Paint transportation problem   **[10%]**

A company has two factories, one each at Bristol and Leeds. The factories produce paints which are sold to five wholesalers. The wholesalers are either supplied directly from the factories or through one of the company warehouses, the transportation costs being paid by the company. The company has three warehouses, one each in London, Birmingham and Glasgow. Table 1 shows the transportation costs per ton for deliveries from the factories to the warehouses or wholesalers and also from the warehouses to the wholesalers, omitting entries when delivery from a certain supplier or warehouse is impossible for some destination.

Supplier	Warehouse			Wholesaler				
	London	Birmingham	Glasgow	1	2	3	4	5
Bristol	25	23	-	80	-	90	100	86
Leeds	30	27	30	-	70	54	-	100
London	-	-	-	37	31	-	40	44
Birmingham	-	-	-	36	40	43	40	46
Glasgow	-	-	-	45	42	30	-	36

The two factories at Bristol and Leeds can produce up to 40,000 and 50,000 tons per week respectively. No more than 20,000, 15,000 and 12,000 tons can be moved each week through the warehouse in London, Birmingham and Glasgow, respectively. Wholesalers 1, 2, 3, 4 and 5 require at least 15,000, 20,000, 13,000, 14,000 and 16,000 tons per week respectively.

a) Formulate a linear programming model to determine the minimum cost transportation schedule. Explain clearly the variables you use and the constraints you construct. What is the minimum cost transportation schedule and what are the corresponding costs?

b) Discuss the effect on the minimum transportation cost when capacity at each factory or warehouse is altered by adding or subtracting one ton. What are the minimum capacity changes at Glasgow that will alter the optimum set of routes and what will those alterations be? Explain how you arrive at each one of your answers.

c) The management of the company is considering the possibility of closing down one of the warehouses as this is expected to result in substantial labour and maintenance savings. Further, the manager of the Birmingham warehouse is considering sub-letting some of the capacity of this warehouse. Such sub-lets would have to be in exact multiples of 1000 tons. It is estimated that each 1000 tons of capacity could be let for £21,000 per week. Formulate a mixed integer linear programming model – or, if necessary, different model variants – to examine and evaluate the alternative courses of action. What would you recommend the company to do, and why? Discuss the alternatives, also taking into account the solution from part (a) and explain which additional information you might need (if any) to give the company more specific advice.

New product development problem   [5%]

A company has developed a new product. It needs to decide whether or not to product test and market test before launch, and has been advised that, even though these processes do cost money, they increase the likelihood of success for the product. (Note that it has been agreed within the company that you can only market test a product once it has passed product testing. If a product fails either test it is regarded as worthless). You have been able to obtain details of the costs of these testing processes, together with historical data which suggest how much the likely success of the product is enhanced by successful testing. Launching the product will cost €300,000 and the estimates of profit are as follows:

Highly successful	=	€2,000,000
Moderately successful	=	€1,000,000
Low level success	=	€500,000
Failure	=	€100,000

The historical data that has been collected gives the following results:

	No testing	Product testing	Product testing & market testing
High success	0.1	0.1	0.2
Medium success	0.2	0.4	0.45
Low success	0.4	0.4	0.3
Failure	0.3	0.1	0.05

Product testing costs €100,000 and Market testing costs €100,000. Should the product fail either of these tests it is abandoned. The probability of passing product testing is 0.8 and the probability of passing market testing is 0.9. The alternative to this process is to sell the product design for €500,000.

a) Construct a decision tree and write a very brief report advising the company on its best course of action.

b) What would be the 'best' decision if the profit from the highly successful product were estimated to be €3,500,000 rather than €2,000,000?

c) Discuss your solution to part b) by listing all the possible outcomes that could happen if the company is to follow the recommendation suggested by your solution.

d) Refer to the settings specified under part b) once again and imagine that you were the decision maker of this company. What would you really decide to do? Would you follow the recommendation obtained by the decision tree model? Why yes or why not?

Balanced syndicate groups   [25%]

Aston Business School has one of the most culturally diverse students in the UK. Students often differ from each other in their ethnic background. While this could help to enrich students' learning experiences, in particular during their group work, students often fail harnessing cultural diversity for their learning in such groups. The research in this area has shown that a proper support and a proper environment needs to be established in order for students to reap all the potential benefits of cultural diversity.

While at Aston, students are often allocated into syndicate groups to work together on various projects, which are subsequently assessed as a group work. Ideally, an allocation of students into groups should support and encourage harnessing cultural diversity. To achieve this, the groups formed should maximise the diversity of members within groups and minimise the average differences between groups. Groups formed on this basis are called "balanced groups". Creating balanced groups for a large class can be a very tedious and time-consuming administrative task if that process is carried out manually using a trial and error approach. For this reason, it would be good to construct a system that would produce balanced groups at a "touch of a button".

Your task for this case study will be to prepare the model that will be able to perform automatic allocation of students into groups while satisfying as much as possible these ideal targets:

1. Groups should be of the same size if possible. The ideal size is 5 members per group.
2. Groups should be balanced with respect to gender (G).
3. Groups should be balanced with respect to quantitative background (Q).
4. Groups should be balanced with respect to ethnic background but in a very specific way. According to the most up-to-date research on harnessing cultural diversity:
   − Ideally, each international (non-British) student should be paired in the same group with another international student of the same nationality (N).
   − If the above is not possible to achieve, then the next best thing is to pair international students based on the same cultural background (C).
   − Pairing of British students is perceived not to add any value and so it is not necessary to pair British students.

The data provided to you contains the records for 45 students with the relevant characteristics for each one of them given through the five columns: Student ID (S), Nationality (N), Cultural Background (C), Gender (G) and Quantitative Background (Q).

To solve the problem, feel free to use any of the techniques (or any mix of the techniques) we learned in Decision Models. Also, feel free to transform any of the raw data provided to you before you use them in your model, if you think that any such transformation will have more positive than negative effects to the overall quality of your solution. You will need to produce: a model, the final solution obtained from the model, a brief justification of any assumptions you made in the process, and a brief explanation as for what you have managed to achieve with your solution. Your model should be flexible enough to be feasible and to produce a reasonable solution for any other set of 45 students (that may have very different characteristics from the ones given), but it does not have to be flexible to work well for any other number of students.

Download the data set in Excel file: Balanced syndicate groups.xlsx