EE4001/IM2001 Software Engineering -Tutorial 1

1) Verify the correctness of the following sentences and give your answers in the form "true" and "false":
   a) Abstraction is a fundamental problem solving activity that focuses on essential aspects and ignore unessential aspects of a problem.
   b) Modeling allows us to develop a machine independent solution (a logical model) through focusing on the important aspects of a problem before programming starts.
   c) A logical model excludes all the physical characteristics (e.g., details that are only specific to implementation) of a problem and its solution.
   d) Mathematics can be used in modeling.
   e) Modeling uses concepts and notations that have precise meaning.
   f) An algorithm operating on its required data structure forms a logical model for a computer program.

2) Discuss the one key difference between: (a) software development and hardware manufacturing; (b) software maintenance and hardware maintenance.

3) Identify a suitable prescriptive process model for developing software under each of the following situations:

   a) A moderate size system with well-defined requirements and sufficient manpower to develop.
   b) A large system with well-defined requirements and insufficient manpower to develop.
   c) The users themselves are not sure about their requirements of a system.
   d) A small system that requires intensive user interaction and the users are not sure about their requirements.
   e) A large, complex and high-risk system and the users are not sure about their requirements.
   f) A system to implement a solution that will be developed by a research project.

4) List the key criteria for deciding the appropriateness of the four prescriptive software process models.

5) Identify the most suitable concept from the four basic concepts, entity type, relationship type, instance of entity type and instance of relationship type, in Entity-Relationship (ER) modeling to model each following item:

   a) The structure of student information.
   b) The information of the supplier IBM.
   c) Dr CK Lee teaches OO Programming.
   d) Doctor treats Patient.
   e) Subject.

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Tutorial 2

1) From the definitions of basic concepts, interpret the ER diagram shown in Figure 1 precisely.

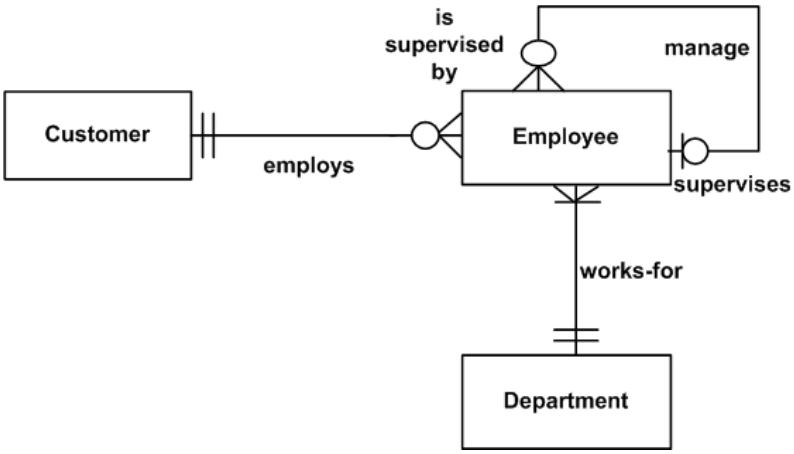

Figure 1. An ER diagram

2) Draw an entity-relationship diagram to model the following information:

   A student may take many courses possibly none. Each course is enrolled with many students and taught by one lecturer. Each lecturer teaches at least one course.

3) In a university, each undergraduate student must take at least one subject. A subject may have some tutorial and/or lab classes. Except those subjects are purely for lab work, a subject is lectured by some professors. Each tutorial class is taught by one professor. A professor may lecture multiple subjects concurrently. He/she may also teach some tutorial classes and/or supervise some lab classes concurrently. Each lab class is supervised by some professors and/or research students. Professors who are holding senior management positions may not involve in these teaching activities. Draw an entity-relationship diagram to model the information described. You may make reasonable assumption and state them clearly if needed.

4) A physician serves many patients who subscribe to their own insurance carrier. Each patient is always served by the same physician and is subscribed to one insurance carrier. Clearly, many patients may subscribe to the same insurance carrier. The physician needs to keep information about all the treatments that a patient has received so far. A treatment may include taking of multiple drugs. Many treatments may include the same drug. All the drugs kept in the clinic have been included in some treatments before. Draw an entity-relationship diagram to model the information described. Please make assumption on the attributes of

each entity type and include them in the diagram. You may make other assumptions and state them clearly if needed.

5) Identity the most suitable concept from the four basic concepts, process, external entity, data flow and data store, in Data Flow Diagramming (DFD) technique to model each following fact separately:

   a) All employee particulars kept in a company.
   b) Compute monthly commission.
   c) Total monthly sales reported by a salesman.
   d) A type user, payroll clerk.

6) Figure 2 is a data flow diagram. Draw a data flow diagram to model each following process in Figure 2:

   (i) Process 1: It has three sub-processes; four internal data flows, L, M, N and O; and a data store DSA that is local to the process.
   (ii) Process 2: It has three sub-processes and two internal data flows, I and P. It does not have any data store that is local to the process.
   (iii) Process 3: It has three sub-processes; four internal data flows, F, G, R and S; and a data store DSB that is local to the process.

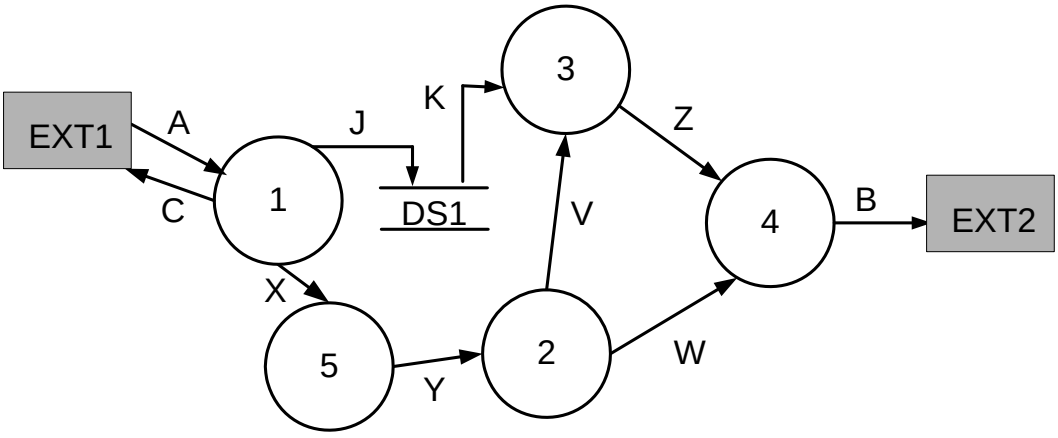

Figure 2. A data flow diagram

EE4001/IM2001 Software Engineering
Tutorial 3

1. Check the data flow diagrams shown in Figure A and B to verify their correctness. List all the errors found.

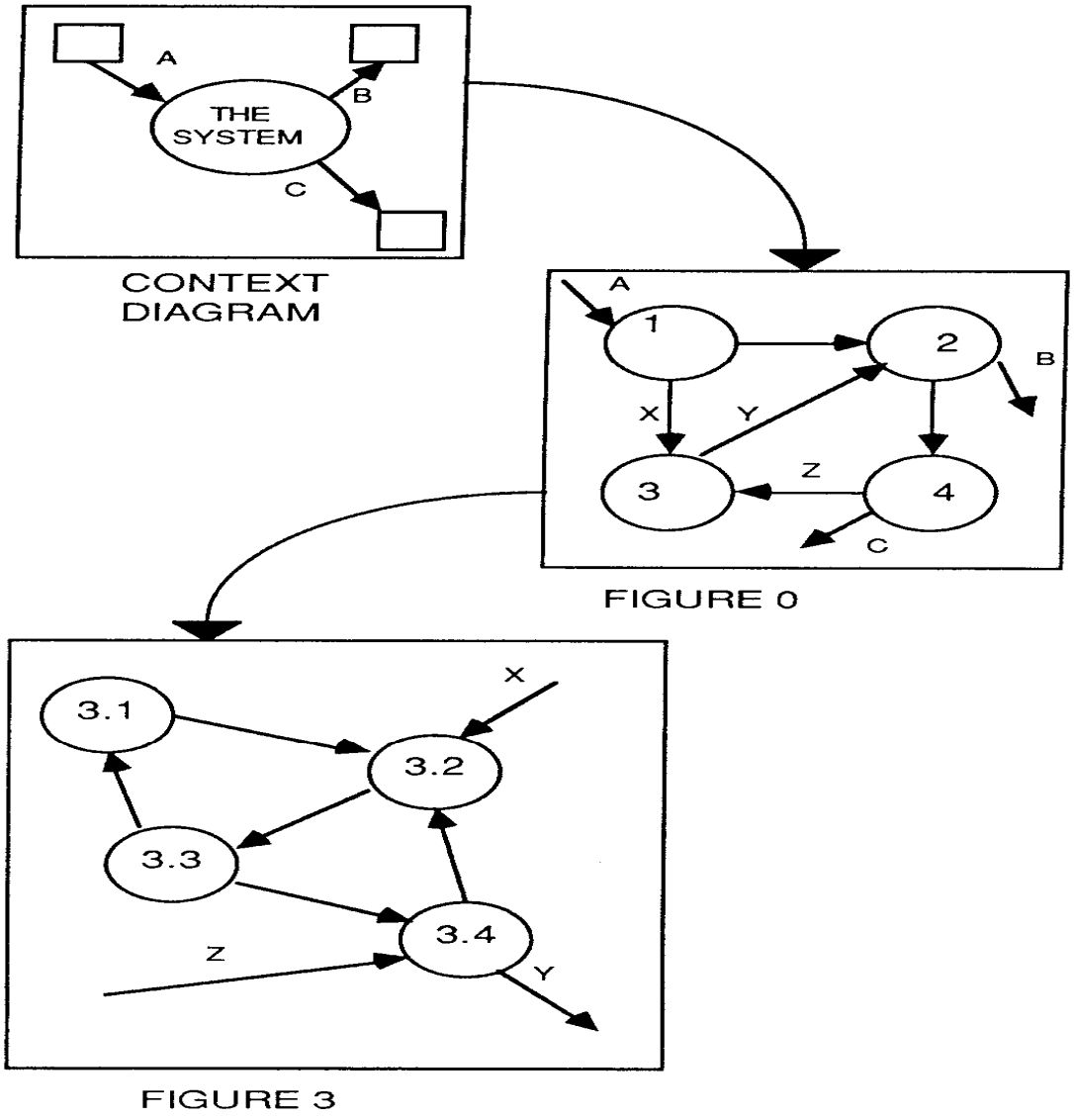

Figure. A

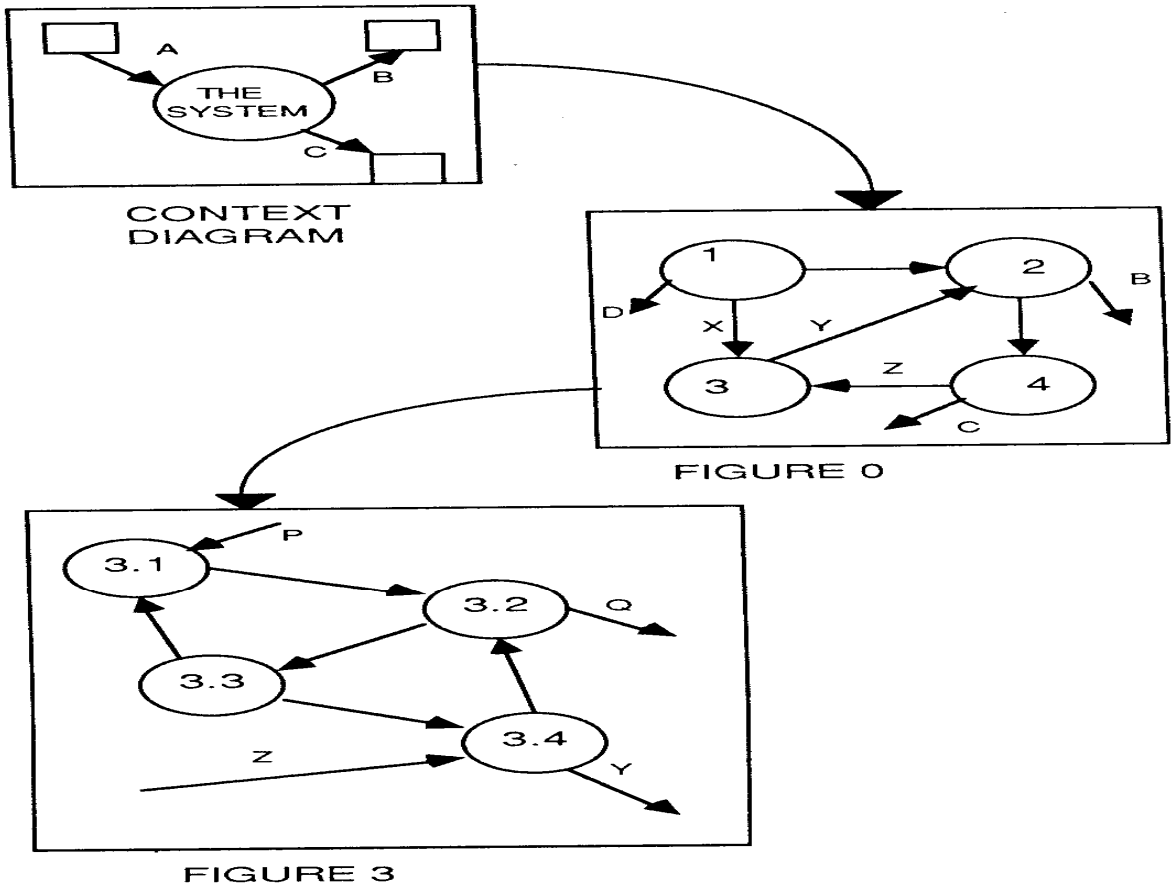

Figure. B

2. Draw a DFD for a distance education university. The enrolment process works as follows:

   Students send in an application form containing their personal details, and their desired course. The university checks that the course is available and that the student has necessary academic qualifications. If the course is available and suitable, the student is enrolled in the course, and the university confirms the enrolment by sending a confirmation letter to the student. If the course is unavailable the student is sent a rejection letter.

3. The authentication and validation of customer and the validation of the requested transaction performed by a bank autoteller machine (ATM) are carried out as follows:

(1) The validation operation requires inputs from the customer's card, from the customer (in the form of the personal identification number or PIN) and from a network directory. The first two of these are used to authenticate the customer's identity, while the third ensures that the card (which may be issued by a different financial institution) is acceptable to the machine.
(2) The outputs from the above process are then concerned with either acceptance (proceeding to the selection of the required transaction by the customer) or rejection (which may involve returning or retaining the card). Even if permission is given to proceed further with the transaction, there will be a further validation process involved to ensure that: (a) the transaction selected is permitted for this customer; (b) the validity of customer account and adequate balance for the withdrawal.
(3) The processing of the accepted transaction is carried out by process ATM transaction. This process will dispense cash or send completion message to customer depending on the type of transaction. The details of this process are excluded from this question.

Furthermore, the authentication and validation of the customer includes checking the readability of card, reading of details from card, checking of expiry date and the right bank group, and requesting the entering of PIN from the customer for checking with maximum of three attempts provided.

Draw the context diagram, the level-1 diagram and a level-2 diagram for the details of the authentication and validation of the customer. Does DFD cover control flow (that is the sequence, selection and iteration of processes)? Use this case as an example to explain.

4. Identify the most suitable basic concept from the seven concepts, class, operation, association, aggregation, generalization, object and instance of association, in Object-Oriented modeling to model each of the following:

a) Robert Tan.
b) Employee.
c) Compute interest.
d) Dentist treats Patient.
e) Chapter is part of a book.
f) Postgraduate students can be classified into research and course work students.
g) City Development bids for a piece of land.

5. Prepare a class diagram for a graphical document editor that supports grouping, a concept used in a variety of graphical editors. Assume that a document is composed of several sheets. Each sheet contains drawing objects, including text, geometrical objects and groups. A group is simply a set of drawing objects, possibly including other groups. A group must contain at least two drawing objects. A drawing object can be a direct member of at most one group. Geometrical objects include circles, ellipses, rectangles, lines and squares.

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Tutorial 4

1 Draw a class diagram to model the following structural properties in the Order Processing System in a company:

Customers place orders with the company to purchase products that are sold by the company. A customer may have none or multiple orders placed. Each order is always placed by one customer. It may have single or multiple order items. Each item is to purchase one product. An order item could be fully fulfilled, partially fulfilled or outstanding (completely unfulfilled). Periodically, an invoice is raised to bill the customer for the order items that have been fully fulfilled.

2. **Diagnostic Test on the Basic OO Concepts:** Based on the class diagram shown in Figure 1 and 2, state the correctness of the following statements and justify your answers:

(i) In R1, each C1 object is associated with at most one C2 object.

(ii) In R1, different C1 instances may associate to the same C2 instance.

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(iii) Each instance of R1 associates a C1 object to a C2 object.

(iv) Some instances of F1 may not be part-of any D1 instance.

(v) Each instance of E1 is an instance of D2.

(vi) Each instance of D2 is an instance of E1 or E2.

(vii) We can add multiplicity notations to the generalization between D2, E1 and E2.

(viii) At a particular point in time, R3 may only have one instance.

(ix) When G2 and G3 both have some instances, it is not necessary for R3 to have some instances.

(x) The number of D2 instances can be greater than the sum of numbers of instances of E 1 and E2.

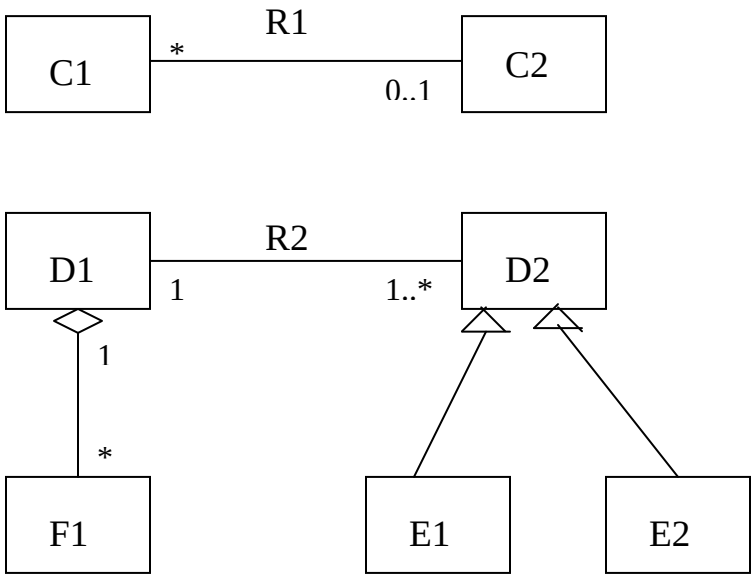

Figure 1. A class diagram

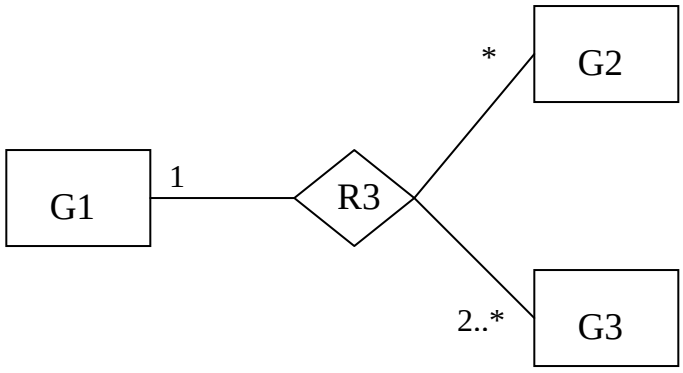

Figure 2. A class diagram

3. From the definitions of basic concepts, interpret the class diagram shown in Figure 3 precisely.

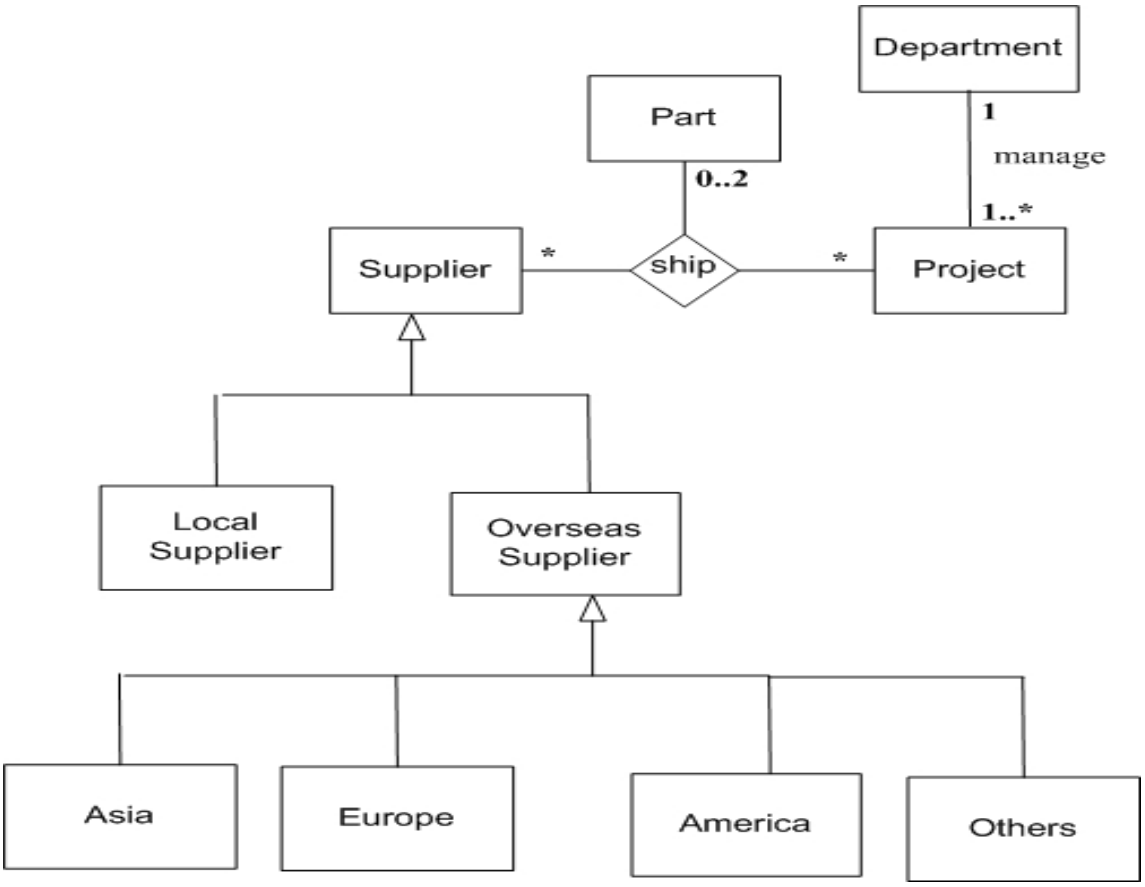

Figure 3. A class diagram

4.In the class diagram shown in Figure 4, let the number of instances of G1, G2, G3 and G4 be m, n, p and q (all greater than zero) respectively. Prove that $n \geq 2*m$ and $m \geq p$.

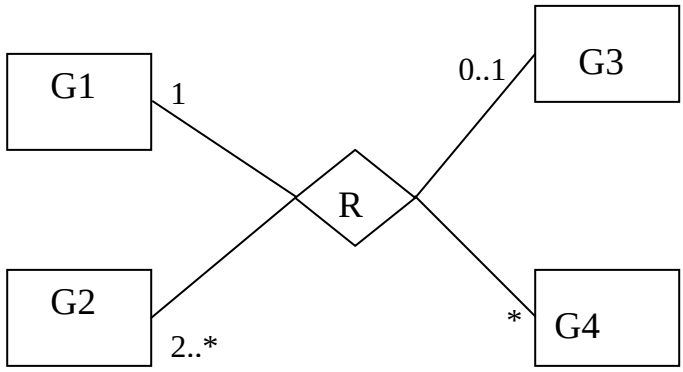

Figure 4. A class diagram

EE4001/IM2001 Software Engineering
Tutorial 5

1) Draw a use case diagram for the following library system:

   The library stores various items that can be borrowed, including books and journals. Books can be borrowed by both staff and students, but only staff members can borrow journals. When users borrows a book, their loan details are checked to ensure that they have no overdue books on loan, and have not already borrowed the maximum permitted number of books.
   Users can check their own loan details at any time. Librarians are permitted to check the loan details of any user.
   Library users can reserve books that are currently out on loan. If three reservations have already been made for a given book, and a further reservation is made, a new copy will be ordered by the librarian.

2) In a project, scheduling payments to supplier invoices via bank is one of the requirements. Payments are scheduled by sending an electronic request to the bank. All the payments are scheduled by an Accountant in the Account Department. If all the goods and services billed in an invoice have been received and the invoice is consistent with the order sent earlier, then the account will decide whether to schedule payment to the invoice. If all the goods and services billed in an invoice have been received, but the invoice is inconsistent with the order, an invoice rejection note must be sent to the supplier. Write a use-case description (only use-case name, primary actor, goal in context, preconditions, scenario and exceptions are required) for the schedule payment use-case.

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Tutorial 6

1. A lamp has two filaments, one of 100 W and another of 50 W. A single switch controls the lamp so that a sequence of cord pulls will turn the lamp from being off to providing illumination at 50 W then 100 W then 150 W then back to off. Externally, there are four behaviors (off, 50 W, 100 W, and 150 W). The event flow outputs have different implications for the system depending on when they occur. For example, turning the 50 W filament on may change the lamp from off to 50 W or it may change the lamp from 100 W to 150 W. Draw a state diagram (with actions accompanied with transitions shown) to model the lamp. You may make additional assumption and state them clearly if needed.

2. Draw a state diagram to model the following lifecycle of the data structure Array that has a maximum size:

   Initially, an empty array is created. After an array is created, an element can be inserted into the array each time so long as it has not reached the maximum size. Once, the array has reached its maximum size, any attempt to insert an element into the array will return with a rejection error message. When the array has some elements, each time, an element can be removed from it. Any attempt to remove an element from an empty array will return with a rejection error message.

3. In a country, all employees must participate in a saving scheme to support their retirement. The minimum age of an employee is 18. An employee must save a certain percent of his/her monthly salary according to the following tables:

Salary/Month / **Age**	**≤ 750**	**above 750**
18 ≤ Age ≤ 35	8%	13% with salary ceiling at 5000
35 < Age ≤ 55	5%	10% with salary ceiling at 5000
Age > 55	0%	5% with salary ceiling at 5000

   The amount to be saved for each month is computed by a program based on the above parameters as its input variables. Use equivalence class testing to design a test suite to test this program.

4. Use boundary value testing based on both input and output conditions to design a test suite to test the program specified in the question 1.

5. The monthly commission to be paid a sales executive is computed by a program according to his/her monthly sales of company's own product and agency product denoted by S and T respectively according to the following formula:

$$\begin{aligned} \text{Monthly Commission} &= S*0.01 + T*0.01 && \text{if } S \geq T \\ &= S*0.01 + T*0.005 && \text{if } S < T \end{aligned}$$

This program accepts S and T as its input from users. Both S and T must be nonnegative. That is $S \geq 0$, $T \geq 0$.

Use cause-effect testing technique to design a test suite to test this program, through constructing a decision table with minimal number of basic conditions.

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Tutorial 7

1. Describe the key differences between black-box testing and white-box testing.

2. Draw a control flow graph for the program shown in Figure 1 (specified in pseudocode), identify a basis set of linearly independent paths through the program and use the basis path testing technique to design a set of test cases. Note that the input to this program is x and y.

```
begin
    read (x);
    read (y);
    while x ≠ y loop
        if x > y then
            x := x – y;
        else
            y := y – x;
        end if;
     end loop;
     gcd := x;
end;
```

Figure 1. The pseudocode of a program

3. For the program shown in Figure 1 (specified in pseudocode), use both the statement and branch coverage testing techniques to design a set of test cases each. For a test suite that has only one test case, predict the possible of branch coverage in term of percentages.

4. (a) Draw a control flow graph for the program specified in Figure 2 (in pseudocode). And, use the basis path testing technique to design test cases to test the program.

```
read (i, y, g)
a := 1
b := 1
while (i < 100) do
        c := i + 1
        z := f()
        if (y < 0) then
            a := 2
            b := 2
        else
            a := 3
            b := 3
        endif
        if (g = 0) then
           a := a + 1
           b := b + 1
        endif
        i  := i + 1
        y := y + c
endwhile
print(g, a, b)
```

Figure 2. The pseudocode of a program

(b) In the control flow graph drawn by a student, the following first six statements in Figure 2 are represented by one node:

```
read (i, y, g)
a := 1
b := 1
while (i < 100) do
        c := i + 1
        z := f()
```

Is the control flow graph correct? Please justify your answer clearly.

5. Figure 3 shows a control flow graph (CFG) of a program without showing its code. Based on this CFG, compute the following:

   i) The total number of paths through the CFG for the following three cases:

      Case 1: do not go through the loop in the CFG at all.
      Case 2: do not repeat the loop (i.e., go through the loop at most one time).
      Case 3: repeat the loop at most one time (i.e., go through the loop at most two times).

   ii) The possible branch coverage for a test suite that has only one test case.

   iii) Without considering path feasibility, the number of test cases in a minimal test suite designed from statement coverage testing technique.

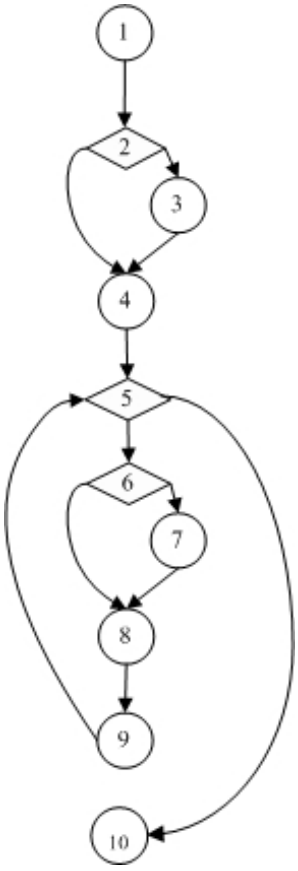

Figure 3. A control flow graph (CFG)