

Practical Exam

Do not open this exam paper until instructed to do so.

Time allowed: **90** minutes

There are **2** questions on this exam for a total of **15** marks

You may access any material during the exam including material on paper, in your electronic files or online. However you may not communicate with other people during the exam.

Submit your Python files for each question through Blackboard before the end of the exam.

Please fill in your details below.

Student number:

Name:

Signature:

Question 1 (9 marks)

A gas exploration company, GasCo, has to determine where to drill exploration wells. They have a large number of candidate sites for these wells (the range S in the code stub) and they know the cost of drilling a well in any candidate site, given by the list $DrillCost$ in the code stub. Their strategic plan requires them to drill 20 wells.

Candidate sites are clustered together in groups – see the list of lists $Group$ in the code stub. Each site may be in 0, 1 or more groups. Due to public relations concerns, the normal practice is to choose at most one site from each group. However a second site can be chosen from a group if a \$10,000 penalty is paid. This penalty is paid for every group that has two sites chosen as exploration wells. No more than two sites can be chosen from any group.

GasCo wish to know which 20 candidate sites to choose so as to minimise the total cost of drilling and penalties, while satisfying all the constraints.

Formulate the problem as an integer programming problem. Write the formulation in the space below. Implement your formulation in Python.

Hint: If you are having difficulty, formulate the problem so that at most one site per group can be chosen and then see if you can work out how to modify your formulation.

Question 2 (6 marks)

A job shop is subject to seasonal changes in demand and requires a different number of operators, as given in the following table:

Season	Summer	Autumn	Winter	Spring	Summer
Operators Required	155	120	140	100	155

These are the minimum numbers of operators required in each season and so employing 155 operators for the whole year would meet the demand. However the manager is reluctant to maintain the peak season payroll costs when they are not required. Yet operators are expensive to hire and train, so she is likewise reluctant to lay off operators during the low seasons, leaving her with a dilemma.

Suppose any employment above the level required costs \$2000 per operator per season. It is estimated that the hiring and firing costs are such that the total cost of changing the level of employment from one season to the next is \$200 times the square of the difference in the number of operators. What employment levels should the manager use in each season so as to minimise the total of these costs?

Implement a dynamic programming formulation in Python, including comments in your code that describe the stages, state variable and value function. Write the optimal solution in the space below.