B.Sc. Engg. / HD CSE 2nd Semester — 24 August 2017 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **SUMMER SEMESTER, 2016-2017**

DURATION: 1 Hour 30 Minutes — **FULL MARKS:75**

CSE 4203: Discrete Mathematics

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **4 (four)** questions. Answer any **3 (three)** of them.

Figures in the right margin indicate marks.

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1. a) Show that the premises 'There is a student such that if he knows programming, then he knows Java.' and 'All students know programming.' imply the conclusion 'There is a student who knows either Java or C++.' Write down the name of each of the rules of inference that you use. — 9

   b) A factory makes custom sports cars at an increasing rate. In the first month only one car is made, in the second month two cars are made, and so on, with n cars made in the nth month. — 3×3

      i. Set up a recurrence relation for the number of cars produced in the first n months by this factory.
      ii. How many cars are produced in the first year?
      iii. Find an explicit formula for the number of cars produced in the first n months by this factory.

   c) Prove the following statement using contradiction: — 7
   'For all rational number x and irrational number y, the sum of x and y is irrational.'

2. a) Describe the worst-case time complexity of the bubble sort algorithm in terms of the number of comparisons used. The algorithm for bubble sort is given in Figure 1. — 10

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procedure bubblesort(a1, …, an: real numbers with n ≥ 2)
for i := 1 to n - 1
      for j := 1 to n - i
            if aj > aj+1 then interchange aj and aj+1
{a1, …, an is in increasing order}
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Figure 1: Code listing for question 2a.

   b) Prove the following statement using contraposition: — 7
   'If $x^2 - 6x + 5$ is even then x is odd'.

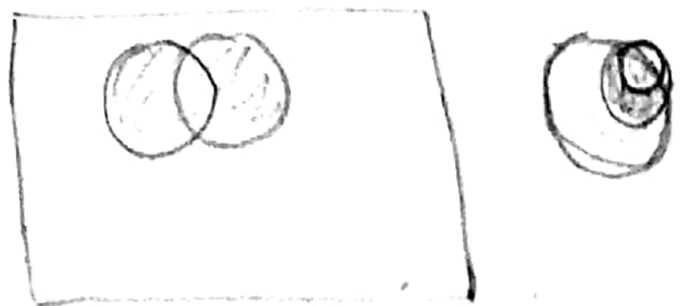
   c) Prove that there are infinitely many primes. — 4

   d) Show that if $n \mid m$, where n and m are integers greater than 1, and if $a \equiv b \pmod m$, where a and b are integers, then $a \equiv b \pmod n$. — 4

3. a) Give big-O estimates for the following functions: — 10

      i. $(n^2 + 8)(n + 1)$
      ii. $(n\log n + 1)^2 + (\log n + 1)(n^2 + 1)$

   b) Draw Venn Diagrams showing: — 8
      i. $A \cup B \subset A \cup C$, but $B \not\subset C$
      ii. $A \cap B \subset A \cap C$, but $B \not\subset C$



c) Suppose there are signs on the doors to two rooms. The sign on the first door reads "In this room there is a lady, and in the other one there is a tiger"; and the sign on the second door reads "In one of these rooms, there is a lady, and in one of them there is a tiger." Suppose that you know that one of these signs is true and the other is false. Behind which door is the lady? 7

3×4

4. a) Express each of these statements using predicates and quantifiers.

i. At least two students like sports, though not everybody likes it.
ii. The sum of an even integer and an odd integer is odd.
iii. Not all cars made by Toyota are durable.
iv. No one in your school owns both a bicycle and a motorcycle.

b) There are two restaurants next to each other. One has a sign says "Good food is not cheap" and other has a sign that says "Cheap food is not good". Are the signs saying the same thing? Justify your answer using predicates, quantification etc. 7

c) Given that $h(x) = 3x$ and $g(t) = -2t - 2 - h(t)$ and $f(n) = -5n^2 + h(n)$, calculate $h(g(8))$. 6