

Q1 ~~X~~ a

Next state must satisfy (a)

$S1 \rightarrow S2$ satisfies (a)

$S2 \rightarrow S3$ satisfies (a, b)

$S3 \rightarrow S1$ satisfies (a)

$S4 \rightarrow S2$ satisfies (a)

b) ~~XXXX~~ a

After 3 transitions

$S1 \rightarrow S2 \rightarrow S3$ satisfies (a)

$S2 \rightarrow S3 \rightarrow S1$ satisfies (a)

$S3 \rightarrow S1 \rightarrow S2$ satisfies (a)

$S4 \rightarrow S2 \rightarrow S3$ satisfies (a)

c) ~~G~~ b

b must be held globally (every state must have b)

~~X~~

G b is false as it isn't held globally

d) $G F a$

Globally a must eventually hold (on all paths, a is always reachable)

S1 a is true

S2 a is true

S3 a is true

S4 a isn't true S4-S2 a is true

e) $G(b U a)$

Globally b must hold until a becomes true

S1 b isn't true

S2 b isn't true

S3 b is true and a is true

S4 b is true & a is reachable from S2

f) $F(a U b)$

b must occur and before that a must hold

S1 holds b S3 holds a before

S2 holds

Q2

a = c holds globally in S5

b) = Yes because c is reachable from every state

c) = Yes because all paths either skip $\neg c$ or eventually reach c

d) = No c doesn't hold in S2, S3, S4 or S5

e) Holds because all states have paths where a holds until b or c holds including start state S2

X

Q3

a) $G(\text{red} \rightarrow (X) \neg \text{green})$

↑ ↑ ↑
Globally red next state cannot be green

b) Eventually (F), the light becomes green

F green

c) $G(\text{red} \rightarrow F\text{green})$

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d) $G(\text{red} \rightarrow F(\text{yellow} \wedge F\text{green}))$

Globally whenever the light is red, there must exist a point in the future (F) where it becomes yellow, followed by another point (F) where it becomes green.

Q4

a) $G \neg (C \text{Peter.use} \wedge \text{Jane.use})$

b) $G(\text{Peter.use} \rightarrow F \text{Peter.release})$
 $G(\text{Jane.use} \rightarrow F \text{Jane.release})$

c) $G(\text{Peter.request} \rightarrow F \text{Peter.use})$
 $G(\text{Jane.request} \rightarrow F \text{Jane.use})$

d) $G F (C \text{Peter.request}) \wedge G F (C \text{Jane.request})$
*

e) $\text{Peter.use} \rightarrow F(C \text{Jane.use} \wedge \neg \text{Peter.use})$
 $\text{Jane.use} \rightarrow F(\text{Peter.use} \wedge \neg \text{Jane.use})$