. The following algorithm must sort the data C(1), C(2), …, C(n) in ascending order by Insertion sort method.

Here:

n	number of elements in an array
C( )	an array containing data
i	index of first element of unsorted subarray. The first value, step and final value for the index are given by the notations `i:2,1,n` in Start-loop box.
j	index of any element of sorted subarray. The first value, step and final value for the index are given by the notations `j:1,1,i-1` in Start-loop box.
k	additional index which is used for moving elements one position to the right
b	additional variable which is used for storing the first element of unsorted subarray

Subquestion 1

Select correct operations that must be in the steps marked by A, B, C and D respectively in the above algorithm.

Answer group for A

a)   b ← C(i)

b)   C (1) ← 0

c)   j ← 1

d)   i ← 1

Answer group for B

a)   i > j

b)   i = j

c)   k < i

d)   k > j

Answer group for C

a)   C (k) ← C(k-1)

b)   b ← C(i)

c)   C(k-1) ← C(k)

d)   C(i) ← 1

Answer group for D

a) b ←C(i)

b) C(j) ← b

c) j ← i

d) i ← j

Subquestion 2

Find correct sequence of iterations when this algorithm works for a given array C=(5,2,4,6,1,3) .

Answer group

a) (1, 2, 4, 6, 5, 3), (1, 2, 4, 6, 5, 3), (1, 2, 3, 6, 5, 4), (1, 2, 3, 4, 5, 6), (1, 2, 3, 4, 5, 6)

b) (1, 5, 2, 4, 6, 3), (1, 2, 5, 4, 6, 3), (1, 2, 3, 5, 4, 6), (1, 2, 3, 4, 5, 6), (1, 2, 3, 4, 5, 6)

c) (2, 5, 4, 6, 1, 3), (2, 4, 5, 6, 1, 3), (2, 4, 5, 6, 1, 3), (1, 2, 4, 5, 6, 3), (1, 2, 3, 4, 5, 6)

d) (5, 2, 4, 6, 1, 3), (5, 2, 4, 1, 3, 6), (5, 2, 1, 3, 4, 6), (5, 1, 2, 3, 4, 6), (1, 2, 3, 4, 5, 6)

Subquestion 3

When an array with **n** elements is sorted into non-decreasing order by insertion sort method, comparison operation of two elements in the array is done   M   times in the worst case. Then, find this number M.

Answer group

a)   (n+1)(n+2)

b)   n(n+1)

c)   n(n-1)/2

d)   n

Q5. Read the following description concerning programming design, and then answer Subquestions 1 through 3.

Company X develops an order controlling system. As a part of the system, there is a program which enables the customers to query when the articles are shipped and to display the result on a screen, after they ordered.

[Description of the system]

(1) Customer code, password, zip code, address, name, and phone number are registered to the customer table, having the customer code is as the key of the table. The key is shown underlined in the table.

The record format of the customer table

Customer code	Password	Zip code	Address	Name	Phone number

(2) A customer orders 1 – *n* kind(s) of article per order. The content of the order is registered in the order table. The order number is allocated uniquely and automatically by the system. "Number of statements" is the number of the order statements.

The record format of the order table

Order number	Date of order	Customer code	Number of statements *n*	Order statement 1		...	Order statement *n*	
				Article code	Number of order	...	Article Code	Number of order

(3) Manufacturing department staff extract the records whose date of order are the day before from the order table everyday at the start time, and begin to manufacture the articles.   The "necessary days" to complete an article depend on the kind of the article, and the necessary days for each article are set in the article table.   When the necessary days is 1, they manufacture the article in one day, i.e., they complete the article on the day when they begin.

The record format of the article table

Article code	Article Name	Unit value for sale	Necessary days

(4) Manufacturing department staff print delivery slips per order number on the day when they completed all the articles in one order.
(5) They ship the articles based on the delivery slips on the next day of the day when they print the delivery slips.   The necessary day(s) for delivery of the articles to the customer depend on the residence area of the customer, and the necessary day(s) for delivery from the shipment are set in the delivery area table.   When the necessary days for delivery is 1, the articles are delivered to the customer in one day, i.e., the articles are delivered to the customer on the same day when they ship.

The record format of the delivery area table

Zip code	Name of delivery area	Necessary days for delivery

(6) The order, manufacturing, and shipment are in operation 365 days a year.

[Program Description]

(1) When a customer starts the program, the input window is shown.
(2) The program stores the current date in the variable "Date of Processing", and 0s in the variable "Maximum Necessary Days" and in the variable "Delivery Days to Customer".   "Maximum Necessary Days" is used to store the number of the days which it takes to complete manufacturing of all the articles in one order.
(3) The customer inputs the customer code and the password.
(4) The program reads the record from the customer table, having the inputted customer code as the key.

(i) If the record does not exist, the program outputs the error message of error code ER1, shown in the Table 1, to the window, and terminates.

(ii) If the record exists and the password does not match, the program outputs the error message ER1 to the window, and terminates.

(iii) If the record exists and the password matches, the program reads the delivery area table, having the zip code of the record as the key, and stores the delivery days in "Delivery Days to Customer".

(5) The customer inputs the order number.

(6) The program reads the record from the order table, having the inputted order number as the key.

(i) If the record does not exist, the program outputs the error message of the error code ER2 to the window, and terminates.

(ii) If the record exists, the program compares the customer code in the record and the inputted customer code. If the two customer codes are equal, the program searches the article table with the article codes, as many numbers as the statement, gets the maximum necessary days among the ordered articles, and stores it in "Maximum Necessary Days".   If the two customer codes are not equal, the program outputs the error message of the error code ER3 to the window, and terminates.

Table 1   Error Messages

Error code	Message
ER1	Error: ⌷ A ⌷ or the password does not match.
ER2	Error: This ⌷ B ⌷ does not exist.
ER3	Error: ⌷ C ⌷

(7) The program counts the difference between the date of processing and the date of order.

(i) If the difference is less than or equals to "Maximum Necessary Days", the program outputs the replying message of the replying code RP1, shown in the Table 2, to the window and terminates.

(ii) If the difference is more than "Maximum Necessary Days", the program outputs one of the three messages of replying codes of RP2, RP3, or RP4 to the window, and terminates.

Table 2   Replying messages

Replying code	Message
RP1	Not shipped yet: The articles will be shipped in $\texttt{SSS}$ days, and delivered to you in $\texttt{TTT}$ days.
RP2	Already shipped: The articles will be delivered to you in $\texttt{TTT}$ days.
RP3	Already shipped: The articles are being delivered to you today.
RP4	Already delivered to you: The articles are supposed to have delivered to you.

(8)   The structure of the program is shown in the figure below.
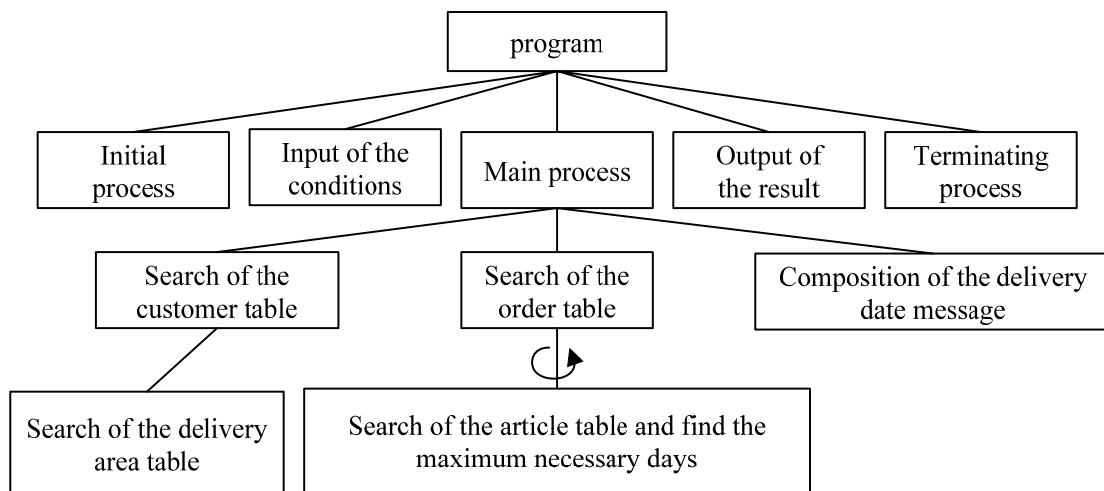
Figure   The structure of the program

Subquestion 1

"Search of the article table and find the maximum necessary days" in the figure is processed repeatedly. From the answer group below, select the correct answer as the number of search of the article table, when no error occurs.

Answer Group

a) The averaged number of the statements of all the records in the order table.

b) The maximum number of the necessary days in the article table.

c) The number of statements of the record matched in the order table.

d) The total number of the records in the article table.

e) The total number of the records in the order table.

Subquestion 2

From the answer groups below, select the correct answers to be inserted in the blanks ☐☐☐☐☐☐ in the Table 1.

Answer Groups for A and B

a) Article code b) Customer code c) Order number

d) Password e) Phone number f) Zip code

Answer group for C

a) The order number is not correct.

b) The zip code to your address is not correct.

c) There is no article matched in this order.

d) We cannot get the maximum necessary days of the article in this order.

Subquestion 3

From the answer groups below, select the correct answers to be inserted in the blanks [____] in the following descriptions concerning the Table 2.

(1) Let "Maximum Necessary Days" be α, and "Delivery days to Customer" be β. Following is an example, when the date of order is October 1, $\alpha = 3$, and $\beta = 4$.

The starting date of manufacturing: October 2

The shipping date: October 5

The delivering date of the article to the customer: October 8

(2) The replying code RP1 shows the status that the ordered articles have not shipped yet. The value of the message content SSS is given as the result of the calculation of [D], and the value of TTT as the result of the calculation of [E]. Here f (x, y) is a function which calculate the days from the date of order x to the date of processing y. When $x = y$, $f(x, y) = 0$.

(3) The replying code RP2 shows the status that the ordered articles have already shipped, and they have not been delivered to the customer.

(4) The replying code RP3 shows the ordered articles are to be delivered to the customer on the date of processing. When the number of the days between the date of order and the date of processing is equal to the result of [F], this message is outputted.

(5) The replying code RP4 shows that the ordered articles have already been delivered to the customer before the date of processing.

Answer Groups for D and E

a) $\alpha - f(x, y) - 1$ b) $\alpha - f(x, y)$

c) $\alpha - f(x, y) + 1$ d) $\beta - f(x, y) - 1$

e) $\beta - f(x, y)$ f) $\beta - f(x, y) + 1$

g) $\alpha + \beta - f(x, y) - 1$ h) $\alpha + \beta - f(x, y)$

i) $\alpha + \beta - f(x, y) + 1$

Answer group for F

a) α b) $\alpha + \beta$ c) $\alpha + \beta + 1$

d) $\alpha + \beta - 1$ e) β

Q6. Read the following description of a C program and the program itself, and then answer the Subquestions 1and 2.

[Program Description]

An elementary geometric problem is to determine if two line segments intersect or not. The figure below illustrates the test cases in determining if two line segments intersect or not.
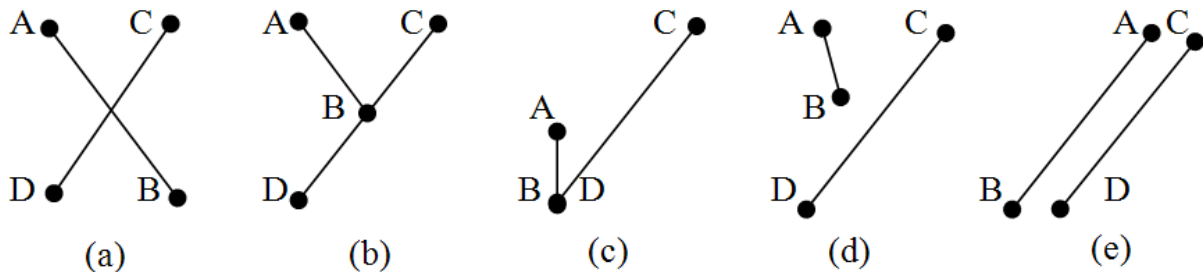
Both cases (a) and (b) are clearly seen to be intersecting. For case (c), we assume that the line segments are closed thus line segments having common endpoints are considered to be intersecting. For case (d), even if the line segments would intersect based on its slope, they do not intersect. Case (e) clearly shows that the line segments do not intersect.

An approach in solving this problem is to consider three points, A, B and C, where A and B are endpoints of one line segment and C is the endpoint of the other line segment, then consider the direction when traveling from point A to B and B to C, whether it is clockwise or counter-clockwise.

Given two line segments with endpoints A-B and C-D, the line segments are said to intersect if and only if both the travel direction of both line segment race are opposite. Meaning A-B-C and A-B-D are opposite and C-D-A and C-D-B are also opposite, as in case (a). Cases (b) and (c) have the end point in the other line segment, which is consider also opposite to the other endpoint outside the line segment. Case (d) only has opposite directions for line segment A-B, while case (e) has the same directions for both segment tests.

[Program]

```c
#include <stdio.h>

/* The function ccw accepts a line represented by its endpoints  */
/* (x0, y0) - (x1, y1) and a single point (x2, y2). It then      */
/* computes if the single point is running clockwise or counter- */
/* clockwise to the line. It returns -1 if clockwise, 1 if        */
/* counter-clockwise and 0 if the single point is on the line.    */

int ccw (int x0, int y0, int x1, int y1, int x2, int y2) {

        int dx1, dy1, dx2, dy2;
        int ans;

        dx1 = x1 - x0;
        dy1 = y1 - y0;
        dx2 = x2 - x0;
        dy2 = y2 - y0;

        if ((dx1*dy2) > (dy1*dx2)) ans = 1;
        if ((dx1*dy2) < (dy1*dx2)) ans = -1;
        if ((dx1*dy2) == (dy1*dx2)) {
              if (((dx1*dx2) < 0) || ((dy1*dy2) < 0))
                    ans = -1;
              else {
                    if ((dx1*dx1+dy1*dy1) >= (dx2*dx2+dy2*dy2))
                          ans = 0;
                    else
                          ans = 1;
              }
        }
        return ans;
}

int intersect (int x10, int y10, int x11, int y11,
               int x20, int y20, int x21, int y21) {
        int ans;
```

```
        if ((( ccw (x10,y10,x11,y11,x20,y20) *

             ccw (x10,y10,x11,y11,x21,y21))  [  A  ]  0) &&

            ((ccw (x20,y20,x21,y21,x10,y10) *

             ccw (x20,y20,x21,y21,x11,y11))  [  B  ]  0))

             ans = 1;  else ans = 0;
        return ans;
}


int main () {
        int x10, y10, x11, y11;
        int x20, y20, x21, y21;
        int ans;

        x10 =  0; y10 =  0;
        x11 = 20; y11 = 20;

        x20 = 120; y20 = 100;
        x21 = 100; y21 = 120;

        ans = intersect (x10, y10, x11, y11, x20, y20, x21, y21);

        printf ("Line (%d, %d)-(%d, %d) and ", x10, y10, x11, y11);
        printf ("line (%d, %d)-(%d, %d) ", x20, y20, x21, y21);

        if ( [  C  ] )

             printf (" does not ");
        printf ("intersect.");
        return 0;
}
```

Subquestion 1

From the answer groups below, select the correct answers to be inserted in the blanks
in the above program.

Answer group for A

    a) >=   b) !=
    c) <=   d) ==

Answer group for B

    a) >=   b) !=
    c) <=   d) ==

Answer group for C

    a) ans == 1   b) ans == 0
    c) ans == -1

Subquestion 2

What is the return value of `ccw(0, 0, 1, 0, -1, 0)`? From the answer group below, select
the correct answer.

Answer group

    a) 1   b) 0
    c) -1

Q7. Read the following description of a Java program and the program itself, and then answer the Subquestion.

[Program Description]

A subclass is a class that derives from another class. A subclass inherits state and behavior from all of its ancestors. The term superclass refers to a class's direct ancestor as well as all of its ascendant classes. If your method overrides a method in its superclass, you can use the keyword *super* to bypass the overridden version in the subclass and invoke the version in the superclass.

The *Object* class which is at the top of the Java class hierarchy provides a number of useful methods for all objects to use. For example, Object provides a method by which one object may *compare* itself to another object, a method to *convert* an object to a string, a method to *wait* for a specified condition to occur, a method to *notify* other objects that a condition has changed, and a method to *return* a Class object that describes *the class* of the object. Classes that you define will all inherit the *equals()* method from the Object class. You can use this method to compare two objects for equality. Note that it is not the same as comparing two object references using the == operator. That test simply determines if two object references point to the same object.

The output from the program 1:

```
In main
Incoming parameter is false
Overridden method invoked
Incoming parameter is true
Base-class method invoked
```

The output from the program 2:

```
obj1 equals obj1: true
obj1 equals obj2: true
obj1 equals obj3: false
obj1 equals obj4: false
```

[Program 1]

```
class Base
{
        void myMethod(boolean superFlag)
        {
                System.out.println("Incoming parameter is " + superFlag);
                System.out.println("Base-class method invoked");
        }
}


class TestSuper extends Base
{
        void myMethod(boolean superFlag)
        {
                if(superFlag)
                    [        A        ] ;
                else
                {
                  System.out.println("Incoming parameter is " + superFlag);
                  System.out.println("Overridden method invoked");
                }
        }

        public static void main(String[] args)
        {
            TestSuper obj = new TestSuper();
            System.out.println("In main");
            obj.myMethod(false);
            obj.myMethod(true);
        }
}
```

[Program 2]
```
class TestEquals
{
        private int myData;

        TestEquals(int data)
        {
              myData = data;
        }

        public int getMyData()
        {
              return myData;
        }

        public boolean equals(Object arg)
        {
              if( (arg != null) && (        B        ))
              {
                    return (this.myData ==        C        );
              }
              else return false;
        }

        public static void main(String[] args)
        {
           TestEquals obj1 = new TestEquals (2);
           TestEquals obj2 = new TestEquals (2);
           TestEquals obj3 = new TestEquals (3);
           String  obj4 = "A string object";

           System.out.println("obj1 equals obj1: " + obj1.equals(obj1));
           System.out.println("obj1 equals obj2: " + obj1.equals(obj2));
           System.out.println("obj1 equals obj3: " + obj1.equals(obj3));
           System.out.println("obj1 equals obj4: " + obj1.equals(obj4));
        }
}
```

Subquestion

From the answer groups below, select the correct answers to be inserted in the blanks ☐ in the above programs.

Answer group for A

    a) `this.super.myMethod(superFlag)`   b) `super.this()`

    c) `super()`   d) `super.myMethod(superFlag)`

Answer group for B

    a) `arg instanceof TestEquals`   b) `arg == TestEquals`

    c) `arg == this.TestEquals`   d) `arg.equals(this)`

Answer group for C

    a) `arg`   b) `arg.myData`

    c) `arg.getMyData()`   d) `((TestEquals)arg).myData`

Q8. Read the following description of a C program and the program itself, and then answer the Subquestion.

[Program Description]

This subprogram obtains the critical path, the sequence of project network activities which add up to the longest overall duration (any delay of an activity on the critical path directly impacts the planned project completion date, i.e. there is no float on the critical path). This determines the shortest time possible to complete the project.

(1) Subprogram `CriticalPath` obtains and outputs the critical path from point 0 (departure point) to point N-1 (destination) using PERT network expressed as a directed graph with N number (N>1) of points, as shown in Figure 1 bellow.
In Fig. 1, each activity which constitutes a project is expressed by an arrow and is given a name. An activity name is placed above the arrow and duration for the activity is placed under the arrow. A connection point (circle) is given to the both ends of the arrow and a number is put in the circle. This circle is called a **node**. There must be relationship between the predecessor node number and the successor node number: Predecessor node number < Successor node number.
When there are multiple activities between two nodes, define a non-existent activity with zero time and zero cost represented by a dotted-line between these nodes. This activity is called a **dummy activity** which is used only to show the precedence relationship between a number of activities.

(2) This Subprogram uses the following arrays. The values of elements i and j are 0, 1, 2,..., N-1 and correspond to the various points.

Edge[i][j]: This array element denotes the duration for the activity starting at the point i and ending at the point j. The value of the element is -1 when does not exist the arrow from the node i to the node j.

For example in the Figure 1, Edge[0][1] = 25, Edge[1][2] = 40, Edge[1][3] = 20, Edge[2][3] = 0, Edge[2][4] = 50, Edge[3][4] = 30, Edge[4][5] = 20. The values of remaining elements are –1.

ET[i]: This array element is for storing the earliest node time. It is the earliest possible time to start an activity at node i. It is "the time at which an activity can be started at the node if the predecessor activities are started as early as possible".

LT[i]: This array element is for storing the latest node time. It is the latest possible time to start an activity at node i without delaying the completion of the project beyond its earliest possible completion time"

(3) The procedure for obtaining the critical path is as follows:

i) Forward computation: Calculates the earliest node time at each node and duration of the whole project, starting with the initial node and working forward through the network towards the final node.

- Starting with the value 0 at the initial node (node number 0).

- Then, the earliest node time at each node is calculated as the maximum of cumulative durations of all its predecessor activities.

ii) Backward computation: Calculates the latest start time of each activity without extending the optimum duration of the whole project, starting with the final node and moving backward through the network toward the initial node.

- Starting with the value earliest node time at the last node (node number N-1)

- Then, the latest node time at each node is calculated as minimum of subtractions of the successor activity durations from the latest node time of the last node.

iii) Critical Path Method: A **critical path** is a path through the network where all of the nodes have no delay allowance, i.e., latest node time = earliest node time.

Since a critical path is a path with zero slack, a delay in the time of any critical path activity results in a delay in the project completion time.

(4) Subprogram CriticalPath uses the subprogram Update_ET, which update earliest node time at the given node, and subprogram Update_LT, which update latest node time at the given node.

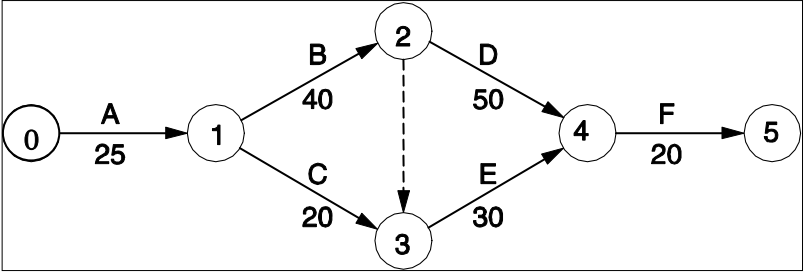(5) The output result for the PERT Network in the Figure 1 is given in the Figure 2.

Figure 1. Example of PERT network.

0
1
2
4
5

Figure 2. Output result for the PERT network in Figure 1.

[Program]

```c
#define MAX 100

void update_ET(int);

void update_LT(int);

void CriticalPath();

int N, Edge[MAX][MAX], ET[MAX], LT[MAX];


void CriticalPath()
{
    int i, j;


    for (i = 0; i < N; i++) ET[0] = 0;

    for (i = 1; i < N; i++) update_ET(i);

    for (i = 0; i < N; i++) LT[i] = ET[N-1];

    for (i = N - 1; i >= 0; i--) update_LT(i);

    for (i = 0; i < N; i ++)

      if (ET[i] == LT[i]) printf("%d\n", i);

}


void update_ET(int i)
{
    int j;

    for (j = 0; j < i; j++)

      if( |    A    | && ( |    B    | )) |   C   | ;

}
```

```
void update_LT(int i)

{

    int j;

    for (j = N - 1; j > i; j--)
        if(    D     && (    E     )) [    F    ] ;

}



// test CriticalPath()
main()
{
    int i, j;

    N = 6;
    for (i = 0; i < N; i++)
        for (j = 0; j < N; j ++) Edge[i][j] = -1;
            Edge[0][1] = 25;
            Edge[1][2] = 40;
            Edge[1][3] = 20;
            Edge[2][3] = 0;
            Edge[2][4] = 50;
            Edge[3][4] = 30;
            Edge[4][5] = 20;
            CriticalPath();
}
```

Subquestion

From the answer groups below, select the correct answers to be inserted in the blanks [   ] in the above program.

Answer group for A and D

a) `Edge[i][j] != -1`

b) `Edge[i][j] != 0`

c) `Edge[j][i] != -1`

d) `Edge[j][i] != 0`

Answer group for B and E

a) `ET[i] + Edge[i][j] > ET[j]`

b) `ET[i] + Edge[j][i] > ET[j]`

c) `ET[j] + Edge[j][i] > ET[i]`

d) `LT[i] - Edge[i][j] < LT[j]`

e) `LT[i] - Edge[j][i] < LT[j]`

f) `LT[j] - Edge[i][j] < LT[i]`

Answer group for C and F

a) `ET[j] = ET[i] + Edge[i][j]`

b) `ET[i] = ET[j] + Edge[j][i]`

c) `ET[j] = ET[i] + Edge[j][i]`

d) `LT[i] = LT[j] - Edge[i][j]`

e) `LT[j] = LT[i] - Edge[i][j]`

f) `LT[j] = LT[i] - Edge[j][i]`

Q9. Read the following description and a Java program itself, and then answer the Subquestion.

The java class is written to be used for master mind game.

Rule of the game is as follows: the program generates 4 digits random number, but the program doesn't show the number. You need to guess the hidden number by reaching the correct answer within specified attempts.

In each guess, the program evaluates your guess and the hidden number and gives you hint for the next guess.
As shown in Figure 1, if a digit you guessed appears in the hidden number at the same position, the program displays '*'. If a digit you guessed appears in the hidden number but at the different position, the program displays '!'.

Your guess	3	4	5	6
Hidden number	2	4	6	8
Output		*	!	

Figure 1

At the start of the game, the program automatically generates the number as a secret. You have to enter your guess and the response follows.　A sample output is shown in Figure 2.

```
Please Guess four Hidden Digits
Enter Your Guess: 4567
*
Enter Your Guess: 4576
*
Enter Your Guess: 3487
!!
Enter Your Guess: 4387
*!
Enter Your Guess: 4873
**
Enter Your Guess: 4573
*
Enter Your Guess: 4856
**
Enter Your Guess: 4849
**
YOU LOST
CORRECT ANSWER IS 4801
```

Figure 2

[Program 1]

```java
import java.util.*;

public class MasterMind {

    private static int    defaultmaxAllowTime = 8;
    private static int    QuizzLength = 4;
    private static char   allCorrect='*';
    private static char   numberCorrect='!';

    public enum State {PROGRESS, LOST, WIN }


    private String        hiddenNumber;
    private State         GameState;
    private int           maxAllowTime ;
    private ArrayList      attemptList;
    private String        CorrectAnswer=new String();

    public MasterMind() {

      GameState =  State.PROGRESS;
      hiddenNumber = generateHiddenNumber();
      maxAllowTime = defaultmaxAllowTime;
      for(int i=1;i<=QuizzLength;i++){
       CorrectAnswer = CorrectAnswer + allCorrect;
      }

      attemptList = new ArrayList();
    }

    public String getHiddenNumber(){
        return hiddenNumber;
    }

    public boolean  isProgress(){return GameState==State.PROGRESS;}
    public boolean  isGameOver(){return GameState==State.LOST;}
    public boolean  isWon(){return GameState==State.WIN;}
```

```java
private String generateHiddenNumber(){

    Random rand = new Random();
    return      String.format("%04d", rand.nextInt(10000));
}


public String getResult(){
    [                        A                        ] ;
    return ans.getResult();
}


public void evaluateResult(Answers Ans){
    if( [                    B                    ] ){
            Ans.setResult(matchResult(Ans.getAnswer()));
            this.attemptList.add(Ans);
    }
    changeGameStatus(Ans);
    }


private void changeGameStatus(Answers paraAttmpt){

    if (attemptList.size() < maxAllowTime){
        if ( [              C              ] )
            GameState=State.WIN;
    }
    else
        GameState = State.LOST;
}


public String matchResult(String inputNumber){

    char [] inChar;
    char [] hidChar;
    String rtnValue    = new String();

    inChar = inputNumber.toCharArray();
    hidChar = hiddenNumber.toCharArray();
```

```java
        for (int i=0;i < hiddenNumber.length();i++){
            if (inChar[i]==hidChar[i]){
                inChar[i] = '#';//mark the character is already used
                rtnValue= rtnValue + this.allCorrect;
            }
            else
               for (int j=0;j < hiddenNumber.length();j++){
                   if (               D               ){
                       inChar[j] = '#';//mark the character is already used
                       rtnValue=rtnValue + this.numberCorrect;
                       break;
                   }
               }
        }
        return rtnValue;
    }
}


 public class Answers{

     private String Answer;
     private String Result;

     public Answers(String ans){
           this.Answer= new String(ans);
           Result= new String();
     }

     public String getResult(){return this.Result;}
     public String getAnswer(){return this.Answer;}
     public void setAnswer(String Answer){this.Answer = Answer;}
     public void setResult(String Result){this.Result = Result;}

 }
```

[Program 2]

```java
import java.io.*;

public class MasterMindGame {

public static void main(String[] args) throws IOException {

   MasterMind mGame = new MasterMind();
   displayScreen();

    while (mGame.isProgress()){

      System.out.print("Enter Your Guess : ");
      ┌─────────────────────── E ───────────────────────┐ ;
      System.out.print(mGame.getResult()+"\n");
   }


   if (mGame.isWon()) System.out.print("YOU WIN");
   else
   {
     System.out.print("YOU LOST \n");
     System.out.print("CORRECT ANSWER IS " + Game.getHiddenNumber());
    }
   }


   public  static void displayScreen(){
      System.out.println("Please Guess four Hidden Digits");
   }


   private static String acceptNumber() throws IOException {
      BufferedReader br =
            new BufferedReader(new InputStreamReader(System.in));
      return br.readLine();


   }
}
```

Subquestion

From the answer groups below, select the correct answers to be inserted in the blanks ☐ in the above program.

Answer group for A

a) `Answers ans = (Answers) attemptList.get(attemptList.size()-1)`

b) `Answers ans = (Answers) attemptList.get(attemptList.size())`

c) `Answers ans = attemptList.get(attemptList.size()-1)`

d) `Answers ans = attemptList.get(attemptList.size())`

Answer group for B

a) `attemptList.size()==maxAnswer && GameState==State.PROGRESS`

b) `attemptList.size()<=maxAnswer && GameState==State.PROGRESS`

c) `attemptList.size()<=maxAnswer && isProgress()`

d) `isProgress()`

Answer group for C

a) `paraAttmpt.getResult().equals(CorrectAnswer)`

b) `paraAttmpt.getResult()==(CorrectAnswer)`

c) `paraAttmpt.getResult().equals(allCorrect)`

d) `this.getResult().equals(allCorrect)`

Answer group for D

a) `inChar[i]==hidChar[i]`

b) `inChar[i]==hidChar[j]`

c) `inChar[j]==hidChar[i]`

d) `inChar[j]==hidChar[j]`

Answer group for E

a) `mGame.attemptList.get(attemptList.size()-1).setResult(acceptNum ber())`

b) `mGame.changeGameStatus(acceptNumber())`

c) `mGame.evaluateResult(acceptNumber())`

d) `mGame.evaluateResult(new Answers(acceptNumber()))`