



This exam paper must not be removed from the venue

Venue _____

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Student Number

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Family Name _____

First Name _____

School of Mathematics & Physics

EXAMINATION

Semester Two Final Examinations, 2019

MATH4202-1 Advanced Topics in Operations Research (Practical)

This paper is for St Lucia Campus students.

Examination Duration: 120 minutes

Reading Time: 10 minutes

Exam Conditions:

This is a School Examination

This is an Open Book Examination

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 - Any calculator permitted - unrestricted

Materials To Be Supplied To Students:

None

Instructions To Students:

This exam has one question for a total of **20** marks.

Write your answers on the exam booklet and submit your code through Blackboard.

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

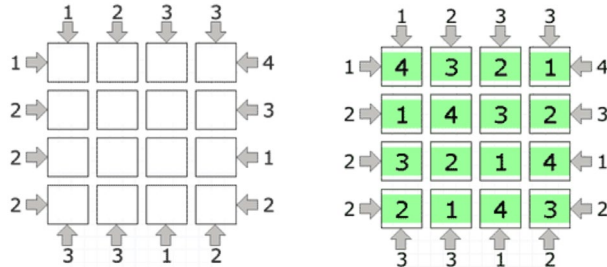
For Examiner Use Only

Question Mark

Total _____

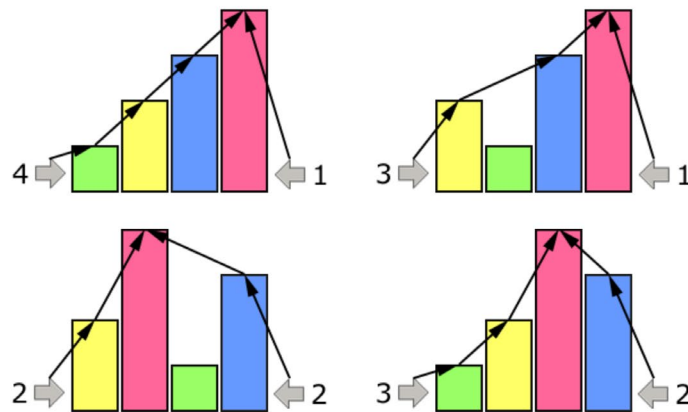
Question 1.*(Total of 20 marks)*

Consider the puzzle “Skyscrapers”.



The diagrams above show a starting grid and a completed puzzle. The rules of the puzzle are as follows:

- For a grid of size N , each digit from 1 to N must appear exactly once in each row and each column. $N=4$ in the example above.
- Any prefilled squares must be respected. There are no prefilled squares in the example above.
- The number of skyscrapers “visible” from each direction must correspond to the number next to the arrows around the perimeter of the grid. Some examples of how this calculated are given below. Some parts of the perimeter may not have hints.

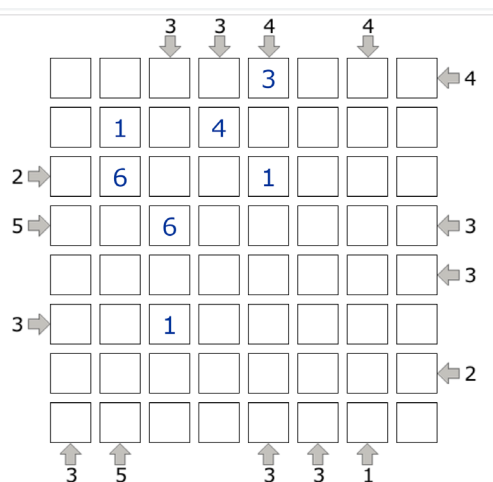
**Part 1a (4 marks)**

In the space on the next page, formulate the Skyscrapers puzzle as an MIP, **ignoring the visibility constraint**. Define all sets, data and variables.

Part 1b (4 marks)

Using the stub code provided, implement your model for 1b in python. Your code should write out the answer.

The stub code corresponds to the starting puzzle grid below:

**Part 1c (5 marks)**

The visibility constraints can be formulated directly, but this will be difficult. It will be considerably easier to reformulate the model with “composite” variables, where each variable represents a candidate row or column. Write a composite variable formulation below.

Part 1d (7 marks)

Implement your model from 1c in python. Include code to print the answer and additional code to verify that there is only one solution to the puzzle.

END OF EXAMINATION