
This exam contains 8 pages (including this cover page) and 25 questions. Total of points is 100.

Conditions: You are permitted the following resources $R = \{ \text{book, notes, compilers} \}$. No other items are permitted, e.g. no persons, no Internet,

Note: The pages are double-sided. **PLEASE WRITE your name** on all pages! No questions during the quiz.

I, _____, understand the above statements and agree to follow these terms, and upon my honor, I swear that the answers provided are of my design and of my effort alone. I have not received nor viewed answers from any source but myself.

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1 Basic Semantics.

- (2 points) _____ refers to when a variable is bound to an attribute.
 - Binding Time
 - Static Scope
 - Allocation
 - Overloading
- (2 points) The _____ of a statement is the collection of all variables that are visible in the statement
 - Referencing Environment
 - Lifetime
 - Dynamic Binding
 - Precision
- (2 points) A _____ is a mapping from a collection of machine representations to a collection of semantic values
 - Scope
 - Data type
 - Dynamic Binding
 - Runtime stack

4. (2 points) A _____ variable is dynamically bound to a location/address.
- A. static
 - B. heap-dynamic
 - C. stack-dynamic
 - D. Both B and C
5. (5 points) The dangling pointer is a memory management concern for the language designer. A language designer can provide a “built-in” mechanism to mitigate this problem. Identify and Explain 1 such dangling pointer solution.
6. (5 points) Data types are limited by their finite storage. They are limited in precision and range. Provide an example of a data type and explain its limitations in precision and range.

2 Statements

1. (2 points) A(n) _____ conversion converts a value to a type that can include at least approximations of all of the values of the original type.
 - A. Narrowing
 - B. Widening
 - C. Coerced
 - D. Underflow
2. (2 points) A(n) _____ evaluation of an expression is one in which the result is determined without evaluating all operands and/or operators.
 - A. short-circuit
 - B. dynamic
 - C. compound
 - D. static
3. (2 points) _____ may be used to determine order of evaluations
 - A. Side effects
 - B. Operator associativity
 - C. Scoping Rules
 - D. Conversions
4. (2 points) A(n) _____ expression may have operands of different types.
 - A. short-circuit
 - B. binary
 - C. mixed mode
 - D. overloaded
5. (10 points) Define and Discuss the importance of understanding operator associativity within the context of the following example. Suppose a programmer codes the following assignment: $x = 2 * *3 * *2$. Assume $**$ is the exponentiation/power operator.

6. (10 points) Define referential transparency. Follow up: In pure functional languages there are no variables. Speculate as to whether a pure functional language adheres to referential transparency. Explain.
7. (5 points) Within the context of functional languages, define **applicative order** and **normal order** evaluation. Extend the discussion by supporting the following statement: Functional languages are well-suited for parallelization for improved efficiency.

3 Subprograms

1. (2 points) The _____ of a subprogram is the number, order and types of its formal parameters.
 - A. prototype
 - B. parameter profile
 - C. evaluation
 - D. closure
2. (2 points) When a parameter is _____ a copy of the parameter is assigned to the formal parameter
 - A. pass by reference
 - B. pass by result
 - C. pass by value
 - D. none of the above
3. (2 points) When multiple activations records are open, the _____ is used to point to the base of the activation record currently being executed
 - A. stack pointer
 - B. environment pointer
 - C. dynamic link
 - D. return address
4. (2 points) In _____ the dynamic link is traced back to evaluate identifier names.
 - A. stack scoping
 - B. dynamic scoping
 - C. dynamic binding
 - D. static scoping
5. (5 points) Identify and Explain 2 ways a programming language can facilitate polymorphic behavior of subprograms.

4 Object Oriented Programming

1. (2 points) _____ is a characteristic of an object oriented language closely related to abstraction and information hiding.
 - A. Encapsulation
 - B. Inheritance
 - C. Polymorphism
 - D. Dynamic dispatch

2. (2 points) The _____ is upheld when a variable of a class can be substituted for a variable of one of its ancestor classes in any situation without causing type errors and without changing the behavior of the program.
 - A. principle of inheritance
 - B. principle of substitution
 - C. principle of polymorphism
 - D. principle of abstract data types

3. (2 points) _____, or the truncation of objects, may occur in object oriented languages which provide for inheritance when objects are allocated on the runtime stack.
 - A. Object slicing
 - B. Dynamic dispatch
 - C. Subtyping
 - D. Supertyping

4. (2 points) A _____ is a class that is defined through inheritance.
 - A. derived class
 - B. superclass
 - C. base class
 - D. abstract class

5. (10 points) Define multiple inheritance. Discuss the main problem associated with permitting multiple inheritance in a programming language. Briefly explain how each C++, LISP, and Java deal with this problem (or don't deal with it).

6. (8 points) Define a class instance record (CIR). Discuss how class instance records help facilitate dynamic dispatch.

7. (10 points) Consider the concepts of inheritance and dynamic vs. static binding. In Java, all methods are dynamically bound unless the method is declared to be **final**, in which case it cannot be overridden and all bindings are static. Speculate as to why static binding is also used if the method is declared to be **private**.