Design and Analysis of Software Systems
SPRING 2025 - Mid-Semester Exam

INSTRUCTIONS: This is a closed-book, closed-notes exam. It consists of 20 questions. You should answer all questions. You have 90 minutes to complete the exam for a total of 55 points.

Credit is given for what you write, not what you are thinking. Partial credit will be given based on Quality of the content, not Quantity. A voluminous content-free answer may simply annoy the grader.

1. **(1 point)** In unit testing, what is the primary purpose of using a test-driven development (TDD) approach?
   A. To write tests after developing code to ensure functionality is as intended.
   B. To create automated tests before the code is written, promoting better design and early detection of defects.
   C. To focus on integration and system testing instead of unit testing.
   D. To prioritize performance testing as the main focus of the development lifecycle.

2. **(1 point)** The _____ for a project is the timetable that specifies when each activity should start and finish.
   A. objective
   B. schedule
   C. scope
   D. time scope

3. **(1 point)** The need and requirements are usually written up by the customer in a document called:
   A. request for price
   B. request for proposal
   C. request for contracts
   D. request for bids

4. **(1 point)** In the context of project scheduling, what is the primary benefit of utilizing the Critical Path Method (CPM)?
   A. It enables flexibility in task management by eliminating critical tasks.
   B. It identifies the longest sequence of tasks to determine project duration, facilitating effective scheduling.
   C. It allows for arbitrary prioritization of tasks regardless of their dependencies.
   D. It emphasizes the importance of individual task completion without considering overall project impact.

5. **(1 point)** What are the activities associated with requirements engineering?
   A. Elicitation, Verification & Validation, Code Inspections, Design Reviews
   B. Elicitation, Modeling, Domain Analysis, Specification
   C. Domain Analysis, Object-Oriented Design, Testing, Configuration Management
   D. Specification, Object-Oriented Design, Code Inspections, Domain Analysis

6. **(1 point)** Which of the following tools or methodologies is most effective for tracking project progress in an Agile environment?
   A. Waterfall-style Gantt charts that detail every phase of the project.
   B. Kanban boards that visualize tasks and track their status through different stages.

C. Comprehensive project plans that outline strict deadlines for all tasks.
D. Monthly summaries that track high-level tasks without daily updates.

7. **(1 point)** In the process of defining use cases for a new software system, which of the following approaches is most effective in ensuring that all stakeholder perspectives are captured?
   A. Conducting interviews with key stakeholders to gather their insights for the use cases.
   B. Developing use cases based on feedback from the development team without stakeholder input.
   C. Relying on existing documentation from previous projects to draft the use cases.
   D. Creating use cases based solely on user reviews and feedback post-implementation

8. **(1 point)** In requirements engineering, which of the following techniques is most effective for eliciting high-quality requirements from stakeholders?
   A. Surveys that gather quantitative data without much context.
   B. Joint Application Development sessions that facilitate collaborative discussions among stakeholders.
   C. Reviewing previous projects' documentation without stakeholder involvement.
   D. Solely relying on email communications to gather requirements from stakeholders.

9. **(1 point)** In UML class diagrams, how do multiplicities enhance the understanding of relationships between classes?
   A. They illustrate the visibility levels of class attributes and methods across different classes.
   B. They serve to define the methods and attributes of classes without reflecting their relationships.
   C. They detail the sequence of messages exchanged between objects in a communication diagram.
   D. They specify the exact number of instances from each class that can participate in the relationship, indicating constraints on associations.
   E. None of the above

10. **(1 point)** In unit testing, assertions are used to confirm that the expected outcomes match the actual results. A common assertion method is _____, which checks that a specific condition holds true during the test.

11. **(2 points)**
    One of the keys to team development is managing concurrent development and integration. Briefly discuss (in 2-4 sentences) how a system like "Git" is useful in this regard.

12. **(2 points)**
    What's Deming's Cycle? Briefly outline the 4 steps in the cycle

13. **(2 points)**
    At the end of each stage of some lifecycle models we perform "V & V." Each V is shorthand for a software project activity. What is the goal of each step?

14. **(2 points)**
    What does product backlog mean?

15. **(3 points)**

The following pseudo-code for a function that calculates the monthly repayment amount for a home loan. Identify at least three potential edge cases or error conditions and write test cases for them.

```
function calculateRepayment (principal, annualInterestRate, years) {
  monthlyInterestRate = annualInterestRate / 12
  numberOfPayments = years * 12
  return (principal * monthlyInterestRate) / (1 - (1 + monthlyInterestRate)^(-numberOfPayments))
}
```

16. (4 points)

Assuming you are an organizing member of the Megathon (hackathon organized by IIITH students), detail out the Initiatives, activity lists, high level effort estimates and priorities (high-medium-low). This should be in a form that can be used to track just the progress of the project as things get done.

17. (4 points)

What characteristics of good requirements does the following requirements statement lack? Rewrite it to reflect the characteristics of good requirements.
"The cash register program must show the correct prices for all items bought by the customer and print the total at the bottom."

18. (4 points)

You are working in a team of 4 people for 6 months, to build a mobile application that evaluates the user interfaces of various mobile applications. Reason about the lifecycle model would you use for this.
The question specifically requires you to reason about the process model of choice. So, make sure you provide proper rationale.

19. (8 points)

Based on the following table, calculate the ES (Early Start), EF (Early Finish), LS (Late Start), LF (Late Finish) times and SLACK for each task. In addition, identify the critical path and the amount of time needed to complete the project.

Task	Time (man hrs)	Immediate Predecessor
A	15	-
B	20	A
C	40	A
D	20	B, C
E	10	D
F	10	E
G	25	F
H	20	F
I	15	G, H

20. (Total 14 points)

The next three questions refer to this system description.

SoftModel Inc. has been contracted to build a software simulation system for parking garages that could be attached to Space Stations of the 22nd century. Each parking garage will be able to park up to 100 space vehicles of all types. It will be have 3 air locks which allow the space vehicles to move from airless space into the pressurized atmosphere of the space station. Each air lock can fit either one space ore vehicle or 3 regular (passenger or military) space vehicle.

Future parking garages may have more (or fewer) parking spaces and a different number and size air lock.
The parking technology is similar to those currently used on Earth. Drivers can enter the garage with a permit that can be swiped with a card reader. They can also get a ticket by pressing a button at the entrance. The vehicles have automatic arms to get the ticket inside. You don't want to open a window and let the air out. The ticket has a date and time-stamp indicating the date/time of entering the garage. After swiping the permit or getting a ticket, the driver enters an air lock (if there is room) and then enters the garage itself.
The system to be developed by SoftModel should keep track of the number of cars currently in the garage, and in each air lock. It displays signs indicating whether or not the garage is full, and whether or not each air lock is full. Drivers with tickets pay the attendant at a gate before leaving the garage; drivers with permits have a parking fee added to their account when they swipe their permits upon exiting from the garage. Drivers must pass through an air lock to exit the garage. An operator console displays the status of the system including the number and types of (1) parked vehicles, (2) vehicles in air locks, and (3) vehicles waiting for space in the lot or space in the air locks.
The system must keep track of the payments being made, and the amounts due from permit holders. It must also provide summaries to authorized personnel regarding peak garage hours and the number of permits used.

A. (5 points)
List the features (use cases) for this system and draw a use case diagram.

B. (6 points)
Choose the most important feature and write a "ideal" (main flow) scenario for it.

Hint: Consider the next question when selecting the feature for this question.

C. (3 points)
For that same feature, write an alternate scenario. Be sure to indicate how it relates to the original success scenario, i.e. at what point in the success scenario does it start and return, if appropriate.