Universiti Malaysia PAHANG

Engineering • Technology • Creativity

FACULTY OF COMPUTER SYSTEMS & SOFTWARE ENGINEERING

FINAL EXAMINATION

COURSE	:	FORMAL METHODS
COURSE CODE	:	BCS2213
LECTURER	:	Dr. BALSAM ABDULJABBAR MUSTAFA
DATE	:	6 JUNE 2012
DURATION	:	2 HOURS
SESSION/SEMESTER	:	SESSION 2011/2012 SEMESTER II
PROGRAMME CODE	:	BCS

INSTRUCTIONS TO CANDIDATE:

1. This question paper consists of **FIVE (5)** questions. Answer **ALL** questions.
2. Write your answers in the answer booklet provided.
3. Answer EACH question on a new page.
4. All calculations and assumptions must be clearly shown.

EXAMINATION REQUIREMENTS:

NONE

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

This examination paper consists of **SIX (6)** printed pages including the front page.

SECTION A: Structured Questions

[40 MARKS]

QUESTION 1

[15 Marks]

(a) Which of the relations below define functions from X = {2, 4, 5} to Y= {1, 2, 4, 6}? Justify your answer.

    1. R_1 = {(2, 4), (4, 1)}   [2 Marks]

    2. R_2 = {(2, 4), (4,1), (4, 2), (5, 6)}   [2 Marks]

    3. R_3 = {(2, 4), (4,1), (5, 6)}   [2 Marks]

(b) Domain restriction works like a database query, a bit like using an internet search engine to list all entries that contain the phrase "Z Notation". You might get many entries listed, or none at all. If you have the relation `phone`

```
Phone = {Philip ⟼ 4220, John ⟼ 5012, Liza ⟼ 4220,
         Fred ⟼ 3214, Hana ⟼ 4410}
```

Use the relation `phone` and Z notation to evaluate

    i.   { Liza } ◁ phone   [1 Mark]

    ii.   Dom(phone) ◁ phone   [1 Mark]

    iii. phone ▷ {3214}   [1 Mark]

    iv. phone ▷ Ran (phone)   [1 Mark]

(c) In Z, relations associate elements from different sets. Relations can also be composed to create new relations. Assuming the sets

```
Person = {Jim, Dave, Mary, Kathy, Ted},

Car = {Peugeot, Mazda, Fiat, Ford, Honda}

Fuel = {Diesel, superstar, 2strock, N20, Unleaded}
```

'R' is the relation from 'Person' to 'Car' and 'S' is the relation from 'Car' to 'Fuel' as shown in the table below.

Person	Car	Fuel
Jim	Peugeot	Diesel
Dave	Mazda	Superstar
Mary	Fiat	2strock
Kathy	Ford	N20
Ted	Honda	Unleaded

Compose R and S to form a relation which is denoted by (R $\overset{o}{9}$ S), then draw a diagram to illustrate the composition.   [5 Marks]

QUESTION 2   [8 Marks]

(a)   Consider the following Z specification

"A car park has a capacity - a limited number of spaces. A counter is maintained of the number of cars currently occupying spaces. When a car enters the car park, the counter is increased. When a car leaves the car park the counter is decreased. The system outputs the number of spaces left in the car park".

Develop a formal specification in the (declaration/predicate style) to introduce the (park capacity, number of cars that can be parked, A car may depart from the car park provided there is at least one car in the car park, The number of available spaces in the park at any time).   [4 Marks]

(b)   In formal specification, sequences can be used to model arrays and lists of data. Assume you are required to use Z notation to model a sequence of week days (Sunday.......... Saturday). Develop a formal specification in the (declaration/predicate style) of the sequence 'weekday' which includes the sequence operators 'head' and 'concatenation'.   [4 Marks]

QUESTION 3   [9 Marks]

(a)   Distinguish any inconsistency in the following piece of specification written in Z. Justify your answer.   [2 Marks]

[BOOKTITLE]

p, q : BOOKTITLE
r : Z
p = r

(b)   Given 'CHARACTER' as the set of all printable characters found on any computer keyboard that can be used in any country,   [2 Marks]

[CHARACTER]

ch : CHARACTER

Comment on the validity of the expression:
ch $\in$ Z

(c)   Comment on the validity of the expression: [2 Marks]

$\{ n : Z \mid n < 1 \ \lor \ n > 5 \} = \{ ..., -2, -1, 0, 6, 7, 8, ... \}$

(d)   Consider the Z specification below   [3 Marks]

Patrick works on the adhesives team in the materials group, which is part of the research division.

| patrick: PERSON
| adhesive, materials, research: ℙ PERSON
|_____
| adhesive ⊆ materials
| materials ⊆ research
| patrick ∈ adhesive

i.   Is Patrick in the research division?

ii.   Can you find any bug in the above Z specification? Suggest how to fix it

QUESTION 4   **[8 Marks]**

Consider the following inference:

If the sun is eclipsed the moon is not full
If the moon is eclipsed then the moon is full

Therefore, if the sun is eclipsed, then the moon is not eclipsed

(a)   Explain the meaning of the terms 'inference' and 'validity' as they are
        used in logic.   [2 Marks]

(b)   Formulate the above inference into propositions using propositional logic notation.
                                                                             [3 Marks]

(c)   Construct a truth table for the propositional logic inference you have formulated in
        (b), and use the truth table to determine whether or not that inference is 'valid'.
        Explain fully how you determine this.   [3 Marks]

SECTION B : Case Study

QUESTION 5   [10 Marks]

Students may join the 'Programming' class provided the class is not full. Those who successfully complete all the assignments may leave with a certificate.

There is a limit to the number of students who can join the class. Initially there are no enrolled students and no students have passed. A student may join the class if the class is not already full and if the student has not already enrolled. New students cannot have passed all their assignments. Not all students pass the class. An existing student is transferred to the passed group provided he/she has passed all the assignments and has not already been transferred. Only those existing students who have passed may leave with a certificate.

Based on the above scenario, develop a Z specification using schema that includes (system state, initial state, student joins the class, student passed the class, student leaves with a certificate).

END OF QUESTIONS PAPER