1 Introduction

<u>Problem 1.1:</u> Machine identification.

Given a number of strongly connected sequential machines in reduced form R_j, $R_j \in \mathcal{R}(4,1,1)$. Thus, each R_j has 4 internal states, 1 input, and 1 output symbol. The following definitions will be used in this problem:

- A homing sequence is an input sequence such that the final state is uniquely determined from the output sequence regardless of initial state,
- a synchronizing sequence is an input sequence such that the final state is fixed independent of initial state or output sequence,
- a distinguishing sequence is an input sequence such that the corresponding output sequence is different for each initial state.

Question 1 An input sequence I_1=(1111111) is applied to R_1 yielding the output sequence O_1=(0010001). Determine the known parts of the state transition table $\mathcal{T}_1$ for R_1. Is I_1 a homing sequence or a synchronizing sequence for R_1? Could I_1 be shorter without loss of information?

Question 2 In order to further investigate the state transition table $\mathcal{T}_1$ for R_1, the sequence I_2=(0111...) is appended to I_1. Discuss the implications of the output response O_2=(1000100010...) on $\mathcal{T}_1$. Determine the minimum length of I_2, whereby no information is lost.

Question 3 Determine $\mathcal{T}_1$ for R_1, when applying I_3 yields O_3:
I_3=(1111111011101101111011) and O_3=(00100011000010000100001).

Question 4 The input sequence I_1 applied to R_{4a}, R_{4b}, and R_{4c} yields output sequences O_{4a}=(0010010), O_{4b}=(0001111), and O_{4c}=(0000000), respectively. Answer the similar questions as in Question 1.

Question 5 O_5=(00000000) is obtained when applying I_5=(11110000) to R_5. What may be deduced about R_5?

$\mathcal{T}_6$	x=0	x=1
α	β,0	δ,0
β	α,0	β,0
γ	δ,1	α,0
δ	δ,1	γ,0

$\mathcal{T}_8$	x=0	x=1
α	γ,0	δ,1
β	γ,0	α,1
γ	α,1	β,0
δ	β,0	γ,1

Question 6 Construct a homing sequence I_6 for R_6 described by the state transition table $\mathcal{T}_6$.

Question 7 Construct a synchronizing sequence I_7 for R_6.

Question 8 Construct a minimum length distinguishing sequence I_8 for R_8 described by the state transition table $\mathcal{T}_8$.

2 Fault Modeling

Problem 2.1: Undetectable faults.

Devise a circuit that has an undetectable stuck-at fault.

Problem 2.2: Check point faults.

The primary inputs and the fanout branches of a circuit are called check points. In practice, the check points of a circuit are readily determined. This fact is used for fast fault collapsing.

Question 1 Show that in a fanout-free combinational circuit $\mathcal{C}$, any test set that detects all single stuck faults on the primary inputs of $\mathcal{C}$, detects all single stuck faults in $\mathcal{C}$.

Question 2 Show that in a combinational circuit $\mathcal{C}$, any test set that detects all single stuck faults on the primary inputs and the fanout branches of $\mathcal{C}$, detects all single stuck faults in $\mathcal{C}$.

Problem 2.3: Check point faults.

Let d_f denote the detection probability of a fault f under application of random test patterns. Show that the fault with the smallest detection probability in a circuit is a checkpoint fault.