COS10003 Computer and Logic Essentials – Assignment 3

Semester 1 2025

Plagiarism Warning

If plagiarism is detected in your submitted work, you will be subjected to serious penalties.

Acts of plagiarism includes:

- sharing your original work with other students either on purpose or by accident – under no circumstances should you show or give your full/partial assignment to another student, nor should you ask to see another student's assignment;
- soliciting answers from online forums and tutoring sites (even if it does not involve any form of money payment);
- copying answers publicly posted online.

Do note that **answers containing traces of AI-generated response will be given 0 marks**. The unit outline of this unit clearly says that "*The assessments in this unit should be completed entirely without genAI assistance.*".

Please review the Declaration and Statement of Authorship on Canvas submission page. Electronic submission of your project report signifies that you agree with this declaration.

Aim

This assignment allows you to demonstrate your problem-solving ability on problems covering Boolean algebra and circuits, counting, graphs and trees. It is worth **20%** of your final mark for this unit.

Due date

Please check due date in Canvas submission page.
Any submissions after the due date will be penalised based on policy outlined in unit outline unless permission has been granted. Permission is rarely granted and only for special cases where proof is given to the unit convenor.

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 and **save it as a single PDF**. You will not be allowed to upload image files (e.g., jpg, png, etc.) in Canvas.

Submission guidelines

- Make sure you have checked Canvas for any announcements or discussions related to the assignment and for any updates/clarifications.
- Submission must be done in Canvas only. **Any submissions via email will not be accepted.**
- Cover page is not required, however please **indicate clearly your student name and student ID** on the first page.

- **Before submission, please check the following:**
    - Your PDF contains all the content that you have prepared.
    - Answers are arranged in the correct sequential order according to the question number.
    - Any images of your hand-writing must be in the correct orientation. Your tutor should not need to bend their heads when reading and marking your work.
- Only the newest submission in Canvas will be considered for grading. You can submit several times in Canvas before the due date; each new submission will overwrite the previous submission.
- With the amount of submissions we receive, we are unable to inform you individually **if your submission appears to be incomplete**. Resubmissions during the late submission period will attract a late penalty.

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 where 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.

Questions

Topic: Boolean algebra and circuits

Question 1 **(2 + 4 + 2 = 8 marks)**

Given the following expression:

$$\boldsymbol{E} = (\boldsymbol{P} + \boldsymbol{Q})((\boldsymbol{P}' + \boldsymbol{Q}') + (\boldsymbol{Q}'\boldsymbol{P}))'$$

a) Draw the circuit that represents this expression as is (do not simplify).

b) Simplify the expression using Boolean algebra rules. State your steps and the rules used.

c) Given the simplified circuit, state how the depth and size of the circuit have changed compared to the original circuit. The simplified circuit diagram does not need to be included in your submission.

Topic: Counting

Question 2 **(3 + 2 + 2 = 7 marks)**

A theme park offers 6 attractions that visitors can experience in one day. These include:

- Roller Coaster
- Ferris Wheel
- Water Slide
- Carousel
- Bumper Cars
- Balloon Darts

Assume that each attraction can be visited at most once a day (e.g., once you have visited the Ferris Wheel, you won't visit it again), and it is not compulsory to visit all attractions. The sequence of visiting the attractions matters. For example, visiting the Bumper Cars before the Water Slide is different from visiting the Water Slide before the Bumper Cars. We're interested in finding out the different ways that visitors can visit these attractions.

a) How many different visiting patterns can be formed from these 6 attractions? Assume that you must visit at least 2 attractions, and it is not compulsory to visit all attractions.

b) How many visiting patterns contain exactly 5 attractions?

c) How many visiting patterns with 3 attractions that start with visiting the Carousel?

Note: *Include combinatoric/factorial notation as your working steps. An answer consisting of solely an integer will be awarded 0 marks.*

Question 3 **(2 + 2 + 2 + 2 + 2 = 10 marks)**

You are organizing activities for 11 friends during the upcoming semester break.

a) If you have 7 entry tickets for an E-sports tournament, how many ways are there to choose your friends to join you?

b) You invite all 11 friends to join you for a movie at cinema. How many possible outcomes are there from this invitation? (Hint: each friend can accept or decline.)

c) You and 10 friends are going for dinner at a Korean steamboat restaurant. You have reserved 3 tables, each with a maximum seating capacity of 4 people. Using the concept of partitioning, how many ways can you organize the seating such that two tables are full and one table is not full?

d) Show an alternative way to solve the problem in Question 2(c).

e) A coding bootcamp offers tutorial exercises in 5 programming languages (Python, C++, C#, JavaScript, PHP). How many random tutorial exercises must you complete to guarantee you've done at least 4 tutorial exercises in the same programming language?

Note: *Include combinatoric/factorial notation as your working steps. An answer consisting of solely an integer will be awarded 0 marks.*

Topic: Graphs and Trees

Question 4 **(2 + 8 + 5 = 15 marks)**

Using the following representation of weighted undirected graph $G(V, E)$:

$$V = \{a, b, c, d, e, f\}$$

Weight of edges E:

$$(a, b) = 9, \quad (a, d) = 6, \quad (a, e) = 4, \quad (b, d) = 16, \quad (d, e) = 13,$$
$$(b, c) = 18, \quad (c, e) = 10, \quad (c, f) = 2, \quad (e, f) = 7$$

a) Draw the graph G including weights.

b) Using Dijkstra's algorithm, find the shortest distance between vertex d and vertex c in graph G. Use vertex d as the starting point. State the path that should be travelled in order to achieve that shortest distance to vertex c.

Note: *Use the method taught in lecture to compose your answer. Any answer consisting of solely sentences to describe the whole process will be awarded 0 marks.*

c) Using Kruskal's algorithm, find a minimum spanning tree for the graph G.

Note: *Use the method taught in lecture to compose your answer. Any answer consisting of solely sentences to describe the whole process will be awarded 0 marks.*