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UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
Academic Session 2004/2005

March 2005

**CPT104 – Introduction to Logic and Abstraction**

Duration : 3 hours

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**INSTRUCTIONS TO CANDIDATE:**

- Please ensure that this examination paper contains **FOUR** questions in **FIVE** printed pages before you start the examination.
  - Answer **ALL** questions.
  - This is an 'Open Book' Examination.
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ENGLISH VERSION OF THE QUESTION PAPER

1. (a) Given the following atomic propositions:

R : Hamid saves money

S : Hamid has enough saving

T : Hamid will go for a tour

Based on the above propositions, convert the following expressions into simple English (Use the related rules if needed).

(i)  $R \wedge S \Rightarrow T$

(ii)  $R \wedge \neg S \vee \neg R \Rightarrow \neg T$

(iii)  $\neg(S \wedge R) \Rightarrow \neg T$

(iv)  $T \Leftrightarrow R \wedge S$

(20/100)

- (b) Use truth table to determine the conditions/situations that make the expression A below a valid proposition.

$$A \equiv (X \Rightarrow \neg Y) \Rightarrow (X \wedge Y) \Leftrightarrow Z$$

(10/100)

- (c) Generate the complete disjunctive normal form for function f below using algebraic manipulation:

$$f = B \vee A \vee (B \wedge \neg C)$$

(20/100)

- (d) Given the following argument:

If Erin likes traveling, Erin will learn many languages. If Arif is sincere, Arif likes Erin. But if Erin likes traveling and Erin does not learn many languages, Arif does not like Erin. Erin does not learn many languages. Therefore, if Arif likes Erin, Arif is not sincere.

- (i) Represent the above argument in symbolic forms.

- (ii) Prove that the above argument is valid using theorem deduction.

(50/100)

2. (a) Given the following predicates:

$R(x)$  :  $x$  is a city

$S(x)$  :  $x$  is busy

$T(x)$  :  $x$  has many shopping centers

$U(x)$  :  $x$  attracts foreign tourists

Assuming that the universe of discourse is the set of all places in Malaysia.

Provide the symbolic form for each of the sentence below:

- (i) All cities are busy.
- (ii) Not all cities have many shopping centers.
- (iii) There are some cities, which are busy but attract foreign tourists.
- (iv) Some cities do not have many shopping centers or do not attract foreign tourists.

(20/100)

(b) Given set  $Z = \{\text{Johor Bahru, Kuantan, Kuala Lumpur, Bandaraya Melaka}\}$  as the universe of discourse. Based on the predicate  $R$ ,  $S$ ,  $T$  and  $U$  given in question 2(a) above, the values are **only true** for the following instantiations:

- $R(\text{Johor Bahru}), S(\text{Johor Bahru})$
- $R(\text{Kuantan})$
- $R(\text{Kuala Lumpur}), S(\text{Kuala Lumpur}), T(\text{Kuala Lumpur})$
- $R(\text{Bandaraya Melaka}), U(\text{Bandaraya Melaka})$

Determine the truth value for each of the following expressions. Show the work flow.

- (i)  $\forall x R(x) \Rightarrow \exists x R(x)$
- (ii)  $\neg \forall x R(x) \Rightarrow \neg \forall x S(x)$
- (iii)  $\exists x R(x) \Rightarrow \forall x (S(x) \wedge T(x))$
- (iv)  $\forall x (R(x) \Rightarrow T(x)) \Rightarrow \neg \exists x U(x)$

(40/100)

(c) Prove the following argument:

$$\frac{(\forall x)(\forall y)(F(x) \Rightarrow (G(y) \Rightarrow H(x,y)))}{(\forall y)(\exists x)(F(x) \wedge \neg H(x,y) \Rightarrow \neg G(y))}$$

(40/100)

3. (a) Given the following specification:

$$\text{pasukan} : \text{id\_pasukan} \xrightarrow{m} \text{id\_pemain-set}$$

The table below provides an example value for variable L of type **pasukan** where **id\_pasukan** is a 3 digit number and **id\_pemain** is a 4 digit number.

L	210	$\mapsto$	{3040, 2213}
	123	$\mapsto$	{6220}
	100	$\mapsto$	{4410, 9048, 6610}

Provide answer to each of the following expressions:

- (i)  $\text{id\_pemain}(100)$
- (ii)  $\text{dom } L$
- (iii)  $\text{rng } L$
- (iv)  $\{210 \mapsto \{1402\}, 888 \mapsto \{2210, 4320, 1111\}\} \upharpoonright L$
- (v)  $\{210, 888, 100\} \triangleleft L$

(30/100)

(b) If  $S = [C, P, T, 1, 0, 4, 2, 0, 0, 5]$ , provide answer to each of the following expressions:

- (i)  $\text{len } S$
- (ii)  $\text{inds } S$
- (iii)  $\text{elems } S$
- (iv)  $\text{tl } (\text{tl } s)$
- (v)  $S^{\wedge}[u, s, m]$
- (vi)  $\text{hd } (\text{tl } s)$

(30/100)

- (c) (i) A car rental company is having a special offer for its customers. For the first 3 days of renting, the rate is RM110 per day, followed by an additional RM100 per day for the next 7 days. A customer renting more than 10 days will be charged at RM90 per day. Provide an implicit specification for a function that calculates total payment for every customer. Input for this function is the number of days a customer rents a car.
- (ii) During festive seasons, the above car rental company gives a 10% discount for total payments exceeding RM1000. Provide an implicit specification for the function used to calculate the discounts.
- (40/100)
4. Your first assignment as an information system officer in a private university is to develop a system to manage the panel clinics of the university. All the information of the university associate panel clinics is kept in the system for better management. The data that needs to be captured for each panel clinic are clinic name, owner of the clinic, IC number of the owner, clinic code, clinic address, whether operating 24 hours or not, telephone number, year appointed as panel clinic, number of registered students in the clinic and number of registered staff in the clinic.
- (a) Define a suitable composite object to represent the above data.
- (20/100)
- (b) Provide an implicit function specification called Year\_Appointed to determine the year a clinic is appointed as panel clinic.
- (10/100)
- (c) For a given panel clinic, determine whether the number of registered students exceeds 200 and the number of registered staff exceeds 100. Provide an implicit function specification called Count for the above purpose.
- (20/100)
- (d) Assume all data of the panel clinics are represented using set structure. Provide an implicit function specification to compute the number of panel clinics operating 24 hours, which have been appointed by the University since 1998 until now.
- (25/100)
- (e) Provide a specification for an operation to produce a list of owner names for those panel clinics, which have been appointed in the year 2000.
- (25/100)