COS10023 Computer and Logic Essentials – Assignment 2

Teaching Period 1, 2023

Aim

This assessment task allows you to demonstrate your problem-solving ability on problems covering logic, relations and functions, and Boolean algebra and circuits.

Due date

This assignment is due by **9th of April 2023.**

Due date and submission

Each individual student should submit their assignment via Canvas before the deadline. You can submit several times before the deadline; each new submission will overwrite your previous submission. Before submitting the assignment, please ensure that you have undertaken the following activities:

- Checked Canvas for announcements to the assignment and for any updates/clarifications;
- Ensured that the work submitted by you is your original work. If this is not the case, then a penalty will apply. Note this also extends to sharing your original work with other students;
- Reviewed the declaration at https://www.swinburne.edu.au/current-students/manage-course/ exams-results-assessment/submit-work/assessment-declaration/. Electronic submission of your assignment signifies that you agree with this declaration. Note a cover page is not required, however please put your preferred name and student ID on at least the first page, ideally all pages.

If you have exceptional circumstances that mean you are unable to submit the assignment by the due date and time, please contact the convenor as soon as practicable. Note evidence of circumstances will be required.

General instructions

This is an individual assignment. It is preferred that you use word processing software to create your submission; if handwriting is required or preferred please scan your document as a PDF rather than submitting images. Marking scheme Marks will be awarded in accordance with the scheme allocated for each sub-part of the problems as indicated in the assignment. Partial marks will be awarded to the extent that the component parts of the question have been correctly answered. Please note that if a problem requires the answer to be justified, no marks will be awarded for simply giving the correct answer.

Stars

The stars suggest the difficulty of the problem:

* Should be straightforward based on lecture and tutorial material.
**Should be more challenging but still based on lecture and tutorial material.
***Might require some further thought or extra research beyond lecture and tutorial material.

Questions

Important: Your responses to the following questions must show your reasoning (or working out). No marks will be provided for correct answers alone.

Logic (10 marks)

1. [2 marks] For this question the following statements and symbols should be used:

   (a): Andrew plays football

   (d): David plays esports

   (h): Harry plays cricket

** Translate the following into English.

i. $H \wedge (d \vee a)$
ii. $d \rightarrow \neg a \vee h$
iii. $\neg(h \vee d)$
iv. $a \leftrightarrow (h \wedge d)$

2. [1+2=3 marks] Given the following statements:

A Hawks player is either running at the Glenferrie oval or sitting in the gallery. If he is running, then he is not reading newspaper. The player is reading a newspaper. Therefore, he is sitting in the gallery.

i. [1 mark] * Convert these statements into **propositional** logic statements

ii. [2 marks] ***Without using a truth table, show that this argument is valid using concepts described in the unit. This could be done using contradiction or the laws/axioms of algebra (note the latter is a long process though).

3. [2 marks] ** Simplify the following statement using the laws and axioms of logic. Clearly state which law or axiom has been used at each step.
   $p \wedge \neg (\neg q \vee p)$

4. [1.5 marks] ** You have a friend who has written the following condition statement in his/her code: (height<=50 or width>10) and (height>50 or width>10) and height<=50

Show using the laws of logic that this condition statement can be simplified to:
width>10 and height<=50
For each step, state which law of logic you have used.

5. [1.5 marks] * Using the truth table find out whether the proposition ((p ∧¬q) V (q -> p)) V q is tautology, contradiction or neither.

Functions and Relations (8 marks)

6. [2 marks] Given the following relation S on Z×Z where Z= {a, b, c, d, e}: S={(a, a),(b, b),(a, b),(b, a),(c, c),(d, d),(e, e),(c, e),(d, e),(e, c),(e, d)}
Determine whether it is an equivalence relation, by showing whether it satisfies the three criteria needed. State your final answer.

7. [3 marks] **For the domain X={x, y}and co-domain Y={x, y, z}:
   i. How many functions f: X→Y are possible? Provide an example of a function, using formal notation or a diagram.
   ii. How many of the functions in i) are injective? Provide an example that is injective and an example that is not.
   iii. How many of the functions in i) are bijective? Provide an example if one exists, if not explain why not.

8. [3 marks] ** Give an example for the following and justify why your example is valid.

   i. A function that is surjective but not injective.
   ii. A function that is injective but not surjective.
   iii. A function that is neither injective or surjective.

9. [2 marks] *A function could be defined as

   f(x)={(*a*,*b*): *b* is two characters shifted along from *a* wrapping at the end},

that is, a Caesar cipher with a right shift of 2. As an example, across the lowercase alphabet, this is enumerated as {(a,c),(b,d)…(y,a),(z,b)}.

   i. Given the domain {'h','o','w','x','l'}, draw an arrow diagram to show the ordered pairs produced by *f*.

   ii. What is the image for the domain in question i. through *f*?

Boolean algebra and circuits (8 marks)

10. [1 + 2 + 2 = 5 marks] Given the expression

$$E = \overline{(A + \bar{B}) + (A + \bar{C})}$$

   i. *draw the circuit that represents this expression as is.
   ii. **simplify the expression using Boolean algebra rules. State your steps and the rules used.
   iii. *given the simplified circuit from 10/ ii, state in a sentence how the depth and size of the circuit have changed compared to the original (10/ i). The simplified circuit diagram needs to be included in your submission.

11. [1 + 2 = 3 marks] **Given the following circuit:

i. [1 mark] determine the expression for the circuit in Figure 1. Note you do not need to simplify the expression.

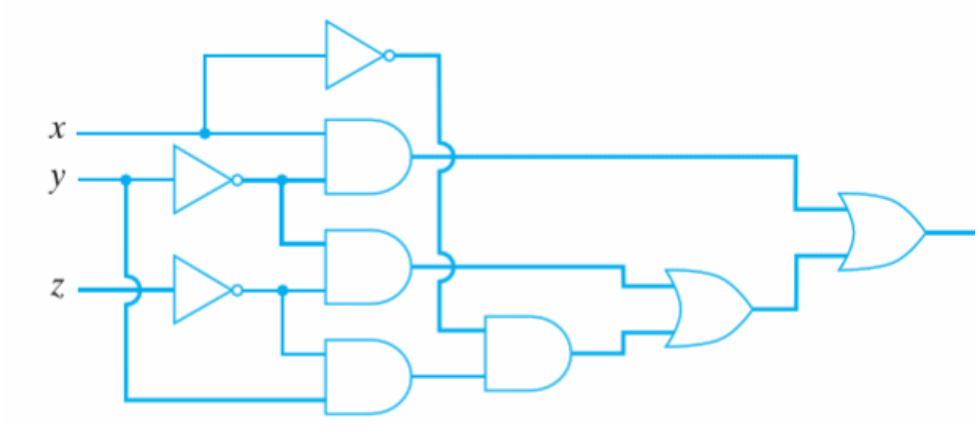

Figure 1: Question 11 (i)

ii. [2 marks] draw a truth table to represent the circuit in Figure 2. Please include intermediate columns to show working; an outcome column alone will incur a deduction.

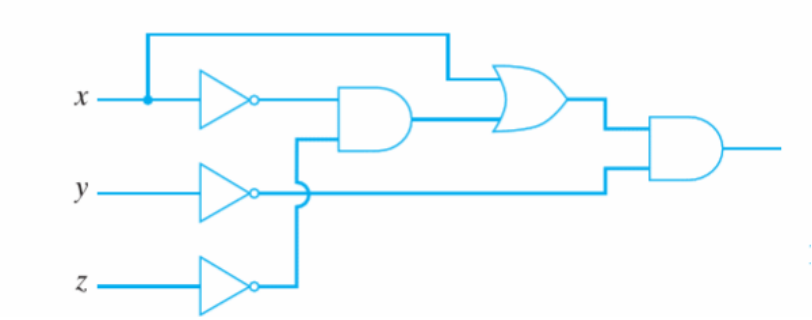

Figure 2: Question 11 (ii)