Student ID: ________________________________

Software Metrics
Comprehensive Examination
Spring, 2007

I. (5 points)
Indicate to the left of each statement whether the statement is True (T) or False (F).
.

_____1. The estimated number of lines of code in a software product is the only known basis for estimating software development cost and schedule.

_____2. The median is an appropriate statistic to use in analyzing data across all four measurement scale types.

_____3. A development team in crisis should postpone collecting metrics until the problems have been solved.

_____4. It takes at least 2 appraisers to determine the repeatability of a measurement process.

_____5. We say that a statement involving measurement is meaningful if its truth value is invariant under transformations of allowable scales.

II. (10 points)
The following statements have omitted words or phrases which may be filled in from the list below. Certain words from the list may not be used at all; others may be used more than once. **FILL IN BY NUMBER ONLY.**

1. The total cost of software development is composed of the cost of performance of the specific work plus the Cost of (Poor) Quality that is composed of

(1) _____: Unnecessary repetition of any process step due to error.

(2) _____: Process steps needed to evaluate the product to determine if there are any errors.

(3) _____: Process steps to prevent (or reduce) errors from getting into the product.

2. Identify the scale type that is best described by the following characteristics:

(1) _____ Scale: Addition and subtraction are acceptable, but multiplication and division are not.

(2) _____ Scale: The empirical relation system consists only of different classes for which there is no notion of ordering.

(3) _____ Scale: The numbers can be ranked, but addition, subtraction and other arithmetic operations have no meaning.

(4) _____ Scale: The measurement mapping must start at zero and increase at equal intervals, known as units.

3. In the statement: “x is taller than y”, the phrase “taller than” is a(n) _____ for height.

4. A(n) _____ is a mapping from the empirical world to the formal, relational world.

Selection List

1. accuracy
2. appraisal
3. attributes
4. code and unit test
5. cohesion
6. consistent
7. correctness
8. costs
9. coupling
10. detailed design
11. empirical relation
12. heuristics
13. interval
14. measure
15. measurement
16. nominal
17. ordinal
18. precision
19. prevention
20. processes
21. products
22. ratio
23. resources
24. rework
25. right
26. value
27. yardstick

III.   (25 points)

Consider the following Java code:

```
public static void ShellSortAlgorithm ( int a[] )
{
        int h = 1;

        while ((h * 3 + 1) < a.length)
        {
           h = 3 * h + 1;
        }

         while( h > 0 )
        {
                int i = h – 1:
                while( i < a.length )
                {
                 /*
                * pick the last element in the set
                 */
                        int B = a[i];
                        int j = i;
                        while( (j >= h) && (a[j-h] > B) )
                         {
                                a[j] = a[j-h];
                                j -= h;
                         }

                        /*
                         *  insert B into the correct place
                        */

                        a[j] = B;
                        i++;
                 }
                 /*
                 * all sets h-sorted, now decrease set size
                */
                h = h / 3;
        }
   }
```

See the questions on the following page:

III.A. Create a flowgraph of this shell sort (15 points)

III.B. Using any technique that you have learned, calculate the value of the McCabe Cyclomatic Complexity Metric for this algorithm? (5 points)

III.C. For this algorithm, express the McCabe Metric in terms of the number of nodes and the number of edges of the flowgraph. (5 points)

IV. (15 points)

For the shell sort in problem III, count the number of lines of code under the following conditions.

1. Count the number of physical lines (including blank lines). (3 points)

2. Count the number of physical lines except for blank lines and comments. (3 points)

3. Count the number of executable statement. (3 points)

4. In using line of code counts as a basis for prediction development cost and schedule, which of the above three methods would you use. Explain your choice. (6 points)

V. (25 points)

Of the several metrics that have be proposed to measure the complexity of Object Oriented code, coupling between object classes (CBO) is one of the best understood. i.e., for a given class, this measure is defined to be the number of other classes to which the class is coupled.

Which of the following complexity metric properties hold for CBO and which do not? Provide the rationale for your answer.

Assume that P, Q and R are object classes and M(P), M(Q), M(R) represent the CBO of each class. Further, P|Q represent the combining of P and Q into one class.

1. There are classes P and Q for which $M(P) \neq M(Q)$.

2. There are distinct classes P and Q for which $M(P) = M(Q)$.

3. For any classes P and Q, we have $M(P) \leq M(P|Q)$ and $M(Q) \leq M(P|Q)$.

V. continued

4. There exist classes P, Q and R such that $M(P) = M(Q)$ but $M(P|R) \neq M(Q|R)$.

5. There exist classes P and Q such that $M(P) + M(Q) < M(P|Q)$.

VI. (20 points)

Suppose the software engineers in your organization tell you that they want to modify their process to bypass the Unit Test phase and go right to Integration. The unit tests are very time consuming to set-up because they require writing much “throw-away” code such as unit test drivers and stubs. Suppose further that you are not willing to give up on unit testing yet. Instead, you would like to make the process more efficient (i.e., take less time), so you decide to try a Goal-Question-Metric exercise. You set a Goal “to improve the efficiency of our unit test process.” Identify at least 3 questions that must be answered to know if progress is being made in making the process more efficient. Finally, identify one or more metrics that will supply the necessary information to answer each question. Note: this question does not have a unique answer. Use the reverse side of this page if you need more space.

VI. continued