You have 90 minutes to work on this exam. It is a "closed-book/closed-notes" test. Pay attention to point values, since you may not have time to work all 20 problems.

PRINT your name above NOW and sign the pledge at the bottom of the last page, if appropriate, when you are finished.

PLEASE PRINT ANSWERS IN THE SPACE PROVIDED ONLY – PREFERABLY USING A BALLPOINT PEN TO INCREASE LEGIBILITY. Good luck!

1. (3 pts.) What, according to Sommerville, is the principle distinction between plan-driven and agile processes? (Circle ONE only.)

   a. Agile process activities are iterative in nature while they are sequential in plan-driven processes.

   b. Agile process activities incorporate incremental development while plan-driven process activities do not.

   c. Plan-driven process activities are planned in advance while planning is incremental in agile processes.

   d. Agile processes explicitly incorporate risk assessment and resolution while plan-driven processes do not.

2. (3 pts.) Sommerville argues that while software engineering is often criticized as being inadequate for modern software development, many so-called software failures are actually a consequence of two (other) factors. One of these is that as new software engineering techniques help us to build larger, more complex systems, demands increase for faster development, even more complexity, and new capabilities previously thought to be impossible. As a result, new software engineering methods must continuously be developed to meet ever increasing demands. Briefly describe the other factor he cites.
3. (3 pts.) One of the issues of professional and ethical responsibility for software engineers discussed in class was that of "confidentiality." Which ONE of the following, if any, describes the issue as discussed?

a. You should normally respect the confidentiality of your employers or clients irrespective of whether a formal confidentiality agreement has been signed.

b. You should be aware of local laws governing the required confidentiality of intellectual property such as patents and copyright.

c. Software engineers should strive to remain confidential in all areas of software engineering if they are to be respected as professionals.

d. Software engineers should always act in a confidential manner that is consistent with the public interest.

e. Software engineers should not misrepresent their level of confidentiality or knowingly accept work which is outside their area of confidentiality.

f. (none of the above)

4. (3 pts.) Which one of the following best describes what it means to say that a requirement can be validated? (Circle ONE only.)

a. The requirement can be changed without large-scale effects on other system requirements.

b. Correctness of the system with respect to the requirement can be determined.

c. Procurers and end-users of the system can understand the requirement.

d. Consistency of the requirement with user needs/desires can be determined.

e. The origin of the requirement can be documented.

5. Sommerville notes that to decide on the balance between a plan-based and an agile development approach, one needs to answer a range of technical, human, and organization questions. Two such questions appear below. Briefly explain their relevance to this issue as described by Sommerville.

a. (3 pts.) What is the expected system lifetime?

b. (3 pts.) How large is the system that is being developed?
6. (10 pts.) Match each description below to the **SINGLE MOST APPROPRIATE TERM** among the following. (Note: terms may apply to none, one, or more than one description.)

A. Boehm’s Spiral Development
B. Throw-away Prototyping
C. Incremental DELIVERY
D. Reuse-based Development
E. Volere
F. RUP
G. Incremental DEVELOPMENT
H. Extreme Programming
I. Waterfall
J. COCOMO

___ Plan-driven model with separate and distinct phases of specification and development.
___ Normal approach used in agile methods (but may also be used in plan-driven development) -- the system is developed in increments that are made available for customer evaluation and feedback (but not usually deployed for actual work in the customer’s own environment).
___ System integration, in this model, may be part of the development process rather than a separate activity.
___ Hybrid process model that explicitly represents both “in-phase” and “cross phase” iteration.
___ A drawback is the difficulty of accommodating change after the process is underway.
___ Combines change avoidance with change tolerance. It assumes that changes are a result of project risks and includes explicit risk management activities to reduce these risks.
___ Difficult to carry out for replacement systems as increments provide less functionality than the system being replaced.
___ Important innovations are the separation of phases and workflows (activities), and the recognition that deploying software in a user’s environment is part of the development process.
___ Once the development of an increment is started, its requirements are “frozen” while requirements for later increments can continue to evolve.
___ Usually leads to reduced cost and faster delivery of software, but requirements compromises may lead to a system that does not meet the real needs of users.

7. (3 pts.) The term *information hiding* is often associated with the notion of encapsulation. David Parnas, however, suggests a more general interpretation. State his definition of *information hiding.*
8. (9 pts.) Match each description below to the **SINGLE MOST APPROPRIATE TERM** among the following. (Note: terms may apply to none, one, or more than one description.)

A. Mockup  
B. Breadboard  
C. Horizontal Prototyping  
D. Vertical Prototyping  
E. Throw-away Prototyping  
F. Experimental Prototyping  
G. Back-to-back Testing  
H. Paper Prototyping  
I. Wizard of Oz Prototyping  
J. Operational Prototyping

___ Using a validated prototype as the source for expected results during system test.
___ Designed to be highly functional and easily modifiable with little or no emphasis on appearance
___ A potential problem is that developers may be “pressurized” to deliver the prototype as the final system.
___ Used to evaluate the feasibility or performance of a proposed solution
___ Used to elicit and validate requirements before software specification and development.
___ Emphasis is on breadth of feature coverage as opposed to realism
___ A non-functioning but realistic looking model
___ Very cost-effective way to obtain user reactions to an interface design proposal
___ “System responses” to user interactions are an illusion created by a person pretending to be the system

9. (9 pts.) Three general open source software licensing models were described in class: the GNU General Public License (GPL), the GNU Lesser General Public License (LGPL), and the Berkley Standard Distribution (BSD) License. Briefly explain how each of the models handles the issue of **reciprocity**.
10. (16 pts.) Circle either “true” or “false”, as appropriate, for each of the following statements concerning Extreme Programming (XP). Note that to compensate for random guessing, you will receive +2 pts. for each correct answer and -2 pts. for each incorrect answer. (The minimum score possible for this problem is 0 pts.) Therefore, DON’T CIRCLE AN ANSWER UNLESS YOU ARE MORE THAN 50% SURE THAT IT IS CORRECT!

a. XP’s focus is on managing iterative development rather than specific agile practices or principles.  
   true false

b. An automated unit test framework is used to write tests for a new piece of functionality before that functionality itself is implemented.  
   true false

c. Refactoring involves constantly improving documentation to increase understandability -- even if there is no immediate need for this.  
   true false

d. Pairs of developers work only on their own areas of the system so that expertise that encourages refactoring will develop quickly. Either developer can change anything in the areas of the system they jointly “own.”  
   true false

e. A representative of the end-users of the system aids in identifying requirements, but the development team is isolated from the representative with all communications channelled through the so-called XP "master".  
   true false

f. The focus in XP is on people – not process – through pair programming and a process that avoids long working hours.  
   true false

g. Releases of the system are frequent and incrementally add functionality. Enough design is carried out to meet the current requirements and no more.  
   true false

h. Instead of employing conventional SE wisdom, which cannot be reliably anticipated, XP proposes design for change to make changes easier when they have to be implemented.  
   true false

11. (3 pts.) Sommerville describes three major configuration management activities. Two of these are version management (keeping track of the different versions of software components) and problem tracking (keeping track of reported bugs, who is working on them, and when they are fixed). Briefly describe the third major configuration management activity identified by Sommerville.
12. (14 pts.) Match each description below to the **SINGLE MOST APPROPRIATE TERM** among the following. (Note: terms may apply to none, one, or more than one description.)

A. System Goal
B. User Requirements
C. System Constraint
D. System Requirements
E. Domain Requirement
F. System Attribute
G. External Requirement
H. Process Constraint
I. Operational Specification
J. Form/template-based Specification
K. Interface Specification
L. Scenario
M. Software Requirements Document

___ Example would be: "The development team is required to follow the Rational Unified Process."

___ Example would be:

```java
interface PrintServer {
    // defines an abstract printer server
    // requires: interface Printer, interface PrintDoc
    // provides: initialize, print, displayPrintQueue, cancelPrintJob, switchPrinter
    void initialize ( Printer p ) ;
    void print ( Printer p, PrintDoc d ) ;
    void displayPrintQueue ( Printer p ) ;
    void cancelPrintJob (Printer p, PrintDoc d) ;
    void switchPrinter (Printer p1, Printer p2, PrintDoc d) ;
} //PrintServer
```

___ Example would be: "The system shall be fully compliant with will mandatory Nuclear Regulatory Commission standards for fail-safe operation."

___ Example would be: "The automated cooling system must be easy to bypass in case of serious emergencies."

___ Example would be:

- **pre-condition:** \( N \geq 1 \)
- **post-condition:** there exists an \( i \) in \([1,N]\) such that \( \text{BIG}=A[i] \) & for every \( j \) in \([1,N]\), \( \text{BIG} \geq A[j] \) & \( A \) is unchanged

___ Example would be:

___ Example would be: “probability of application unavailability must be \( \leq .05 \)”

___ Official statement of what is required of system developers; it should include both user and system requirements.

( cont’d on next page)
Example would be: "The deceleration of the train shall be computed as:

\[ D_{\text{train}} = D_{\text{control}} + D_{\text{gradient}} \]

where \( D_{\text{gradient}} \) is \( 9.81 \text{m/s}^2 \) * compensated gradient/alpha and where the values of \( 9.81 \text{m/s}^2 / \alpha \) are known for different types of trains".

Statements in natural language plus diagrams of system services and constraints, written primarily for customers.

Detailed descriptions of system services and constraints that may serve as the basis for a contract.

Example would be: "percentage of target dependent statements"

A (partial) example would be:

```java
class ATM {
    // declarations here
    public static void main (String args[]) throws InvalidCard {
        try {
            thisCard.read () ;  // may throw InvalidCard exception
            pin = KeyPad.readPin () ; attempts = 1 ;
            while ( !thisCard.pin.equals (pin) & attempts < 4 )
            {
                pin = KeyPad.readPin () ; attempts = attempts + 1 ;
            }
            if (!thisCard.pin.equals (pin))
                throw new InvalidCard ("Bad PIN");
            thisBalance = thisCard.getBalance () ;
            do { Screen.prompt (" Please select a service ");
                service = Screen.touchKey () ;
                switch (service) {
                    case Services.withdrawalWithReceipt:
                        receiptRequired = true ;
                }
            }
        }
    }
}
```

Initial assumption: The patient has seen a medical receptionist who has created a record in the system and collected the patient’s personal information (name, address, age, etc.). A nurse is logged on to the system and is collecting medical history.

Normal: The nurse searches for the patient by family name. If there is more than one patient with the same surname, the given name (first name in English) and date of birth are used to identify the patient.

The nurse chooses the menu option to add medical history.

The nurse then follows a series of prompts from the system to enter information about consultations elsewhere on mental health problems (free text input), existing medical conditions (nurse selects conditions from menu), medication currently taken (selected from menu), allergies (free text), and home life (form).

Example would be:
13. (10 pts.) Match each description below to the **SINGLE MOST APPROPRIATE ARCHITECTURAL PATTERN OR TYPE** among the following. (Note: patterns or types may apply to none, one, or more than one description.)

A. Model-View-Controller  
B. Repository  
C. Pipe and Filter  
D. Transaction Processing  
E. Layered Architecture  
F. Client-server  
G. Event Processing  
H. Language Processing

___ Examples include compilers and command interpreters.

___ Used when building new facilities on top of existing systems or when there is a requirement for multi-level security.

___ Used when data in a shared database has to be accessed from a range of locations across a network. May also be used when the load on a system is variable.

___ The processing of the data in a system is organized so that each processing component is discrete and carries out one type of data transformation. The data flows from one component to another for processing.

___ Used when you have a system in which large volumes of information are generated that has to be stored for a long time. All data can be managed consistently (e.g., backups done at the same time) as it is all in one place.

___ Also know as the *abstract machine* model.

___ Separates presentation and interaction from the system data. Allows the data to change independently of its representation and vice versa.

___ Commonly used in data processing applications (both batch- and transaction based) where inputs are processed in separate stages to generate related outputs.

___ Systems process user requests for information from a database or to update the database. Examples include E-commerce and reservation systems.

___ Example would be:
14. (3 pts.) One of the advantages of software inspections (over machine based testing) mentioned in class concerned the **masking** of defects. Briefly explain what it means to say that one defect may **mask** others in the context of machine based software testing?

15. (3 pts.) In addition to focusing on the interactions among (previously independently tested) components making up a system, **system testing** also focuses on the functional and non-functional **emergent behaviors** of a system. Briefly explain what is meant by an emergent behavior in this context and give a concrete example.

16. (3 pts.) Some have suggested that Test-Driven Development (TDD) reflects an element of “methodological hyperbole.” (“Hyperbole” in this context, means a deliberate exaggeration used for dramatic effect.). In particular, the process model includes a step that seems to serve no purpose other than to **dramatically reinforce** the principle that testable requirements for new functionality should be the focus BEFORE code is written to implement that functionality -- a principle that is already clearly reflected in the process requirement that a test be written and implemented before the functionality is implemented. What is this additional, seemingly “hyperbolic step” in the TDD process model?

17. (4 pts.) Fowler, et al., suggest that there are stereotypical situations (called “bad smells”) in which program code can be improved through refactoring. Examples cited include **duplicate code, long methods, switch (case) statements, data clumping, and speculative generality.** Briefly describe (a) what the authors mean by “data clumping” and (b) the possible remedy they identify for this situation.
18. a. (3 pts.) Briefly explain WHAT “regression testing” is.

b. (3 pts.) Briefly explain the PURPOSE of “regression testing.”

19. a. (3 pts.) Briefly describe Lehman’s “Law of continuing change.”

b. (3 pts.) Briefly describe Lehman’s “Law of increasing complexity (entropy).”

20. (3 pts.) Which one of the following best reflects the point Sommerville makes in connection with how “team stability” can affect maintenance costs? (Circle ONE only.)

a. If the maintenance contract is given to a company other than the original system developer, there may be little or no incentive for a development team to write the software so that it is stable and easy to change.

b. Maintenance costs can be dramatically reduced if development contracts stipulate that system developers receive group psychotherapy at the very first sign of team instability.

c. Unless prior training of maintenance personnel is contractually mandated, a lot of the effort during the maintenance process is taken up with stabilizing the system before changes can be implemented.

d. In organizations that still consider development and maintenance to be separate activities, it is normal for development teams to be broken up with their members being assigned to new projects after systems have been delivered. The new individuals who become responsible for maintenance must then spend time trying to understand the system before being able to implement changes to it.

e. Contractual requirements related to the use of modern software engineering techniques, system structure, system documentation, configuration management, and other stabilizing factors can significantly impact maintenance costs.

On my honor, I have neither given nor received unauthorized aid on this exam and I pledge not to divulge information regarding its contents to those who have not yet taken it.

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SIGNATURE