CONCORDIA UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING
SOEN331: Introduction to Formal Methods for Software Engineering

Sample Final examination

1. For propositions p and q, the inverse of $p \to q$ is logically equivalent to

   (a) $\neg p \to \neg q$.

   (b) $q \to p$.

   (c) $p \leftrightarrow q$.

   (d) $\neg q \to \neg p$.

2. Consider the following statement: $p \to q, q \vdash p$.

   (a) This is a validating pattern, called "modus ponens."

   (b) This is a non-validating pattern called "affirming the consequent" (or "converse error").

   (c) This is a validating pattern called "modus tollens."

   (d) This is a non-validating pattern called "denying the antecedent" (or "inverse error").

   The following statements refer to Questions 3 - 6:

   (i) $\forall\ x\ P(x)$.

   (ii) $\forall\ x\ [\neg P(x)]$.

   (iii) $\exists\ x\ P(x)$.

   (iv) $\exists\ x\ [\neg P(x)]$.

3. Indicate any and all pairs of statements that are *contradictories*:

   (a) (i, ii) and (iii, iv).

   (b) (i, iv) and (ii, iii).

   (c) (ii, iii).

(d) (i, iii) and (ii, iv).

4. Indicate any and all pairs of statements that are *contraries*:

   (a) (i, ii).

   (b) (i, ii) and (iii, iv).

   (c) (i, iv) and (ii, iii).

5. Indicate any and all pairs of statements that are *subcontraries*:

   (a) (i, ii).

   (b) (i, iii).

   (c) (ii, iv).

   (d) (i, iv).

6. Indicate any and all pairs of (superaltern-subaltern) statements:

   (a) (i, iv) and (ii, iii).

   (b) (iv, i) and (i, iv).

   (c) (i, iii) and (ii, iv).

   (d) (iii, i) and (iv, ii).

7. The binary relation "is reachable from" on the set of nodes of a directed mathematical graph, can be best described as follows:

   (a) It is reflexive and symmetric.

   (b) It is reflexive but not symmetric.

   (c) It is symmetric and transitive.

   (d) It is reflexive and transitive.

   (e) It is reflexive, symmetric, but not transitive.

8. The statement "It is always the case that once the machine accepts a coin followed by a selection, the machine will eventually provide coffee or tea" can be translated into formal logic as follows:

   (a) $\Box(coin \land \bigcirc selection \to \Diamond(coffee \lor tea)$.

   (b) $\Box(coin \land \bigcirc selection \to \bigcirc(coffee \lor tea)$.

   (c) $\Box(coin \land \bigcirc selection \to \Diamond(coffee \oplus tea)$.

   (d) $\Box(coin \land selection \to \Diamond(coffee \oplus tea)$.

   (e) $\Box(coin \land \bigcirc selection \to \bigcirc(coffee \oplus tea)$.

9. The statement "A process is active unless it is placed in a waiting queue" can be translated into formal logic as follows:

(a) *active* $\mathcal{W}$ *placed in queue.*

(b) *active* $\mathcal{U}$ *placed in queue.*

(c) *placed in queue* $\mathcal{R}$ *active.*

10. For a proposition p, $\Box p$ supports the following property:

    (a) Guarantee.

    (b) Stability.

    (c) Recurrence.

    (d) Invariance.

11. For propositions p and q, $p \to (\Diamond q)$ supports the following property:

    (a) Precedence.

    (b) Response.

    (c) Correlation.

    (d) None of the above.

The following paragraph refers to Questions 12 - 13:

Consider the case of a shared (concurrent) resource. Let $criti_i$ denote that $thread_i$ is in the critical section, and $wait_i$ denote that $thread_i$ is waiting.

12. The expression $\Box(\neg criti_1 \vee \neg criti_2)$ refers to the following property:

    (a) Weak fairness.

    (b) Strong fairness.

    (c) Unconditional fairness.

    (d) Liveness.

    (e) Safety.

13. The expression $(\Diamond\ criti_1) \wedge (\Diamond\ criti_2)$ refers to the following property:

    (a) Weak fairness.

    (b) Strong fairness.

    (c) Unconditional fairness.

    (d) Liveness.

    (e) Safety.