

**FACULTY OF COMPUTER SYSTEMS & SOFTWARE ENGINEERING**

**ANSWERS SCHEMA FOR MID-TERM EXAMINATION**

**COURSE : FORMAL METHOD**

**COURSE CODE : BCS2213**

**LECTURER : VITALIY MEZHUYEV**

**DATE : 06 NOVEMBER 2014**

**DURATION : 90 MINUTES**

**SESSION/SEMESTER : SESSION 2014/2015 SEMESTER I**

**PROGRAMME CODE : BCS/BCN/BCG**

**INSTRUCTIONS TO CANDIDATE:**

1. This question paper consists of **THREE** **(3)** questions. Answer **ALL** questions.
2. All calculations and assumptions must be clearly shown.
3. Full mark is 100 and will carry 20% of the final mark.

**EXAMINATION REQUIREMENTS:**

NONE

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

This examination paper consists of **THREE (3)** printed pages including the front page.

**QUESTION 1 [35 Marks]**

1. In own words give definition to
2. discrete system

[2 Marks]

A discrete system (opposite to continuous system) is a system with a countable (limited) number of states.

1. concurrent system

[2 Marks]

It’s a systems in which several computations are executing simultaneously, and interacting with each other.

1. distributed system

[2 Marks]

A *distributed system* is a system in which components located in network of computers, which communicate and coordinate their actions by passing messages to achieve a common goal.

1. real-time system

[2 Marks]

Real-time systems guarantee response within strict time constraints ("deadlines").

1. Give **TWO (2)** reasons explaining necessity of using *temporal logic* for specification of the modern software systems.

[3 Marks]

* for describing *asynchronous* systems (systems with components that do not operate in strict lock-step manner).
* to specify real-time properties of systems.
* to specify liveness properties of systems (what the system should do).

1. Given the function

Evaluation = { Mohamed  5, Ahmad  5, Adam  4, Lina4, Muna3}

(a) Draw a diagram to show the relation between the sets in the above statement.

[2 Marks]

(b) Find ‘Dom’ of Evaluation

[1 Mark]

**Dom = 5**

(c) Find ‘Ran’ of Evaluation

[1 Mark]

**Ran = 3**

1. Is the following relation a function? Justify your answer.

x2 = y2

[3 Marks]

This is not 1-1 dependency, because it is true relation for different possible values of x, e.g. with x=-1 and x=1.

1. Is the statement below True? Justify your answer

*m http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/in.gif http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/N.gif*, *http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/exists.gifn http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/in.gif http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/N.gif*, *http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/exists.gifp http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/in.gif http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/N.gif*, *m2+n2 = p2* and *m, n, p http://staff.scm.uws.edu.au/~zhuhan/dm_notes/tex/geq.gif 1*



[3 Marks]

**There are exist m=3, n=4, p=5 that *32+42 = 52***

1. Assuming the sets and , calculate the following.

[2 Marks]

1. {a, b, c, d, e}
2. { d, e }
3. Translate the following sentences into logical expressions. You may use quantifiers if appropriate:
   1. You cannot ride the roller coaster if you are less than 4 feet tall unless you are more than 16 years old.

[4 Marks]

Ride the roller coaster = R

Height (tall) = H

Age (old) = A

(H < 4) /\ ⌐ (A > 16) => ⌐ R

* 1. All the nice girls love a sailor.

Love a sailor = L

Nice girls = G

[4 Marks]

* 1. Not all the glisters is a gold.

Glister = Gl

Gold = G

[4 Marks]

**QUESTION 2 [35 Marks]**

**Modelling semaphore traffic light system.**

(a) Write TLA specification of the semaphore traffic light system, having the three possible states (Red, Yellow, Green). Please comment your statements.

[21 Marks]

(b) Draw a state transition diagram, showing behaviour of the system.

[2 Marks]

(c) Write liveness property that after green color a system eventually will have yellow color

[6 Marks]

(d) Write liveness property that system eventually often has both green and red colors

[6 Marks]

--------------------------- **MODULE** Traffic\_Light ---------------------------

**EXTENDS** Naturals

**CONSTANT** Red, Yellow1, Green, Yellow2

**VARIABLE** c

colors == <<Red, Yellow1, Green, Yellow2>>

Safety == /\ c \in colors

Init == /\ c = Red

Next == /\ c' = (c+1)%4

Spec == Init /\ [Next]\_c

Liveness1 == [][(c = Green) => (c' = Yellow2)]\_c

Liveness2 == []<> (c = Green \/ c = Red)

**THEOREM** Spec => [] Safety /\ Liveness1 /\ Liveness2

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**QUESTION 3 [30 Marks]**

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.

Using Z notation develop formal specification for the given natural language description of the water container. Comment your statements.

**Definition of constants (CZT-IDE)**

─

STATE ::= ON | OFF

└

─

CAPACITY == 5000

MIN == 50

└

**Definition of container (CZT-IDE)**

┌ Container

Dial : ℕ1

Lamp : STATE

|

Dial < CAPACITY

└

**Definition of initial state (CZT-IDE)**

┌ InitContainer

ΔContainer

|

Dial = 1000

Lamp = OFF

└

**Adding water into container (CZT-IDE)**

┌ AddWater

ΔContainer

|

(Dial < CAPACITY

Dial′ = Dial + 1)

/\

(Dial > MIN

Lamp′ = OFF)

└

Schema for filing the container when the level of water declined below a danger level

┌ UseWater

ΔContainer

|

Dial < MIN

∧ Lamp′ = ON

∧ AddWater

└