Test 1

October 16, 1997

**Conditions:** Closed book  Duration: 70 minutes

Name: _________________________________

(Please underline last name)

Student Number: __________________________

1. __________/20

2. __________/20

3. __________/20

4. __________/20

5. __________/20

Total __________/100
1. [20 marks]

For each of the following ten statements, indicate whether it is true (mark T) or false (mark F). (No penalty for a wrong answer)

_T_ This is the Test 1 for CS6362.

_1_ The use of a Structure Chart (Program Control Hierarchy) cannot result in a layered system for, say a traffic control system.

_2_ In the context of telephony system architecture, the correctness of a client Object is independent of the correctness of its server Object.

_3_ The architecture of an Object Management System should be quite similar to that of a relational Database System, as an Object corresponds to a tuple.

_4_ The quality of a software architectural design largely depends on the quality of the process whereby the design is produced.

_5_ As is the case with Unix operating system, the essence of a pipe-and-filter architecture can be specified using C.

_6_ In building a critical system (e.g., a patient monitoring system), a software architect should select only those software architectural designs that completely guarantee the satisfaction of all essential non-functional requirements such as reliability.

_7_ In the style of Shared Data, modules can communicate with each other partly via procedure calls.

_8_ In an ADT architecture, modules typically communicate with each other via (remote) procedure calls and asynchronous message passing.

_9_ An essential part of any software architectural design should be design rationale, since design rationale explains why the particular architecture is chosen from the (possibly infinitely) large design space.

_10_ A semi-formal approach to designing a software architecture is often considered bad concerning defects but good concerning understandability.
2. [20 marks]

Consider the following four architectures for the KWIC problem.

**Architecture 1: Shared Data**

```
Master Control
  \[
  \text{Input} \quad \text{Circular Shift} \quad \text{Alphabetizer} \quad \text{Output}
  \]
  \[
  \text{Characters} \quad \text{Index} \quad \text{Alphabetized Index}
  \]
  \[
  \text{Input Medium} \quad \text{Output Medium}
  \]
```

**Architecture 2: Abstract Data Type**

```
Master Control
  \[
  \text{Input} \quad \text{Circular Shift} \quad \text{Alphabetizer} \quad \text{Output}
  \]
  \[
  \text{Characters} \quad \text{Index} \quad \text{Alphabetized Index}
  \]
  \[
  \text{Input Medium} \quad \text{Output Medium}
  \]
```

**Architecture 3: Implicit Invocation**

```
Master Control
  \[
  \text{Input} \quad \text{Circular Shift} \quad \text{Alphabetizer} \quad \text{Output}
  \]
  \[
  \text{Line buffer} \quad \text{Shifted Lines}
  \]
  \[
  \text{Input Medium} \quad \text{Output Medium}
  \]
```

**Architecture 4: Pipe and Filter**

```
Master Control
  \[
  \text{Input} \quad \text{Circular Shift} \quad \text{Alphabetizer} \quad \text{Output}
  \]
  \[
  \text{Input Medium} \quad \text{Output Medium}
  \]
2. [continued]

2.1 Consider Architecture 4. Describe briefly what and where modification is needed to efficiently “omit” indices starting with a noise word (e.g., the, a, an, to, and, or, etc.).

2.2 Consider Architecture 1 and Architecture 4. Compare them with respect to reusability and space performance.

2.3 Consider Architecture 2. Suppose the Master Control module is to be deleted from the architectural design. Describe briefly What should be done to achieve the same functionality as before?

2.4 Consider Architecture 1 and Architecture 3. Describe briefly the major disadvantage(s) of Architecture 3, when compared to Architecture 1.
3. [20 marks]

Consider the following figure given as the layered software architecture for a software system, called *System Integrator*.

![Layered Software Architecture Diagram](image)

**4.1.** Although the details of what each module (e.g., $L_{ij}$, $i, j = 1, 2, 3$) does are unknown, a software architect can point out certain constraints associated with this style of software architecture. Describe in a point form what such constraints are.

**4.2.** Aside from the issue of formal semantics, this figure is not quite adequate even as a diagrammatic software architecture. Describe in a point form major deficiency (ies) of the figure as a software architecture.
3. [continued]  

Suppose the software architects of System Integrator have proposed another software architecture for the system, this time based on pipe-and-filter. Also suppose that they have provided an analysis of tradeoffs between the two software architectures, as given in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Layer</th>
<th>Pipe &amp; Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modifiability</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Performance</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Reusability</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Flexibility</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Testability</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Traceability</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Usability</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

4.3 Discuss who would be involved in the analysis and why.

4.4 List and discuss major issues with carrying out a tradeoff analysis in the manner above.
4. [20 marks]

Consider the following declaration of stack:

Stack (E, C): trait /* E(e.g., integer, string) is an element of C, a stack */
introduces
   new: -> C
   push: C, E -> C
   top: C -> E    exempting top(new)
   pop: C -> C    exempting pop(new)
   isEmpty: C -> Bool

asserts
   C generated by new, push
   forall stk: C, e: E
       top (push(stk, e)) == e
       pop (push(stk, e)) == stk
       isEmpty(new)
       ~ isEmpty(push(stk, e))

implies
   LinearContainer (push for insert, top for first, pop for rest)

Now, suppose you are using a theorem prover, called TP. Also suppose that “Alice” and
“Wonderland” are elements of E.

1. What should TP return as the value of top (push (new, “Alice”))? 

2. What should TP return as the value of pop (push (new, “Alice”))? 

3. What should TP return as the value of isEmpty (pop (push (new, “Alice”)))?

4. What should TP return as the value of pop (push (push (new, “Alice”), pop (push (new, “Wonderland”)))))?

5. What should TP return as the value of insert (rest (insert (new, “Alice”)), “Alice”), assuming that LinearContainer has access to Stack?
Consider the following two architectures for an oscilloscope, as discussed in class:

**Architecture 1**

**Architecture 2**

1. Suppose Architecture 1 is chosen instead of Architecture 2. For each component of Architecture 2, indicate what layer it would belong to.

2. What kind of mechanism would be needed to display Measurement on the screen?