



This exam paper must not be removed from the venue

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Student Number

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First Name \_\_\_\_\_

## School of Mathematics & Physics EXAMINATION

Semester Two Practical Examinations, 2017

### MATH4202/7202 Advanced Topics in Operations Research

*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 - writing is not permitted at all

This examination paper will be released to the Library

#### Materials Permitted In The Exam Venue:

No restrictions

#### Materials To Be Supplied To Students:

Access to laboratory computers

#### Instructions To Students:

This exam contains four questions, with marks indicated.

You must submit your Python files through Blackboard. You may make as many submissions as you like. The last submission will be marked.

#### For Examiner Use Only

Question Mark

1	
2	
3	
4	
5	

Total \_\_\_\_\_

We consider a version of the game Rummikub. Each player has a collection of tiles called a “hand”. Each tile has one of the numbers 1 to 13 on it and a colour – Red, Green, Blue or Yellow. The game is usually played with two or more “decks”, where each deck has 52 tiles. This means any particular number/colour combination may appear more than once in a hand.

The object of the game is to partition your hand into groups so that the numbers on the tiles left ungrouped add to the smallest total. Possible groups are:

- 3 of a kind – 3 tiles with the same number and three different colours
- 4 of a kind – 4 tiles with the same number and all different colours
- Sequences of length 3 or more. The tiles in a sequence must all have the same colour and the numbers must be consecutive. For example, 7 Red, 8 Red and 9 Red make up a sequence.

A group may be used twice if you have two or more copies of each tile in the group. Each physical tile can only appear in at most one group.

Your task is to develop and implement an MIP formulation of the problem of arranging a hand of tiles into groups.

1. Write down an MIP formulation of the problem in the blank space below.  
(5 marks)

2. Implement your MIP formulation in Python, using the hand generated by the stub code. This is a hand of 100 tiles dealt at random from 10 decks. Your code should print out the groups that are used and the tiles left unused. (8 marks)
3. Suppose now that you may substitute one or more tiles in your hand with an equal number of tiles of your choosing, but that each substitution costs 10 penalty points. Modify your formulation to handle substitutions and minimise the total of the numbers on ungrouped tiles and the penalty points. Write this modified formulation in the blank space below. (4 marks)
4. Implement your modified MIP formulation in a separate Python file. Your code should print out the groups that are used, which tiles are discarded, the substitute tiles and which tiles are unused. (3 marks)

**END OF EXAMINATION**

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