UNIVERSITY OF COLOMBO, SRI LANKA

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

BACHELOR OF SCIENCE IN COMPUTER SCIENCE

FIRST YEAR EXAMINATION (2017/2018) – SEMESTER II – 2018

SCS 1112(R) – Foundations of Computer Science

PART A

Multiple Choice Question Paper

(Two Hours for both parts A and B)

Important Instructions:

- The duration of the **whole paper** consisting of **both parts A and B** is **Two (2) hours.**
- The medium of instruction and questions is English.
- **Part A** has **20 questions** on **7 pages**.
- All questions are of the MCQ (Multiple Choice Questions) type.
- **All** questions should be answered.
- Each question has five (5) choices with **one** correct answer.
- Answers should be marked on the special answer sheet provided.
- Note that questions appear on both sides of the paper.
  If a page is not printed, please inform the supervisor immediately.
- Mark the correct choices on the answer sheet which will be machine marked.
- **Completely read and follow the instructions given on the other side of the answer sheet before you shade your correct choices.**
- **Calculators are NOT allowed.**

For each of the Questions, select the correct answer from the five choices given. [40 marks]

1. In the universe, we find problems that are unsolvable (or undecidable) or intractable (solving requires more energy than that is available in the universe). Which of the following problem(s) is/are hard, but solvable?

    i. Given a random sequence of (English) letters, what dictionary words are obtainable from it by unscrambling (reordering)?
    ii. The answer to the question 'if the only barber in town shaves only those who do not shave themselves, who shaves the barber?'
    iii. Exhaustive search of for a 1000 bit key, on a key space on the most powerful computer at present

    a. (i) only b. (ii) only c. (iii) only d. (i) and (ii) only e. none of (i), (ii) and (iii)

2. Which of the following statement(s) is/are true with regards to the historical basis of computability?

    i. David Hilbert proposed that all of mathematics is axiomatisable.
    ii. Kurt Godel refuted Hilbert's axiomatisation premise through his Incompleteness theorem
    iii. Alonzo Church and Alan Turing defined the concept of an algorithm, and what is meant by computation

    a. (i) only b. (ii) only c. (iii) only d. (i) and (ii) only e. all

Answer Questions 3-8 based on the following list of computational problems.

i. Knapsack problem – Given a knapsack of size W find the maximum value subset of objects O(value, size) out of a total of n-objects that can fit the knapsack
ii. Graph isomorphism problem – Given two graphs G and H, whether the vertices of G when reordered becomes identical to H
iii. k- clique problem – In a given undirected n-vertex graph G, is there any completely connected sub-graphs of size k?
iv. Hamiltonian cycle problem - For a n-vertex directed densely connected graph G, find out a path that visits each and every vertex exactly once.

v. Boolean satisfiability problem – Is there a set of values that makes a given standard Boolean formula of n-distinct variables true?
vi. Graph k-colourability problem – Can the vertices of a graph G be coloured with k distinct colours such that no two adjacent vertices are of the same colour?
vii. Integer factorisation problem – what are the integer factors of a composite number?

3. Which problems have a polynomial time greedy solution?
   a. (i) and (iv) only b. (iv) and (vi) only c. (i) , (iv) and (vi) only d. (i) and (ii) only e. (iii) and (iv) only

4. Which of the problems, except for (ii), is not in *NP-complete* class?
   a. (vii) only b. (vi) only c. (v) only d. (iv) only e. (iii) only

5. The 3-SAT problem, a special case of boolean satisfiability, can be polynomially reduced to which of the problems?
   a. (ii) b. (iii) c. (iv) d. (vi) e. (vii)

6. Optimising compilers try to map active variables of a running program into the limited number of available CPU registers. Which of the above problems can be used to solve this issue?
   a. (ii) only b. (iii) only c. (iv) only d. (v) only e. (vi) only

7. An exhaustive search for the k-clique problem has a complexity of the order of
   a. 2^n b. $2^n.k$ c. $n^k.k^2$ d. $n!.k$ e. $2^n.k^2$

8. Which two problems can be classified as combinatorial optimisation problems?
   a. (iv) and (vi) only b. (i) and (iv) only c. (i) and (iii) only d. (ii) and (iv) only e. (iii) and (vi) only

9. Which of the following statement(s) is/are true with regards to the evolution driven computing model?
   i. Evolutionary algorithms mimic nature's ability to propagate best solutions along generations of evolution
   ii. They are able to deliver exact solutions to combinatorial optimisation problems
   iii. Simulated annealing exploits energy minimisation to converge on better solutions among all possible options

   a. (i) only b. (ii) only c. (iii) only d. (i) and (iii) only e. all

10. Suppose the outputs of the following logic gates are plotted on a X-Y coordinate plot for all combinations of their inputs. Which of the following statement(s) is/are true?

    i. AND outputs are linearly separable
    ii. OR outputs are linearly separable
    iii. EXOR outputs are linearly separable

    a. (i) only b. (ii) only c. (iii) only d. (i) and (ii) only e. all

11. Given the set of integers S= {1, 4, 16, 64, 256, 1040, 1093, 1284, 1344} and a target t = 3754, to find out a subset of S that sums up to the target, and is known as the *subset sum* problem, has complexity NP. Which of the following statement(s) is/are true with regards to this observation?

    i. An exhaustive search for the solution costs $O(2^n)$ where n is the number of elements in the set
    ii. A greedy FCFS solution, though runs in polynomial time, is not optimal
    iii. The problem is in the category of other combinatorial optimisation problems such as the knapsack problem and the job shop scheduling problem

    a. (i) only b. (ii) only c. (iii) only d. (i) and (ii) only e. all

12. The maximum value in an array of numbers `a[1..n]` can be calculated using the following three computation models. Which of the following statement(s) is/are true?

    i. Evaluate as `max(a[1], ..a[n]) = larger(a[1], max (a[2],..a[n]))` where, `larger (a,b)` is a pre-defined function
    ii. If `a[1], a[2]...a[n]` are on a shared memory (common pool) then a large number of threads can each evaluate `larger(a,b)` leaving the final result in the pool
    iii. A number of processes each holding a single value `a[i]` arranged in a ring can pass values among its neighbours each evaluating `larger(a,b)` leaving the last process with the maximum value

a. (ii) makes use of the stack for evaluation
b. (i) is a message passing evaluation
c. (iii) is a parallel evaluation
d. (iii) is a functional evaluation
e. (ii) has the highest speed up

Answers Questions 13-15 based on the following list of computational problems.

i. Face detection in crowds
ii. Electricity power utilisation minimisation (for air conditioning, ventilation, lighting and escalator usage etc.) in green building design
iii. Google's *Alphazero*, the self-learning chess player
iv. Supply chain logistics (vehicles, personnel, fuel, capacity, delivery timing etc.) optimisation

13. A pattern driven computing model would be a core part of the solution in
a. (i) and (iii) only b. (i) and (ii) only c. (ii) and (iii) only d. all of (i) to (iv) e. none of the above

14. An evolution driven model will be a core part of the solution in
a. (i) and (ii) only b. (ii) and (iv) only c. (ii) and (iii) only d. (ii) only e. (iv) only

15. A rule based instruction driven model is likely to be a core part of the solution in
a. (i) only b. (ii) only c. (iii) only d. (iv) only e. none

Answer Questions 16-17 based on the following statements:

i. In a continuous piece of Indian classical music, the seven notes *Sa, Ri, Ga, Ma, Pa, Da, Ni* occurs as a permutation like, ...*Sa, Sa, Ri, Ga, Ga, Da*.....

ii. The finite state automaton (FSA) described by $(\{q_1, q_2, q_3\}, \{0,1\}, \delta, q_1, \{q_2\})$ with δ given by

δ	q_1	q_2	q_3
0	q_2	q_3	q_2
1	q_1	q_3	q_1

16. Which of the following statement(s) is/are true?

i. Whereas (i) is non deterministic, (ii) is a deterministic FSA.
ii. Instead of basing on an input alphabet, state transitions in (i) occur probabilistically.
iii. Whereas there is no accepting state in (i), there is an accepting state in (ii).

a. (i) only b. (ii) only c. (iii) only d. (i) and (iii) only e. all

17. Which of the following statement(s) is/are true about (ii)?

i. It has a binary alphabet with a single accepting state q_2.
ii. It accepts the string 0ε
iii. The language of acceptance is { w | w has odd number of zeroes following zero (nil) or more number of ones}

a. (i) only b. (ii) only c. (iii) only d. (i) and (iii) only e. all

18. An algorithm which has a time complexity of O(log log n) takes 3 seconds to execute on a particular computer when n = 256. What would be the most likely time it would take when n = 65536?

a. 128 sec. b. 256 sec. c. 384 sec. d. 4 sec. e. 1536 sec.

19. Which of the given options below provides an increasing order of complexity of functions $f_1, f_2, f_3,$ and f_4 for large n?

$f_1(n) = 2^n$
$f_2(n) = log\ (n^{\log n})$
$f_3(n) = \log(logn)$
$f_4(n) = n^{\log n}$

a. f_3, f_4, f_2, f_1
b. f_3, f_2, f_1, f_4

c. f_3, f_2, f_4, f_1
d. f_2, f_3, f_4, f_1
e. f_2, f_3, f_1, f_4

20. Which of the following statement(s) is/are true about low level (machine code) programming?

i. There are three broad types of processor instruction sets using which low level programming can be done: register based (RISC), memory based (CISC) and stack based
ii. Programmer has a lot of freedom to use a large number of registers when RISC instruction sets are used
iii. Memory to memory transfers dominate when stack instruction sets are used.

a.(i) only b. (ii) only c. (iii) only d. (i) and (ii) only e. all

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