Software Engineering Assignments

Instructions:

Even though you will be submitting only the problem assigned to you, you are expected to solve the entire set of problems for your practice. Practice is very important to learning the skills in software engineering. This is especially true for the skill of arriving at good design.

You need to submit the following for the problem assigned to you:

- Functional requirements specification
- Structured analysis and Structured design (SA/SD)
- UML models: Use case diagrams, Class diagrams, State-chart diagrams.

Copying of assignments will be viewed seriously. Both the person copying and the one supplying the copy will be penalized.

Tips for solution:

- If you cannot solve a problem, solve a simpler problem (by omitting some of the functionalities, details,etc.)
- Now, add some of the functionalities you had omitted and see if you can solve this new problem. It may not be always possible to incrementally add solutions for the new functionalities without any alterations to the simpler solution. You might often have to rework (or drastically modify) your simpler solution to accommodate the new functionality.
- Surely, it is more laborious to do these incremental solutions than solving the problem in one shot. But, it often works, and gives you new insights into the problem.

Prob No. 0: Graphics Editor:

Those who are not familiar with any graphics editor, please look at the Graphics Drawing features available in either MS-Word or Powerpoint software. You can also examine any other Graphical Drawing package accessible to you. An understanding of the standard features of a Graphics Editor will help you understand the different features required.

It is required to develop a graphics editor software package using which one can create/modify several types of graphics entities. In summary, the graphics editor should support the following features:

- The graphics editor should support creating several types of geometric objects such as circles, ellipses, rectangles, lines, text, and polygons.
- Any created object can be *selected* by clicking a mouse button on the object. A selected object should be shown in a highlighted color.
- A selected object can be edited, i.e. its associated characteristics such as its geometric shape, location, color, fill style, line width, line style, etc. can be changed. For texts, the text content can be changed.
- A selected object can be copied, moved, or deleted.
- The graphics editor should allow the user to save his created drawings on the disk under a name he would specify. The graphics editor should also support loading previously created drawings from the disk.
- The user should be able to define any rectangular area on the screen to be *zoomed* to fill the entire screen.

- A *fit screen function* makes the entire drawing fit the screen by automatically adjusting the zoom and pan values.
- A pan function should allow the displayed drawing to be panned along any direction by a specified amount.
- The graphics editor should support grouping. A group is simply a set of drawing objects including other groups which when grouped behave as a single entity. This feature is especially useful when you wish to manipulate several entities in the same way. A drawing object can be a direct member of at most one group. It should be possible to perform several editing operations on a group such as move, delete, and copy.
- A set of 10 clip boards should be provided to which one can copy various types of selected entities (including groups) for future use in pasting these at different places when required.

1. We need to develop the following **Time Management Software** for a company:

   The company needs to develop a time management system for its executives. The software should let the executives register their daily appointment schedules. The information to be stored includes person(s) with whom meeting is arranged, venue, the time and duration of the meeting, and the purpose (e.g. for a specific project work). When a meeting involving many executives needs to be organized, the system should automatically find a common slot in the diaries of the concerned executives, and arrange a meeting (i.e. make relevant entries in the diaries of all the concerned executives) at that time. It should also inform the concerned executives about the scheduled meeting through e-mail. If no common slot is available, TMS should help the secretary to rearrange the appointments of the executives in consultation with the concerned executives for making room for a common slot. To help the executives check their schedules for a particular day the system should have a very easy-to-use graphical interface. Since the executives and the secretaries have their own desktop computers, the time management software should be able to serve several remote requests simultaneously. Many of the executives are relative novices in computer usage. Everyday morning the time management software should e-mail every executive his appointments for the day. Besides registering their appointments and meetings, the executives might mark periods for which they plan to be on leave. Also, executives might plan out the important jobs they need to do on any day at different hours and post it in their daily list of engagements. Other features to be supported by the TMS are the following: TMS should be able to provide several types of statistics such as which executive spent how much time on meetings. For which project how many meetings were organized for what duration and how many man-hours were devoted to it. Also, it should be able to display on the whole during any given period of time what fraction of time on the average each executive spent on meetings.

2. We need to develop the following software for automating the activities of a 5-star hotel.
   Hotel Automation Software: A hotel has a certain number of rooms. Each room can be either single bed or double bed type and may be AC or Non-AC type. The rooms have different rates depending on whether they are of single or double, AC or Non-AC types. The room tariff however may vary during different parts of the year depending up on the occupancy rate. For this, the computer should be able to display the average occupancy rate for a given month so that the manager can revise the room tariff either upwards or downwards by a certain percentage.

   Guests can reserve rooms in advance or can reserve rooms on the spot depending upon availability of rooms. The receptionist would enter data pertaining to guests such as their arrival time, advance paid, approximate duration of stay, and the type of the room required. Depending on this data and subject to the availability of a suitable room, the computer would allot a room number to the guest and assign a unique token number to each guest. If the guest cannot be accommodated, the computer generates an apology message. The hotel catering services manager would input the quantity and type of food items as and when consumed by the guest, the token number of the guest, and the corresponding date and time. When a customer prepares to check-out, the hotel automation software should generate the entire bill for the customer and also print the balance amount payable by him. Frequent guests should be issued an identity number which helps them to get special discounts on their bills.

3. *Road Repair and Tracking Software (RRTS)* to be developed for automating various book keeping activities associated with the road repairing task of the Public Works Department of the Corporation of a large city.
   Road Repair and Tracking System (RRTS): A city corporation has branch offices at different suburbs

of the city. Residents raise repair requests for different roads of the city. These would be entered into the computer system by a clerk. Soon after a repair request is raised, a supervisor visits the road and studies the severity of road condition. Depending on the severity of the road condition and the type of the locality (e.g., commercial area, busy area, relatively deserted area, etc.), he determines the priority for carrying out this repair work. The supervisor also estimates the raw material requirement for carrying out the repair work, the types and number of machines required, and the number and types of personnel required. Based on this data, the computer system should schedule the repair of the road depending up on the priority of the repair work and subject to the availability of raw material, machines, and personnel. This schedule report is used by the supervisor to direct different repair work. The manpower and machine that are available are entered by the city corporation administrator. He can change these data any time. Of course, any change to the available manpower and machine would require a reschedule of the project. The mayor of the city can request for various road repair statistics such as the number and type of repairs carried out over a period of time and the repair work outstanding at any point of time and the utilization statistics of the repair manpower and machine over any period of time.

4. **Judiciary Information System (JIS)** software:
   The attorney general's office has requested us to develop a Judiciary Information System (JIS), to help handle court cases and also to make the past court cases easily accessible to the lawyers and judges.. For each court case, the name of the defendant, defendant's address, the crime type (e.g., theft, arson, etc.), when committed (date), where committed (location), name of the arresting officer, and the date of the arrest are entered by the court registrar. Each court case is identified by a unique case identification number (CIN) which is generated by the computer. The registrar assigns a date of hearing for each case. For this the registrar expects the computer to display the vacant slots on any working day during which the case can be scheduled. Each time a case is adjourned, the reason for adjournment is entered by the registrar and he assigns a new hearing date. If hearing takes place on any day for a case, the registrar enters the summary of the court proceedings and assigns a new hearing date. Also, on completion of a court case, the summary of the judgement is recorded and the case is closed but the details of the case is maintained for future reference. Other data maintained about a case include the name of the presiding judge, the public prosecutor, the starting date, and the expected completion date of a trial. The judges should be able to browse through the old cases for guidance on their judgement. The lawyers should also be permitted to browse old cases, but should be charged for each old case they browse. Using the JIS software, the Registrar of the court should be able to query the following:

   (a) The currently pending court cases.
   In response to this query, the computer should print out the pending cases sorted by CIN. For each pending case, the following data should be listed: the date in which the case started, the defendant's name, address, crime details, the lawyer's name, the public prosecutor's name, and the attending judge's name.

   (b) The cases that have been resolved over any given period.
   The output in this case should chronologically list the starting date of the case, the CIN, the date on which the judgement was delivered, the name of the attending judge, and the judgement summary.

   (c) The cases that are coming up for hearing on a particular date.

   (d) The status of any particular case (cases are identified by CIN).

   The lawyers and the judges need to refer to the past court cases. The lawyers need to refer these to prepare for their line of arguments. The judges need to refer the past court cases to examine the lines of judgements given previously to similar cases. It should be possible to search for the history of past court cases by entering key words. However, the lawyers should be charged for each time they see the details of a court case to recover some of the computerization costs. For this purpose, it is necessary to provide separate login accounts to the JIS software and keep track of how many court cases each lawyer views. The registrar should be able to create login accounts for the different users (i.e. judges, lawyers, etc) and should be able to delete these accounts.

5. **Library Information System (LIS):** Different activities of the library of our institute pertaining to the issue and return of the books by the members of the library and various queries regarding books as listed below are to be automated.

- The library has 10,000 books. Each book is assigned a unique identification number (called ISBN number). The Library clerk should be able to enter the details of the book into the LIS through a suitable interface.
- There are four categories of members of the library: undergraduate students, post graduate students, research scholars, and faculty members.
- Each library member is assigned a unique library membership code number.
- Each undergraduate student can issue up to 2 books for 1 month duration.
- Each postgraduate student can issue up to 4 books for 1 month duration.
- Each research scholar can issue up to 6 books for 3 months duration.
- Each faculty member can issue up to 10 books for six months duration.
- The LIS should answer user queries regarding whether a particular book is available. If a book is available, LIS should display the rack number in which the book is available and the number of copies available.
- LIS registers each book issued to a member. When a member returns a book, LIS deletes the book from the member's account and makes the book available for future issue.
- Members should be allowed to reserve books which have been issued out. When such a reserved book is returned, LIS should print a slip for the concerned member to get the book issued and should disallow issue of the book to any other member for a period of seven days or until the member who has reserved the books gets it issued.
- When a member returns a book, LIS prints a bill for the penalty charge for overdue books. LIS calculates the penalty charge by multiplying the number of days the book is overdue by the penalty rate.
- LIS prints reminder messages for the members against whom books are over due, upon a request by the Librarian.
- LIS should allow the Librarian to create and delete member records.
- The Librarian periodically needs to check if there are any books which have not been issued even once during the last five years. He uses this information in planning to dispose off unused and old books. For this purpose it is necessary for LIS to maintain the statistics regarding issual of different books.
- When books are disposed off, the Library clerk should be able to delete the book from the list of books in the Library and when a book is procured the system should support entering the details.

6. **Word processing** software:

- The word processing software should be able to read text from an ASCII file or HTML file and store the formatted text as HTML files in the disk.
- The word processing software should ask the user about the number of characters in an output line of the formatted text. The user should be allowed to select any number between 1 and 132.
- The word processing software should process the input text in the following way.
  - Each output line is to contain exactly the number of characters specified by the user (including blanks).
  - The word processing software is to both left and right justify the text so that there are no blanks at the left- and right- hand ends of lines except the first and possibly the last lines of paragraphs. The word processing software should do this by inserting extra blanks between words.
  - The input text from the ASCII file should consist of words separated by one or more blanks and a special character PP, which denotes the end of a paragraph and the beginning of another.
  - The first line of each paragraph should be indented by five spaces and should be right justified.
  - The last line of each paragraph should be left justified.
- The user should be able to browse through the document and add, modify or delete words. He/she should also be able to mark any word as bold, italic, superscript, or subscript.
- The user can request to see the number of characters, words, lines, and paragraphs used in the document.

- The user should be able to save his documents under a name specified by him.

7. **Restaurant Automation System (RAS):** A restaurant owner wants to computerize his order processing, billing, and accounting activities. He also expects the computer to generate statistical report about sales of different items. A major goal of this computerization is to make supply ordering more accurate so that the problem of excess inventory is avoided as well as the problem of non-availability of ingredients required to satisfy orders for some popular items is minimized. The computer should maintain the prices of all the items and also support changing the prices by the manager. Whenever any item is sold, the sales clerk would enter the item code and the quantity sold. The computer should generate bills whenever food items are sold. Whenever ingredients are issued for preparation of food items, the data is to be entered into the computer. Purchase orders are generated on a daily basis, whenever the stock for any ingredient falls below a threshold value. The computer should calculate the threshold value for each item based on the average consumption of this ingredient for the past three days and assuming that a minimum of two days stock must be maintained for all ingredients. Whenever the ordered ingredients arrive, the invoice data regarding the quantity and price is entered. If sufficient cash balance is available, the computer should print cheques immediately against invoice. Monthly sales receipt and expenses data should be generated whenever the manger would request to see them.

8. **Transport company computerization (TCC) software:** A transport company wishes to computerize various book keeping activities associated with its operations.

   - A transport company owns a number of trucks.
   - The transport company has its head office located at the capital and has branch offices at several other cities.
   - The transport company receives consignments of various sizes at (measured in cubic meters) its different offices to be forwarded to different branch offices across the country.
   - Once the consignment arrives at the office of the transport company, the details of the volume, destination address, sender address, etc. are entered into the computer. The computer would compute the transport charge depending upon the volume of the consignment and its destination and would issue a bill for the consignment.
   - Once the volume of any particular destination becomes 500 cubic meters, the computerization system should automatically allot the next available truck.
   - A truck stays with the branch office until the branch office has enough cargo to load the truck fully.
   - The manager should be able to view the status of different trucks at any time.
   - The manager should be able to view truck usage over a given period of time.
   - When a truck is available and the required consignment is available for dispatch, the computer system should print the details of the consignment number, volume, sender's name and address, and the receiver's name and address to be forwarded along with the truck.
   - The manager of the transport company can query the status of any particular consignment and the details of volume of consignments handled to any particular destination and the corresponding revenue generated.
   - The manager should also be able to view the average waiting period for different consignments. This statistics is important for him since he normally orders new trucks when the average waiting period for consignments becomes high due to non-availability of trucks. Also, the manager would like to see the average idle time of the truck in the branch for a given period for future planning.

9. We need to develop the following **simulation software**:
   A factory has different categories of machines such as lathe machines, turning machines, drilling machines, soldering machines, etc. The factory can have different numbers of machines from each category such as 200 lathe machines, 50 turning machines, etc. These machines require frequent adjustments and repair. Each category of machine fails uniformly after continuous operation and the failure profile of the different categories of machines is given by its mean time to failure (MTTF). A certain number of adjusters are employed to keep the machines running. The adjusters have expertize in maintaining different categories of machines. An adjuster may be expert in maintaining more than one type of machine. A service manager coordinates the activities of the adjusters. The service manager maintains a queue of inoperative machines.

If there are machines waiting to be repaired, the service manager assigns the machine at the front of the queue to the next available adjuster. Likewise, when some adjusters are not busy, the service manager maintains a queue of idle adjusters and assigns the adjuster at the front of the queue to the next machine that breaks down.

At any given time, one of the two queues will be empty. Thus, the service manager needs to maintain only a single queue, which when it is not empty contains only machines or only adjusters. The factory management wishes to get as much as possible out of its machines and adjusters. It is therefore interested in *machine utilization* — the percentage of time a machine is up and running and the *adjuster utilization* — the percentage of time an adjuster is busy. The goal of our simulation is then to see how the average machine and adjuster utilization depend on such factors as the number of machines, the number of adjusters, the reliability of the machines in terms of mean time to failure (MTTF). This software would be used by different factories to determine the optimum number of adjusters that they should employ.

10. **Software component cataloguing software:** The software component cataloguing software consists of a software components catalogue and various functions defined on this components catalogue. The software components catalogue should hold details of the components which are potentially reusable. The reusable components can be either design or code. The design might have been constructed using different design notations such as UML,ERD,structured design, etc. Similarly, the code might have been written using different programming languages. A cataloguer may enter components in the catalogue, may delete components from the catalogue, and may associate reuse information with a catalogue component in the form of a set of key words. A user of the catalogue may query about the availability of a component using certain key words to describe the component. In order to help manage the component catalogue (i.e., periodically purge the unused components) the cataloguing software should maintain information such as how many times a component has been used, and how many times the component has come up in a query but not used. Since the number of components usually tend to be very high, it is desirable to be able to classify the different types of components hierarchically. A user should be able to browse the components in each category.

11. **Supermarket automation software (SAS):** The manager of a supermarket wants us to develop an automation software. The supermarket stocks a set of items. Customers pick up their desired items from the different counters in required quantities. The customers present these items to the sales clerk. The sales clerk passes the items over a bar code reader and an automatic weighing scale and the data regarding the item type and the quantity get registered.

    - SAS should at the end of a sales transaction print the bill containing the serial number of the sales transaction, the name of the item, code number, quantity, unit price, and item price. The bill should indicate the total amount payable.
    - SAS should maintain the inventory of the various items of the supermarket. The manager upon query should be able to see the inventory details. In order to support inventory management, the inventory of an item should be decreased whenever an item is sold. SAS should also support an option by which an employee can update the inventory when new supply arrives.
    - SAS should support printing the sales statistics for every item the supermarket deals with for any particular day or any particular period. The sales statistics should indicate the quantity of an item sold, the price realized, and the profit.
    - The manager of the supermarket should be able to change the the price at which an item is sold as the prices of the different items vary on a day-to-day basis.

12. We need to develop a software for automating various activities of a small book shop. From a discussion with the owner of the book shop, the following user requirements have been arrived at:

    Book-shop Automation Software (BAS)
    BAS should help the customers query whether a book is in stock. The users can query the availability of a book either by using the book title or by using the name of the author. If the book is not currently being sold by the book-shop, then the customer is asked to enter full details of the book for procurement of the book in future. If a book is in stock, the exact number of copies available and the rack number in which the book is located should be displayed. If a book is not in stock, the query for the book is used to increment a request field for the book. The manager can periodically view the request field of the books to arrive at a

rough estimate regarding the current demand for different books. BAS should maintain the price of various books. As soon as a customer selects a book for purchase, the sales clerk would enter the ISBN number of the book. BAS should update the stock, and generate the sales receipt for the book. BAS should allow employees to update the inventory whenever new supply arrives. Also upon request, BAS should generate sales statistics (viz., book name, publisher, ISBN number, number of copies sold, and the sales revenue) for any period. The sales statistics will help the owner to know the exact business done over any period of time and also to determine inventory level required for various books. The inventory level required for a book is equal to the number of copies of the book sold over a period of two weeks multiplied by the average number of days it takes to procure the book from its publisher. Every day the book shop owner would give a command for the BAS to print the books which have fallen below the threshold and the number of copies to be procured along with the full address of the publisher.

13. We need to develop a software for automating various activities associated with *structured software analysis.* The summary of the requirements are the following:

    CASE tool for Structured Analysis:

    - The case tool should support a graphical interface and the following features.
    - The user should be able to draw bubbles, data stores, and entities and connect them using data flow arrows. The data flow arrows are annotated by the corresponding data names.
    - Should support editing the data flow diagram.
    - Should be able to create the diagram hierarchically.
    - The user should be able to determine balancing errors whenever required.
    - The software should be able to create the data dictionary automatically.
    - Should support printing the diagram on a variety of printers.

14. We need to develop a software for automating various activities associated *structured software design.* The summary of the requirements are the following:

    CASE tool for Structured Design:

    - The case tool should support a graphical interface and the following features.
    - The user should be able to draw modules, control arrows, and data flow arrows. Also symbol for library modules should be provided. The data flow arrows are annotated with the corresponding data name.
    - The diagrams should be organized in neat hierarchical levels.
    - The user should be able to modify his design. Please note that when he deletes a data flow arrow, its annotated data name automatically gets deleted.
    - For large software, modules may be hierarchically organized and clicking on a module should be able to show its internal organization.
    - The user should be able to save his design and also be able to load previously created designs.

15. The local newspaper and magazine delivery agency has asked us to develop a software for him to automate various clerical activities associated with his business.

    Newspaper Agency Automation Software:

    - This software is to be used by the manager of the news agency and his delivery persons.
    - For each delivery person, the system must print each day the publications to be delivered to each address. The addresses should be generated in consecutive order as far as possible so that the commutation of the delivery person is minimal.
    - Customers usually subscribe one or more news papers and magazines. They are allowed to change their subscription list by giving one week's advance notice.
    - For each delivery person, the system must print each day the publications to be delivered to each address.
    - The system should also print for the news agent the information regarding who received what publications and a summary information of the current month.

- At the beginning of every month bills are printed by the system to be delivered to the customers. These bills should be computed by the system automatically and should include the publication type, the number of copies delivered during the month, and the cost for these.
- The customers may ask for stopping the deliveries to them for certain periods when they go out of station.
- Customers may request to subscribe new newspapers/ magazines, modify their subscription list, or stop their subscription altogether.
- Customers usually pay their monthly dues either by cheques or cash. Once the cheque number or cash received is entered in the system, receipt for the customer should be printed.
- If any customer has any outstanding due for more than one month, a polite reminder message is printed for him and his subscription is discontinued if his dues remain outstanding for periods of more than two months.
- The software should compute and print out the amount payable to each delivery boy. Each delivery boy gets 2.5% of the value of the publications delivered by him.

16. Department offices in different universities do a lot of book-keeping activities and it is necessary to develop a software to automate these activities.

    University Department Information System:

    - Various details regarding each student such as his name, address, course registered, etc. are entered at the time he/she takes admission.
    - At the beginning of every semester, students register for courses. The information system should allow the department secretary to enter data regarding student registrations. When the secretary enters the roll number of each student, the computer system should bring up a form for the corresponding student and should keep track of courses he has already completed and the courses he has back-log, etc.
    - At the end of the semester, the instructors leave their grading information at the office which the secretary enters into the computer. The information system should be able to compute the grade point average for each student for the semester and his cumulative grade point average (CGPA) and print the grade sheet for each student.
    - The information system should also keep track of inventories of the Department, such as equipments, their location, furnitures, etc.
    - The Department gets an yearly grant from the University and the Department spends it in buying equipments, books, stationery items, etc. Also, in addition to the annual grant that the Department gets from the University, it gets funds from different consultancy service it provides to different organizations. It is necessary that the Department information system keeps track of the Department accounts.
    - The information system should also keep track of information such as the research projects running in the Department, publications by the faculties, etc. These information are keyed in by the secretary of the Department.
    - The information system should support querying the up-to-date details about every student by inputting his roll number. It should also support querying the details of the cash book account. The output of this query should include the income, expenditure, and balance.

17. A medicine shop has approached us to develop the following software to automate various book-keeping activities associated with the business.

    Medicine Shop Software (MSS):

    A retail medicine shop deals with a large number of medicines procured from various manufacturers. The shop owner maintains different medicines in wall mounted and numbered racks.

    The shop owner maintains as few inventory for each item as reasonable, to reduce inventory overheads after being inspired by the just-in-time (JIT) philosophy.

Thus, one important problem the shop owner faces is to be able to order items as soon as the number of items in the inventory reduces below a threshold value. The shop owner wants to maintain medicines to be able to sustain selling for about one week. To calculate the threshold value for each item, the software must be able to calculate the average number of medicines sales for one week for each part.

At the end of each day, the shop owner would request the computer to generate the items to be ordered. The computer should print out the medicine description, the quantity required, and the address of the vendor supplying the medicine.

At the end of every day the shop owner would give a command to generate the list of medicines which have expired. It should also prepare a vendor-wise list of the expired items so that the shop owner can ask the vendor to replace these items. Currently, this activity alone takes a tremendous amount of labour on the part of the shop owner and is a major motivator for the automation endeavor.

Whenever any sales occurs, the shop owner would enter the code number of each medicine and the corresponding quantity sold. The MSS should print out the cash receipt.

The computer should also generate the revenue for each day and at the end of the month, the computer should generate a graph showing the total sales for each day of the month and also these figures for any given medicine.