The following case description should be followed carefully to arrive at a successful model. Model variables have been highlighted in **bold**. While you are allowed to deviate from the suggested variable names, please keep it neat and tidy so that it is clear to us what we are looking at. Again, don't worry about commenting the variables, but please do ensure the units are correct. Good luck!

Many healthcare systems suffer from capacity issues. In this small assignment you are hired as an external consultant/analyst to help solve capacity issues related to performing surgical operations in a local hospital. People are referred to the hospital by their GP and first enter the waiting list, and thereafter are admitted as patient. After surgery, the hospital tries to admit as many patients as possible to the aftercare department, but if that's full they are forced to send such post-surgery patients home.

After a few rounds of interviews you obtain the following information about the process:

Every week there are some 800 **newly referred patients** that are first listed as **patients on the waiting list before admission** before they are admitted –via **admission of patients**– as **patient** to the hospital. The initial number of **patients on the waiting list before admission** amounts to 2000 patients.

The **admission of patients** is equal to the **capacity of the hospital** minus the number of **patients** divided by the **average administrative processing time before admission** of one week, plus the **patients directed towards aftercare** plus the **patients sent home without aftercare**, unless the number of **patients on the waiting list before admission** divided by the **average administrative processing time before admission** is smaller, then it equals the number of **patients on the waiting list before admission** divided by the **average administrative processing time before admission**.

Hence, **patients** flow in through **admission of patients** and flow out as **patients directed towards aftercare** or as **patients sent home without aftercare**. Initially, the number of **patients** equals the initial **capacity of the hospital** of 700 patients. The surgical intervention is such that nobody dies, which makes that the total number of **discharged patients** is equal to the number of **patients** divided by the **average residence time in the hospital** of 1 week. As many patients as possible are referred to aftercare, but the capacity of **patients in aftercare** is limited to 1000 patients at a time. All others are simply sent home. The number of **patients sent home without aftercare** is thus equal to the total number of **discharged patients** minus the **patients directed towards aftercare**. Also make sure that the full capacity of aftercare is used if its inflow is sufficiently high. The initial value of the **patients in aftercare** is equal to the **capacity of patient aftercare**. The **average administrative processing time of transfers towards aftercare** is 1 week. The **average residence time in aftercare** currently amounts to 3 weeks. The **fraction of recovered patients with aftercare** equals 98%, which feeds an outflow of **recovered patients with aftercare**. The others –**the non-recovered patients with aftercare** referred back to the hospital– flow back to the waiting list –after the same average residence time– as **patients on the waiting list before admission**.
About the same counts for the **patients without aftercare** that are sent home for lack of beds in aftercare. At home, the **average recovery time without aftercare** amounts to 7 weeks. The **fraction of recovered patients without aftercare** is 80%. This causes an outflow of **recovered patients without aftercare**. The others –**the non-recovered patients without aftercare** referred back to the hospital–flow after the same average time back as **patients on the waiting list before admission** to the waiting list. The initial number of **patients without aftercare** amounts to 300 patients.

1. Construct the model and verify that the capacity of the hospital and its aftercare is fully utilized (if that is not the case, there is a mistake in one of your equations and you need to fix it before continuing). Simulate for 3 years and show the plot for the waiting list. (30 pts)
2. To solve the bottleneck, one of the operations managers proposes to add extra capacity to the hospital (250 beds), which could be operational after 52 weeks, while another analyst in the operations department suggests to add 500 beds to the aftercare after 26 weeks. Analyze both options and argue which proposal is better to reduce the waiting list, and why? (10 pts)

3. Meanwhile, the board of the hospital has decided to add 400 beds to the hospital capacity, operational after 52 weeks. How long is the waiting list in that case after 2 years? To this end, first create another variable that calculates what the average waiting time is for a patient to be admitted. (10 pts)
4. What needs to happen in order to reduce the waiting list to approximately 8 weeks after two years? Assume that regular hospital beds and aftercare beds are equally expensive and can only be installed after 52 and 26 weeks respectively. Keep in mind the costs (adding 10,000 beds is not feasible) and try to find the minimum necessary to reduce the waiting list. Show the results in a few graphs. (15 pts)
5. There are some uncertainties, most notably the inflow of newly referred patients (between 600 and 1000), the fraction of recovered patients with aftercare (96% - 100%) and fraction of recovered patients without aftercare (70%-90%). Test the effect of these uncertainties manually with a stochastic formulation (you need not use the Python workbench) **without extra beds**, and describe their impact on the waiting list. Show the results through a graph/table.(15 pts)
6. Now test the uncertainties manually when implementing the policy you found before. Is your policy still acceptable considering these uncertainties? Explain why or why not (10 pts)

Total: 90 pts + 10 for free = 100 pts