Soft Eng 3M04
Mid-Term IIb 2003
Dr. Jacques Carette

Name: _____

Student No.: _____

- This test contains 5 questions on 3 double-sided pages (including this one).

- This test will be marked out of 50.

- Answer the question in the space provided.

- Make sure that your name is on all sheets.

- You may seperate the last page with the MIS/MID.

- Make sure that you do not get stuck on one question; use your time wisely.

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1. Give the value of all state variables, output and/or exception after each call in the calling sequence for the MIS and MID on the last page. On the first line, write down the complete initial state. Assume that 'a=char. [32]

call	state MIS	MID	output MIS	MID	exceptions MIS	MID
addfront(z)						
addfront(a)						
addfront(12)						
* addback(b)						
get(0)						
get(3)						
addfront(w)						
get(3)						
* addback(a)						
* erase()						
addback(c)						
reverse(a)						
addfront(a)						
get(2)						
get(3)						

2.

$$(|a| + |c| = s + t) \wedge \forall i : int.(0 \le i < |a| \rightarrow a[i] = d[Max - 1 - i])$$

$$\wedge \ \forall i : int.(0 \le i < |c| \rightarrow c[i] = d[i])$$

Evaluate the abstraction function given above for the starred (*) states indicated in question 1. Please show all details of the evaluation. *[8]*

addback(b)	
addback(a)	
erase()	

3. The abstraction function above is correct (in the sense that it always evaluates to true). However, it is weaker than one would want, as there are relations between the MIS and MID which are not captured by this function. Provide a better abstraction function. *[3]*

4. Given the declarations

val Γ_0 : 'b set
val Γ_1 : 'b seq
val α : ('c $\rightarrow$ bool) $\rightarrow$ (('c $\rightarrow$ 'a) $\rightarrow$ ('c set $\rightarrow$ 'a set))
val β : 'c $\rightarrow$ bool
val η : 'c $\rightarrow$ 'a

(a) Give an example of values for Γ_0 and Γ_1 such that the elements contained in Γ_0 and Γ_1 are identical but $|\Gamma_0| \neq |\Gamma_1|$. *[3]*

(b) Write a formula that states that all the elements of Γ_0 are also elements of Γ_1. *[2]*

(c) What is the type of (β, η) *[2]*

The following MIS and MID will be used for several questions.

Common information:

Used External Functions: NONE

Used External Data Types: 'b

Exported Constants: Max:int = 4

Exported Functions:

Name	Input Types	Output Types	Exceptions
addfront	'b		full
addback	'b		full
get	int	'b	invalid
erase			

MIS	**MID**
State Variables: a : 'b seq := <> c : 'b seq := <>	Variables: 'b d[0..Max-1] int t := 0, s := 0

MIS

State Variables:
    a : 'b seq := <>
    c : 'b seq := <>

Transition Functions:
addfront(n:'b)
    Exception: $|a| + |c| \geq$ Max $\Rightarrow$ full
    Transition: $a := a \parallel n$

addback(n:'b)
    Exception: $|a| + |c| \geq$ Max $\Rightarrow$ full
    Transition: $c := c \parallel n$

'b get(i:int)
    Exception: $i \leq 0$ or $i > |a| + |c| \Rightarrow$ invalid
    Output: if $i \leq |a|$ then $a[i-1]$ else
                    reverse$(c)[i - |a| - 1]$

erase()
    Transition: a := <>; c := <>;

'b seq reverse(i:'b seq)
    Output: if $|i| = 0$ then <>
              else reverse$(i[1..|i| - 1]) \parallel i[0]$

MID

Variables:
    'b d[0..Max-1]
    int t := 0, s := 0

Exported Functions:
addfront(n:'b)
    if $t + s \geq$ Max then ERROR(full)
    else s := s + 1; d[Max-s] := n;

addback(n:'b)
    if $t + s \geq$ Max then ERROR(full)
    else d[t] := n; t := t + 1;

'b get(i:int)
    if $i \leq 0$ or $i > t + s$ then ERROR(invalid)
    else if $i \leq s$ then RETURN(d[Max-i])
    else RETURN(d[t-(i-s)])

erase()
    t := 0; s := 0;

Remember the convention that negative selection ranges in a sequence means the result is <>.