

IE 202 Assignment

Due: January 27th, 2021

After pandemic, an elementary school plans to have in-class lectures by following regulations. Students are divided into four grades as 1, 2, 3 and 4. In-class lectures are not mandatory as students will still have distant education option. The current numbers of students who are enrolled to in-class lectures are given in the Table 1. The school has 6 classrooms of different sizes and the classroom capacities are given in the Table 2.

Table 1

Grade	Students
1	100
2	110
3	90
4	90

Table 2

Classroom	Capacity
1	32
2	32
3	40
4	36
5	44
6	44

For the transition period, students will come to school on the assigned blocks on each weekday. A block is of length 2-hours. For each weekday, there are 5 blocks (t). Students have to be assigned to classrooms and blocks in groups of different sizes to find feasible schedules. Each group of students should include at least 15 students for teacher utilization.

By regulations, only a proportion of the classroom capacity can be utilized. Currently, only half of the capacity can be used and at most 80 students can be at school for each time block t. Also, classrooms should be cleaned after every usage and this incurs a fixed cost of 90TL and a variable cost of 1TL per student capacity. There is a material cost for the supplies students will use. These supplies costs per student per grade is given in the Table 3. The school board wants to find the optimal daily schedule to minimize total cost.

Table 3

Grade	Cost for supplies per student
1	3
2	2
3	2
4	1

1. (30 pts) What is the optimal schedule? What is the minimum total cost?

Formulate and solve the problem on GAMS. Submit your GAMS model (.gms file). Define the decision variables explicitly. In the report, provide number of students of each grade assigned to each class and block, and also the objective value.

2. (40 pts) Assume that you decided to use the schedule with the minimum cost in question 1. Answer the following questions accordingly and treat each case independently.
- a. Consider the case three third grade students decide not to follow in-class lectures. The true number of students who will attend lectures is 87 instead of 90. Estimate the new total cost without solving an LP.
 - b. The school board want to utilize first classroom also to decrease spread risk and considers assigning some first grade students from the other classroom to there for the first block. Estimate the new total cost without solving an LP.
 - c. What would be the total cost and the optimal schedule if the school were able to use 75% of classroom capacities?
 - d. What happens if the minimum group size requirement is increased to 16? Why? What if you increased minimum group size to 18? Why?
 - e. What happens if at most 75 students are allowed to be at the school for any time block?

You do not need to submit code files for these cases.

3. (30 pts) Consider the case in Question 1. Assume that a new regulation requires that after each group completed their lectures, the classroom must be cleaned and ventilated for 4 hours. (i.e. After using a classroom for a time block, you cannot use it for the next two time blocks.)
- a. Formulate a MIP and find the optimal schedule on GAMS.
 - b. Also, consider the case that where the regulator wants the 1st grade students' contact with other people in the public transportation at minimum. So, they cannot come to school for the 1st or 5th blocks to prevent them taking public transportation at rush hours. Update your formulation at part (a) and find the optimal schedule.

Formulate and solve the problems using GAMS. Submit your GAMS model (.gms file). Define the decision variables and the additional constraints in the report explicitly. Provide schedules and the objective values for each part.

Note that this is an individual work assignment. You are expected to formulate the problem and solve by GAMS. The main body of the report should include your formulation (with the definition of parameters and decision variables) and answers to Questions 1-3 together with discussions and comments. In the report, provide the answers for each part. Also, do not forget to submit your GAMS files, which should have self-explanatory names for parameters, decision variables, equations etc. or should include comments to explain them.