

IE375 –Spring 2020

Comments on Exam I

General Comments:

These notes are expected to complement the solutions I am distributing with it. Note that, I am distributing the solutions as you do not have any chance to see the key for the exam – as a result of the transition to on-line education.

I think that this exam is a reasonably standard one aiming at evaluating your related knowledge, as well as your performance on the basics of the current course. This exam required you to analyze numbers, as well as to conceptually approach to some cases. Engineers work on data, and hence you need to accumulate an experience to understand, interpret, and utilize “numbers” obtained.

The first question is on forecasting that brings most of what you have covered in class. Questions 2 and 3 relied on your knowledge of planning, and part of it relies on your modeling knowledge of IE202, as well as the essence of what we have covered for Aggregate Production Planning.

This exam is a balanced one requiring you to apply modeling or methodologies (Question 1), to model or interpret a given model in a different form (Question 2, Question 3) and finally to use your judgment in many of the above.

I am not especially happy with the results, in general. However, I am not disappointed, as well. I believe the exam was simple in general and I would think that the average should be around 60, taking into account the fact that some of you have the habit of skipping a whole topic and not answer the question at all. One thing that I noticed, although less in number, you have a tendency of writing a number of answers, rather than one – my partial granting scheme did not allow those situations. You were held responsible for everything you have written. If there was something which did not make a sense and or inconsistent with each other, you lost points or were not granted partial grades.

Total duration of the exam might have been insufficient for some of you. However, after grading the exams, my opinion on the main reason for feeling time pressure is lack of knowledge on what to do and how to proceed.

One apparent suggestion after grading exams is related your LP modeling skills. I believe that some of you need to go over the standard material before the second exam. Abstraction, and as a special case formulating LP's should be your least apparent advantage (you'll have more methods and insightful knowledge) over the other fields – and avoiding knowing it (or not knowing it) is not acceptable. Also your knowledge regarding duality and its possible usage needs to be refreshed.

One crucial observation: You need to read the questions carefully. For one reason or another (test habits), some of you still have a tendency to skip parts of the problem information stated in the beginning. Next time, please be more careful on to read and answer all the questions. Of course, this was one of the problems even for Question 2, as most of you didn't read the case carefully, but just skimmed through it. I'll mention more on this issue later.

Another observation is about the way that you round numbers. You have to make sure that you treat all the values in the required accuracy. You lost some points when you rounded too much. Of course there is always a limit on the number of digits to carry, and that understanding should come with the problem statement.

Below, please find some statistics on your exam results. We would like to say that there is at least one full correct answer for each part of any question. This shows that the questions are doable.

Exam Results:

Mean: 48.33

Std. Dev.: 20.75

Max: 96

Min: 11

The frequency distribution of grades you have received for the exam are given below:

Range	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Freq.	0	4	8	9	8	9	5	7	0	2

Suggestions

Note that the mode of the grades is in the range 31-60 (also almost 50% of the grades are in the same range). The grades are symmetric with a bias towards higher grades. I believe this is an indication of a fair exam, though shows that there is huge variation.

I would like to reiterate that your grades are a bit below my expectations. I think that a fair average for this exam would be in the 55-60 range. If your grade is below 40 you should show much more effort in the forthcoming exams. On the other hand, still we have a long way to go in the course; it is too early to feel confident, or to feel anxious.

One comment is presented below to improve your exam effectiveness:

- A very important issue in this course should be formalism in expressions. I think that one of the most important assets you are going to have as engineers is your ability to structure and be able to express complicated problems. To express a difficult decision structure by use of a mathematical program, or a simulation model (computer program) or even with some inequalities are examples of an IE's contribution to hard problems. Similarly, your ability to formally express complicated structures makes you different from an ordinary, a knowledgeable smart person, as with your equipment you can attack much harder problems. I want you to be very careful with respect to this type of formalism in this course. Note that as a result of the idea of formalism, what you are expected to do can be summarized as follows:
 - ✓ When a question is posed, express the question in mathematical (symbolic) terms. Note that you have to give definitions in case you are using parameters to specify quantities and of course decision variables (almost always this is the case! – if you are not sure what a parameter or a decision variable means LEARN). Note that you would get a considerable % of the total available grade in this exam if you have defined the decision variables used.
 - ✓ Never start writing up a bunch of numbers without stating what you are doing. It is likely that you are going to have a mistake in writing those specific numbers, and hence it is always meaningful to specify abstractly the quantities you want to write (example: using a summation term, identifying an index properly, etc.).

Question 1

This question is to test your understanding of the forecasting concepts. The question is very standard, and it requires a minimal set of computations (without much repetition). Some students fully and correctly answered this question. However, there seems to be a number of students who didn't understand slope or

trend or other jargon used in the problem. (This is surprising, as there are only a handful of possible structures you have seen in class, and still you can not relate the question to those.)

The solution is straightforward. You were expected to implement the correct model in every part of the problem – Winter’s model. If you have not implemented this model, you didn’t receive any or very few additional points as partial grades.

In the question current period was given as period 4 (end of period four). Once you realized that, your efforts should be to move from that point on. A common mistake was to use the equations supplied in the exam to solve for unknowns in the “past”. Please make sure that you read the question carefully – there are no implications in the question – simply answer what you are asked. Of course, my comment assumes that you know the topic and the approach to get the answer, and if you do not know, then this is what you do. If I were you, if you do not know the answer and do not have any meaningful guess on what the answer might be (or how the answer can be reached), please do not attempt with garbage.

Most common mistake (among the ones who attempted to solve) is normalization in part b). After re-computing seasonal factors, you need to normalize them before using. Some of you were not able to find the correct formula to use; you used G instead of S, and vice-versa. We expect that you do not memorize the formulas, but understand what it is before coming to the exam. Note that, even if you think there will be no significant change in the values of the seasonal factors, you have to show that you need to pass this stage of the question.

The frequency distribution of grades you have received for the question are given below:

Range	0-7	8-14	15-21	22-28	29-35
Freq.	18	11	7	4	12

Other statistics on the results of this question are:

Mean: (out of 35) 14.42

Std. Deviation: 11.68

Max: 35

Min: 0

Now, probably you can analyze the above information, as well. This graph shows a two-mode data: One in the lowest and one in the highest grade range. The variation is huge. If you look at the question it is a straightforward one with nothing new (actually the only question which is the closest to other problems in the exercise set and homework). If the grade you received is below 14, I suggest you to start forecasting chapter from scratch.

Question 2

This is an aggregate production planning problem with various extensions in mind. The setting is quite realistic, as described in the “mini-case” supplied before the exam. One thing which you should be careful when you have such questions is to make sure that you understand the information supplied in the case and not imagine additional information or situations - just concentrate on what is given. Preparation means that you understand the given facts. Two examples (a significant number in the class worked with these misunderstandings!): The first one is the instructors acting like experienced attendants – you thought that their salaries will go down when they are utilized as flight attendant. This was not supplied as information.

A second example is related to cost of hiring an instructor. There is no mention that in the text that there is a difficulty (i.e. cost) related to hiring an instructor. Of course, there might be some questions which will ask about another possibility – in that case to answer the question you may be required to go beyond the text, but only in that case.

Part a) i) and v) are asking similar things, but of the course the first one in numbers, whereas the second one is more abstract. Part a) ii) can be answered by taking the instructors who may work as attendants into account, as well (depending on how you will formulate the problem as a whole). Part a) iii) and v) are asking for manpower balances – balance means that you are asked to write an equation that relates variables with time subscripts to observe the change from one period to the next. Part a) iv) can be done in different ways – I prefer to write all decision variables (variables which are going to be decided by the method you use to solve the problem) even if I know that they are interrelated. While grading, I was more tolerant, as I accepted answers which took the two key ones into account: number of trainees and number of instructors hired. I assumed that you were aware that the others can be written as a function of these two. Part a) vii) is straightforward.

Part a) vi) deserves a little discussion. The idea behind the question was to consider the need for planning the future as you need to take into account your expectations and make some decisions today to cover yourself in the coming periods. In this problem, if you think you will need attendants you need to hire candidates two periods earlier. So, this brings the fact that planning to be at least 2 periods to make sense. Some of you wrote 3, which I accepted as we conceptualize that we make a decision at time end of 0 to make things ready for period 3, difference being two periods. Of course, the longer it is the better for the model to consider available information in optimization.

Part b) asks questions to be deducted from the model and from the structure of LP. Part b) i) first asks whether the objective function will increase or decrease if the policy of using 5 students per instructor changed to 6 per instructor. The answer should be as follows: The total cost may stay the same or be lower, as the feasible region of the problem is expanded. The second part is more straightforward than you think: You solve two LP's, one with the original constraint and one with the relaxed constraint. The difference in the objective function values is what you are looking for. Some of you tried to use duals; however don't forget duals are only correct locally. Some of you tried to give an exact expression of the difference – if it would be that easy then one wouldn't need to study optimization as a part of a university degree.

Part b) ii) investigates possible advantages of using an additional source to feed the instructor pool: experienced attendants. Answer is: The total cost is expected to stay the same or be lower as the feasible region of the problem is expanded. Here some of you invented the idea of paying less to instructors because they were experienced flight attendants and said that this is a benefit. Note that even if you are going to pay more to those promoted employees, it might be beneficial as you now are paying less in total. Worst case, you do not use the possibility and keep the solution without this possibility.

Part b) iii) is a typical issue you will have in while implementing such models. Note that if you didn't have any delay in hiring experienced flight attendants, you wouldn't have any problem. However, as you have a time lag to work with the desired number of experienced flight attendants this might create infeasibilities. Of course if the forecast change is for a period beyond $t+2$ there might be no problem to react. This is the reason why some companies freeze their plans for some number of periods, as they are aware they are not able to react. In our problem, I left a leeway for not having infeasibility: you can hire instructors and let them work as flight attendants. Hence, the correct response would be: There will be no infeasibilities as we can hire instructors as much as we can and use them as experienced flight attendants. If you answered only using the logic in the beginning of this paragraph, you either received full grades or a significant partial depending on the quality of your arguments.

The frequency distribution of grades you have received for the question are given below:

Range	0-9	10-18	19-27	28-35	36-45
Freq.	4	12	14	15	7

Other statistics on the results of this question are:

Mean: (out of 45) 23.63

Standard Deviation: 10.50

Max: 45

Min: 0

This question's distribution of grades is what one would expect in general. Rather than being symmetric, the grades are biased towards higher value. However the average is in the middle, indicating that those who were not successful in this question didn't do much to deserve partial grades.

Question 3

This question is similar to the question asked in the homework and tests basic knowledge on the meaning of aggregate production planning. Part a) asks you to come up with a formulation of the production planning problem which does not allow for backlogs. Similarly, Part b) asks a similar formulation when you have backlog possibility for some periods. Both of these parts are very standard. The fact that ending inventory requirement for the end of period 4 might be a bit confusing; however it simply means that the net demand for period 4 is the $D_4 + I_f$. (Note that, similarly, the beginning inventory is given as I_0 units, and hence this means that the net demand for period 1 is $D_1 - I_0$ as long as it is positive.)

Part c) i) and ii) are similar as Q2: If you expand the feasible set, the new optimal objective function is either equal to or lower than the original optimal value. Part c) iii) is simply meaning of dual variable

The frequency distribution of grades you have received for the question are given below:

Range	0-4	5-8	9-12	13-16	17-20
Freq.	5	14	15	13	5

Other statistics on the results of this question are:

Mean: (out of 20) 10.27

Standard Deviation: 4.57

Max: 20

Min: 0

This result was the most unexpected one for me: A small standard deviation (compared to its mean) and a low average for such a straightforward question. I believe if you didn't receive 13 or higher, you need to refer to IE202 for an update of modeling and optimization.