THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

This exam paper must not be removed from the venue

Venue _____

Seat Number _____

Student Number |__|__|__|__|__|__|__|__|

Family Name _____

First Name _____

School of Information Technology and Electrical Engineering

EXAMINATION

Semester One Final Examinations, 2019

COMP2048 Theory of Computing

This paper is for St Lucia Campus students.

Examination Duration: 120 minutes

Reading Time: 10 minutes

Exam Conditions:

This is a Central Examination

This is a Closed Book Examination - no materials permitted

During reading time - write only on the rough paper provided

This examination paper will be released to the Library

Materials Permitted In The Exam Venue:

(No electronic aids are permitted e.g. laptops, phones)

Calculators - Casio FX82 series or UQ approved (labelled)

Materials To Be Supplied To Students:

1 x 14-Page Answer Booklet

Instructions To Students:

Additional exam materials (eg. answer booklets, rough paper) will be provided upon request.

You should attempt all questions. All answers should be written in the answer booklet provided. You MUST show the steps used to arrive at your final solution. Best marks will be awarded to numerically correct solutions showing complete working. Partial credit will be given to partially complete solutions or to incorrect solutions where errors have been carried through calculations. Assumptions, if any, should be explicitly stated and justified/verified as appropriate. This exam has 40 marks in total.

For Examiner Use Only

Question	Mark

Total _____

Question 1 – Finite State Machines 1

Prove by construction that if the languages A and B are regular then the language that is the intersection of A and B is also regular.

(5 Marks)

Question 2 – Finite State Machines 2

Design a deterministic finite state machine that recognises the language of all strings from the alphabet {0, 1, 2} that do not have two identical consecutive characters. For example, it should not recognise the strings 00 or 11 etc. Ensure that your design shows either a transition table or transition diagram, as well as a formal description of the machine.

(5 Marks)

Question 3 – Turing Machines 1

Design a Turing machine that accepts the set of strings with an equal number of 1's and 0's (in any mixed order). Include a high-level description of its algorithm and draw its transition diagram.

(5 Marks)

Question 4 – Turing Machines 2

Show that a Turing machine is more powerful than a finite state machine by using an example language that is only decidable by a Turing machine. Provide a high-level description of the Turing machine that decides this language.

(5 Marks)

Question 5 – Lambda Calculus

Explain the concept of Church encoding in the context of Lambda Calculus and explain how it is used to create the Church numerals. Use Church encoding to derive the Church numerals up to 4 and describe how they can be used to count in Lambda Calculus.

(5 Marks)

Question 6 – Combinators

Define and discuss the significance of the following two combinators in Lambda Calculus:

a) Composition Combinator

b) Y Combinator

Describe how each of these combinators contribute to the Turing completeness of Lambda Calculus.

(5 Marks)

Question 7 – Quantum Computation 1

Describe in a paragraph how the superposition principle in quantum mechanics is used to construct a qubit and how the measurement of qubits give rise to the advantages quantum computation has over conventional computation.

(5 Marks)

Question 8 – Quantum Computation 2

Describe the Deutsch problem and explain why a quantum computer can solve it much faster than a conventional computer.

(5 Marks)

END OF EXAMINATION