Prof. Bernd Finkbeiner

Problem Set 9

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Due: July 10, 2007, 9:14 am

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Embedded Systems

Problem 1 (Scheduling) [20 points]

Consider the following set of tasks:

	J_1	J_2	J_3	J_4
a_i	0	4	2	6
C_i	6	2	4	2
D_i	18	4	7	4

Assuming preemption is not allowed, find a feasible schedule on a uniprocessor machine using Bratley's algorithm. Draw the full scheduling tree and mark the branches that are pruned. (*Note:* The D_i are relative deadlines, i.e., the absolute deadlines are $d_i = a_i + D_i$.)

Problem 2 (Scheduling) [40 points]

Consider the following set of tasks $\mathcal{J}$:

	A	B	C	D	E	F	G
a_i	0	0	0	0	0	0	0
C_i	2	3	3	5	1	2	5
D_i	25	25	25	25	25	25	25

and the following precedence relations:

$$A \to C$$
$$B \to C \qquad\qquad B \to D$$
$$C \to E \qquad\qquad C \to F$$
$$D \to F \qquad\qquad D \to G\,.$$

(a) Apply the algorithm of [Chetto, Silly, and Bouchentouf, 1990] to obtain a schedule $\mathcal{J}^*$ with modified timining parameters and no precedence constraints. **[20 points]**

(b) Find an EDF-schedule for $\mathcal{J}^*$. **[20 points]**

Problem 3 (Fault tree analysis) [40 points]

Figure 1 shows a socalled *System with standby*: If the Fehlererkennung-module diagnoses a defect in the Hauptrechner-module then the system shifts to using the Reserverechner-module. The fault tree in Figure 2 describes which combination of events causes the Top Event "Systemausfall" (System failure). For this the following events are distinguished:

- A : Malfunctioning of the Hauptrechner-module.

- B : Malfunctioning of the Reserverechner-module.

- C : The Fehlererkennung-module does not recognize the failure of the Hauptrechner-module.

- D : The Fehlererkennung-module diagnoses a malfunction of the Hauptrechners-module, even if that module is functioning.

- E : The Switch-module does not switch to the Fehlererkennung-module.

Please note that the condition below the inhibitor-gate (the octagonal one) corresponds to the negation of the event E. Thus, the inhibitor gate corresponds to the boolean expression $D \wedge \neg E$.

(a) The fault tree describes a boolean function in the variables A, B, C, D, and E. Determine all the prime implicants of this functions. (By using, for instance, the Quine–McCluskey algorithm).   **[20 points]**

(b) A prime implicant defines a minimal set of events whose collective occurrence implies the Top Event. Thus, every prime implicant describes a minimal cut set of the analyzed system. Let the probability of the events be $P(A) = 0.1$, $P(B) = 0.1$, $P(C) = 0.06$, $P(D) = 0.02$, and $P(E) = 0.05$. Compute a lower bound of the reliability of the system using the minimal cut sets.   **[20 points]**
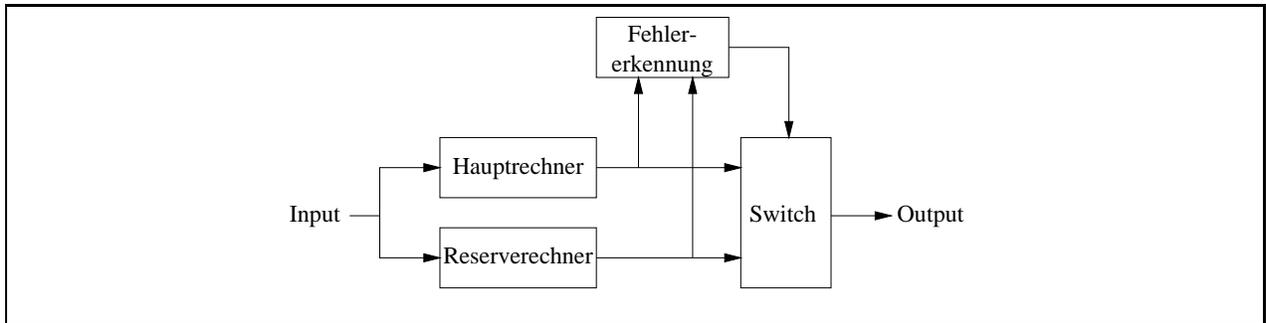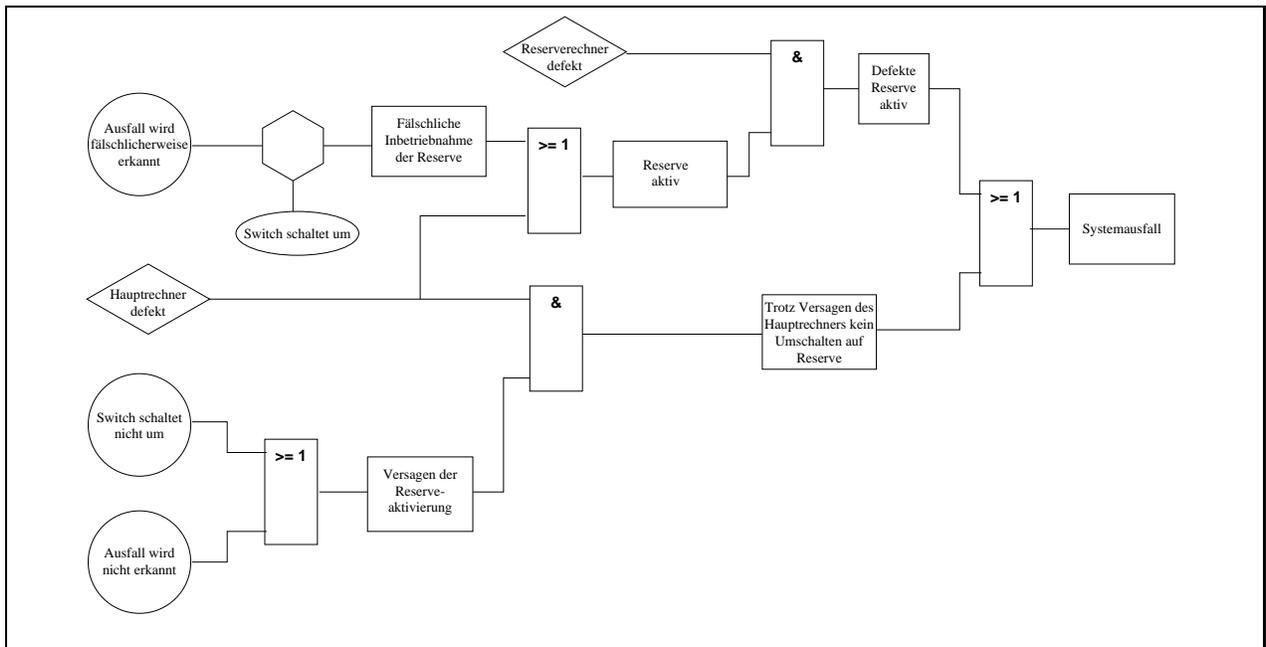

Figure 1: System with standby.

Figure 2: Fault tree.