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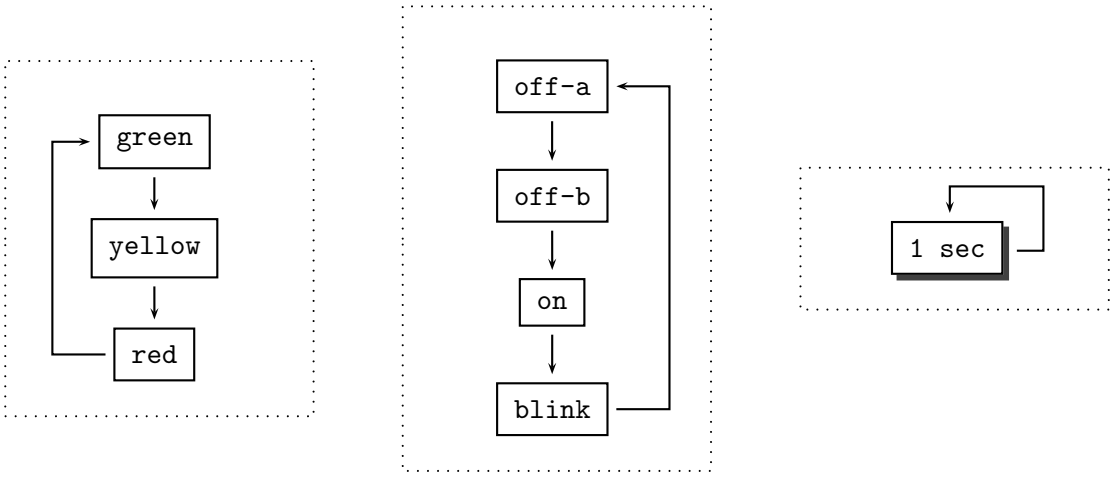
Backup Exam Solutions

Embedded Systems

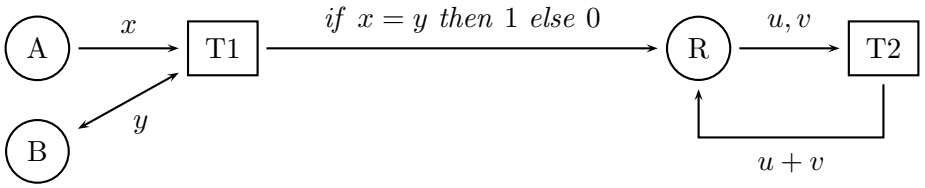
Problem 1 (Statecharts)



Transitions

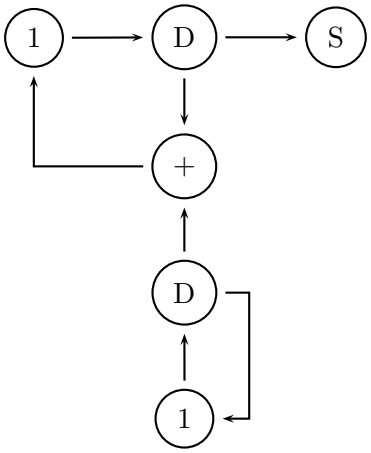
- `green` → `yellow: request`
- `yellow` → `red: after(10, tick)`
- `red` → `green: after(50, tick)`
- `off-a` → `off-b: request`
- `off-b` → `on: after(10, tick)`
- `on` → `blink: after(20, tick)`
- `blink` → `off: after(30, tick)`
- `1 sec` → `1 sec: timeout/tick`

Problem 2 (Petri nets)



Priorities: T1 > T2

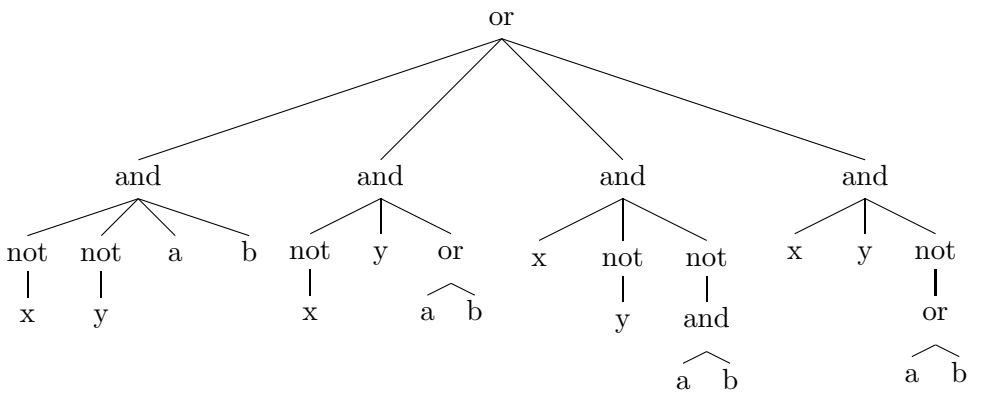
Problem 3 (Kahn process networks)



Problem 4 (VHDL)

(a)
```
architecture b of clb is
begin
   c <= (not x and not y and     (a and b)) or
        (not x and     y and     (a or  b)) or
        (    x and not y and not (a and b)) or
        (    x and     y and not (a or  b));
end b
```

(b)



(c) 40ns (the height of the above tree multiplied by 10ns)

Problem 5 (Reliability)

The reliability of the whole system is $e^{-n\lambda t}$, its failure rate is $n\lambda$, and its MTTF is $(n\lambda)^{-1}$.

Problem 6 (Reliability)

The minimum n such that

$$1 - \left(1 - \frac{1}{2}\right)^n > \frac{9}{10}$$

is equal to 4. Thus, the system costs 400 euros.

Problem 7 (Markov processes)

Solve

$$\begin{aligned} a &= (1/3)a + (1/2)b \\ b &= (2/3)a + (1/2)b \\ a + b &= 1 \end{aligned}$$

obtaining

$$\begin{aligned} a &= 3/7 \\ b &= 4/7 \end{aligned}$$

Problem 8 (A/D conversion)

$$
\begin{array}{lll}
10000 \implies & 11.0 > 9.2 & \implies 0 \\
01000 \implies & 7.0 < 9.2 & \implies 1 \\
01100 \implies & 9.0 < 9.2 & \implies 1 \\
01110 \implies & 10.0 > 9.2 & \implies 0 \\
01101 \implies & 9.5 > 9.2 & \implies 0 \implies 01100
\end{array}
$$

$$
\begin{array}{lll}
10000 \implies & 11.0 < 16.4 & \implies 1 \\
11000 \implies & 15.0 < 16.4 & \implies 1 \\
11100 \implies & 17.0 > 16.4 & \implies 0 \\
11010 \implies & 16.0 < 16.4 & \implies 1 \\
11011 \implies & 16.5 > 16.4 & \implies 0 \implies 11010
\end{array}
$$

Problem 9 (Scheduling)

$\sigma_{\max}$: `111111222233334445555555`

σ_{late} : `22223333444555555555111111`

Problem 10 (Scheduling)

$$
\begin{array}{ll}
C_1 = 2 & D_1 = T_1 = 4 \\
C_2 = 2 & D_2 = T_2 = 5 \\
C_3 = 1 & D_3 = T_3 = 10
\end{array}
$$

Problem 11 (Scheduling)

$$
\begin{array}{lll}
C_1 = 1 & D_1 = 2 & T_1 = 2 \\
C_2 = 1 & D_2 = 1 & T_2 = 4
\end{array}
$$

Problem 12 (Scheduling)

$$
C_1 = 2 \qquad D_1 = 1 \qquad T_1 = 4
$$

Problem 13 (Scheduling)

(a) No. Consider:

$$C_1 = 2 \qquad d_1 = 2$$
$$C_2 = 1 \qquad d_2 = 3$$

(b) Yes. Clearly, preemption does not help minimizing $\overline{R}$. If σ is a schedule that minimizes $\overline{R}$, we can convert it into a SJF-schedule σ' by repeatedly interchanging two tasks.

We need to show that each interchange does not increase $\overline{R}$. Without loss of generality, we are interchanging two consecutive tasks. Before the interchange we have

xxx aaa bbb yyy

and $\overline{R}$ is

$$c_a + c_a + c_b + \alpha$$

After the interchange we have

xxx bbb aaa yyy

and $\overline{R}$ is

$$c_b + c_b + c_a + \alpha$$

Moreover, we have $c_b < c_a$ which implies that $\overline{R}$ becomes smaller after the interchange.

(c) Yes, because there are no idle times in SJF.

(d) No. Consider:

$$C_1 = 2 \qquad d_1 = 2 \qquad w_1 = 3$$
$$C_2 = 1 \qquad d_2 = 3 \qquad w_2 = 1$$

(e) No. Same counterexample as in (a).