UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 1993/94

April 1994

CSI502 - Functional Programming

Masa: [3 jam]

ARAHAN KEPADA CALON:

- Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.

Answer **ALL** questions.

1. (a) (i) Define briefly the notions of:
   - Cartesian product of A and B sets,
   - relations and functions,
   - graph of function,
   - domain and range of function,
   - functional term, value of term.

   (ii) Let z=f1(x,y), x=f2(z,x1) be total functions and x,y,z,x1 be variables. Given the following words:

   f1(x,y) -
   f2(x1,z) -
   f1(f2(x1,f1(x,y)) -
   f1 f2(x1,z) -
   f2(x1,z,x) -

   Indicate which of these words are terms (Yes/No)

   (25/100)

   (b) (i) Define an operator of primitive recursion f=**R**(g,h).

   (ii) Give an example of a primitive recursive function.

   (iii) Is the function $z=x^y$ a primitive recursive function (Yes/No).

   (25/100)

   (c) Define an operator of unbounded minimization **M**(f)

   (15/100)

   (d) (i) Define the class of primitive recursive functions.

   (ii) State and discuss the meaning of Church-Kleene thesis.

   (iii) Prove that x+y is a primitive recursive function.

   (iv) What are the functions f5 and f6 given by the schema of recursive derivation? The answer must be written as elementary function, for example, z=f(x,y)=x*y. Will you compute, please, the value f(2) realizing the schema of recursive derivation.

Recursive schema

$f1=\lambda x[x]$

$f2=\lambda x[x+1]$

$f3=\lambda x_1x_2x_3[x_2]$

f4=f2 f3

f5 to satisfy

$$f5(0,x2)=f1(x2)$$

$$f5(y+1,x2)=f4(y,f5(y,x2),x2)$$

f=f6=f5(f1,f1)

END of recursive schema

(35/100)

2. (a) Give the definition of the following objects and notions:
   (i) variables, operations, algorithm representation ,
   (ii) direct and data flow controle,
   (iii) mapping of an algorithm,
   (iv) realization of an algorithm.
   (v) comparative nonprocedurality of an algorithm representations

   (25/100)

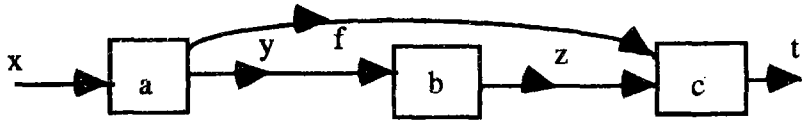
   (b) (i) Give a definition of an asynchronous block, trigger and control functions.
   (ii) Define an asynchronous program.
   (iii) Give an example of asynchronous program

   (25/100)

   (c) Define the rules of asynchronous program execution, including the following:
   (i) rules of asynchronous block execution,
   (ii) condition of asynchronous program completion,
   (iii) rules of asynchronous program execution.

   (25/100)

(d) Develope an asynchronous program of pipe-line execution of the algorithm (Fig. 1) Procedures input(v,n) and output(v,n) can be used to take or to put a value from/in n-values box v If you want, instead of trigger and control functions you can use Petri nets to define a control.



y - 5 values box
z - 3 values box
f - 3 values box

x, t - unlimited boxes

Fig. 1.

(25/100)

3. (a) Define a formal model of computations including:
   (i) computational model, terms and their attributes,
   (ii) non-interpreted computations (notion of (V,W)-plan),
   (iii) algorithm of (V,W)-plan building with minimum number of terms,
   (iv) notion of interpretation.

(40/100)

(b) Describe the derivation algorithm, including:
   (i) the formulation of problem of program synthesis,
   (ii) a bottom-up part of algorithm,
   (iii) an up-down part of algorithm,
   (iv) feasible modifications of problem of program synthesis

(35/100)

(c) Describe an algorithm to buid an application problem solution algorithm, including:
   (i) an algorithm of choice,
   (ii) list basic strategies of operation choice.

(25/100)

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