COL869: Minor-1

Rules

1. You may use class notes and course slides for reference.

2. In all programs all variables are initialized to zero.

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1. Mark the dependencies in the following program. (5)

$$
\begin{array}{ll}
1. & a := 0; \\
2. & b := 0; \\
3. & c := a + b; \\
4. & \textbf{if}(c == 0)\ \{ \\
5. & \quad b := 4; \\
6. & \}\textbf{else}\ \{ \\
7. & a := 5; \\
8. & \} \\
9. & d[b] := a;
\end{array}
$$

2. Show the big-step operational semantics derivation to compute value of i at the end of the loop. Are the steps same in small-step semantics? (7+3=10)

$$
\begin{array}{l}
\mathsf{int}\ i := 0; \\
\textbf{while}(i < 2) \\
\quad i := i + 1;
\end{array}
$$

3. Consider the following outcome $a = c = 1, b = d = 0$ for the program below. Explain if it is an allowed/disallowed by RA, TSO, PSO, RMO? Explain the reasons. (4 X 5 = 20)

$$
X := 1; \left\| \begin{array}{l} a := X; \\ b := Y; \end{array} \right\| \left\| \begin{array}{l} c := Y; \\ d := X; \end{array} \right\| Y = 1;
$$

4. Write operational derivations for the outcome $a = 1, b = 0, X = 1$ for the program below in TSO. Insert minimal number of fences to restrict the respective behaviors. (10+5=15)

$$\begin{array}{l} X := 1; \\ a := X; \\ b := Y; \end{array} \Bigg\| \begin{array}{l} Y := 2; \\ X := 2; \end{array}$$

5. Show that RA preserves coherence and atomicity. (8+7 = 15)

6. Suppose a execution graph G satisfies coherence. Suppose following the execution graph construction step we append a update event $\mathsf{St}(X, v, v')$ to G in thread i to construct G'. Define G' components and show that G' is coherent. (5+10=15)

7. Suppose a processor follows TSO. Modify the processor so that maximum write buffer size is 2. Can it still follow TSO model? If yes, explain why and if no, explain why not. (10)