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	:	**12 JUNE 2013**
DURATION	:	**3 HOURS**
SESSION/SEMESTER	:	**SESSION 2012/2013 SEMESTER II**
PROGRAMME CODE	:	**BCS**

INSTRUCTIONS TO CANDIDATE:

1. This question paper consists of **SIX (6)** 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

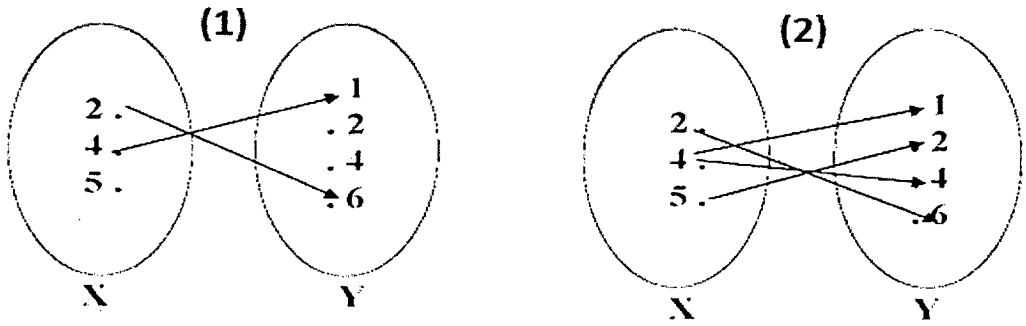
DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

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

SECTION A: Structured Questions **[50 MARKS]**

QUESTION 1 **[8 Marks]**

(a) Which of the arrow diagrams (1) and (2) define functions from X to Y? Justify your answer. [2 Marks]



(b) Is the following relation a function? Justify your answer.

$x^2 = y^2$ [2 Marks]

(c) Given the relation R "is less than" from A to B, where A = {1, 2, 8} and B = {1, 2, 3, 5}. Find the relation 'R', then the 'Domain' and 'Range' of 'R' [2 Marks]

(d) Let A ={1,2,3} and B={1,3,5}and define relation *(S)* from A to B as follows:

For all $(x,y) \in A \times B$

$(x,y) \in S$ where $x < y$

Draw a diagram to show the relation *(S)*. [2 Marks]

QUESTION 2 **[5 Marks]**

(a) Figure (a) shows when the switch is closed in an electrical circuit, current flows through the circuit and when it is open current cannot flow. The light bulb turns on if, and only if, current flows through it. Figure (b) shows a series circuit of the light bulb and Figure (c) shows a parallel circuit of the light bulb. Analyze each of the series and parallel circuit and use truth table to demonstrate all the possible states of p, q and the resulting state of the lighting bulb in each circuit. [3 Marks]

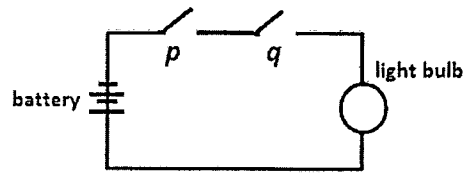


Figure (b)

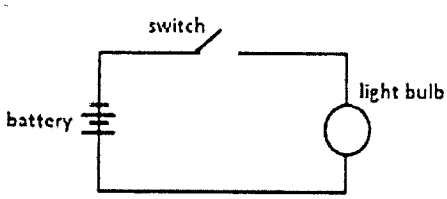


Figure (a)

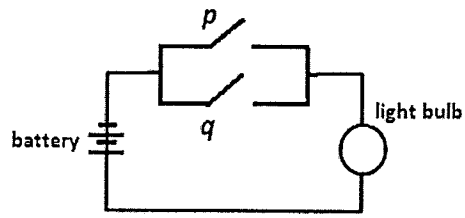


Figure (c)

(b) Let (S) be the set of numbers from 1 to 12 inclusive.

i. Construct a formal definition in the (declaration/predicate style) of the relation **R: S⟷ S**, where x is related to y exactly when y is greater than the square of x but less than the square of $x+1$. [1 Marks]

ii. State **R** as a set of ordered pairs [1 Marks]

QUESTION 3 **[15 Marks]**

Read the following specification :

A container can hold a discrete quantity of water. The contents of the container cannot exceed its capacity (5000 liters) at any time. A dial and warning lamp are attached to the container. The dial reading indicates the level of water inside the container. If the dial reading is below or equal a danger level, which is 50, the warning lamp will switch ON (signaled). When the warning lamp is switched on, an amount of water must be added to keep the normal level of water inside the container. There is a counter with readings (0-100) that shows the number of times an amount of water has been added every week.

Using Z notation:

(a) Develop a formal specification in the (declaration/predicate style) for the natural language specification of the container. [5 Marks]

(b) Develop a formal schema for filing the container when the level of water declined below a danger level. [2 Marks]

(c) Develop a formal schema for the operation of the counter. [5 Marks]

(d) Develop a formal schema which inputs a number and adds its square to the value of the counter, producing the new value as output. [3 Marks]

QUESTION 4 **[10 Marks]**

(a) Translate the following statement into mathematical notation using quantifiers.

"For every student x in your school, x has a computer or there is a student y such that y has a computer and x and y are friends. In other words, every student in your school has a computer or has a friend who has a computer". [3 Marks]

(b) Is the statement below True? Justify your answer

$\exists m \in \mathbb{N}, \exists n \in \mathbb{N}, \exists p \in \mathbb{N}, \; m^2+n^2 = p^2$ and $m, n, p \geq 1$. [3 Marks]

(c) Predicates have applications in computer science as they are used in program verification.

For example here's a program to swap (programming) variables x and y:

```
temp := x
x := y
y := temp
```

Suppose x = a and y = b before this program runs.
Using predicates, how can you show that after the program runs, x = b and y = a.
[4 Marks]

QUESTION 5 **[10 Marks]**

(a) If the conclusion of an English argument is a 'tautology', can the argument be valid? And can it be not valid? Why? [2 Marks]

(b) Determine whether these system specifications are consistent.

- The diagnostic message is stored in the buffer or it is transmitted
- The diagnostic message is not stored in the buffer
- If the diagnostic message is stored in the buffer then it is transmitted
- The diagnostic message is not transmitted [3 Marks]

(c) Consider the following inference:

I will buy a new goat or a used suit.
If I buy both a new goat and a used suit, I will need a loan.
I bought a used suit and I don't need a loan.
Therefore, I didn't buy a new goat.

i. Formulate the above inference into propositions using propositional logic notation.
[2 Marks]

ii. Determine whether or not the inference is 'Valid'. Justify your answer using truth table. [3 Marks]

SECTION B: Case Study

QUESTION 6 [12 Marks]

The provision of accommodation is a highly competitive market nowadays. As tourists look for the best possible value for money, hotel operators must ensure that they are providing a quality venue with cost effective services. As so, the SUNRISE hotel has decided to move heavily into new system. The hotel needs to maintain a record of the current state of its rooms, whether occupied or not. Initially no room is registered in the system. The hotel has a set of rooms named accommodation; guests when arrive may occupy some (or all) of these rooms provided that any room is not already occupied. A room is vacated provided it is occupied in the first place. The system should not allow the user to register a room twice. The system should also be able to show the number of occupied rooms at any time for the management information.

You are a software engineer hired by the hotel management and required to develop a Z formal specification for the new system as described previously.

END OF QUESTIONS PAPER