

Q3)

- a) Created simulink model can be seen below, moreover it can be found on our GitHub repo.

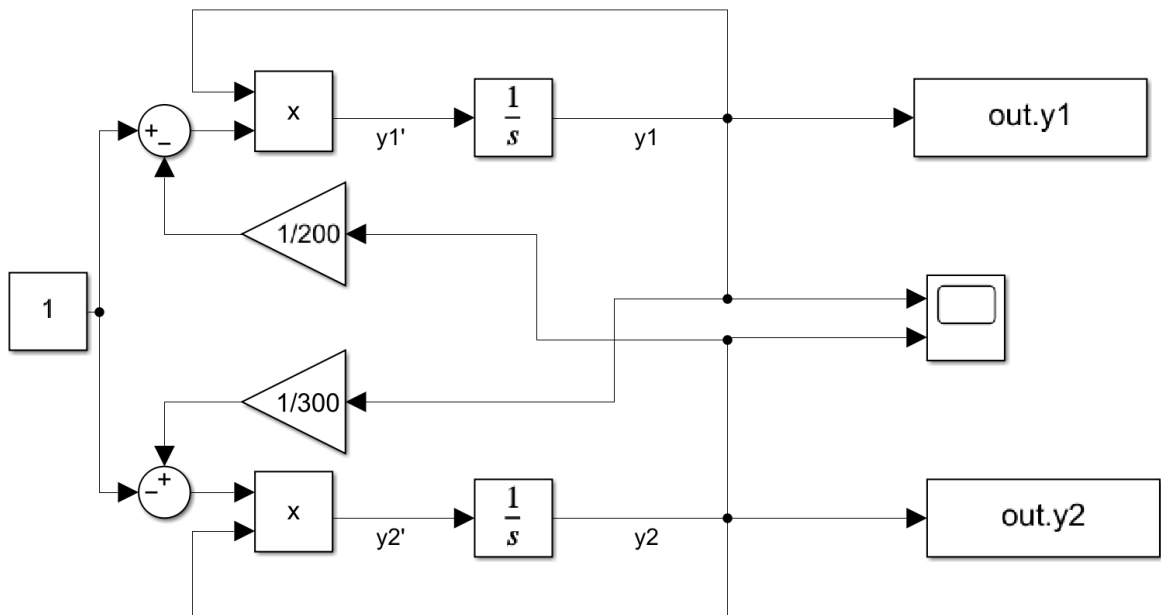


Figure X. Created simulink model with given values

- b) Output of the system for 25 seconds can be seen below.

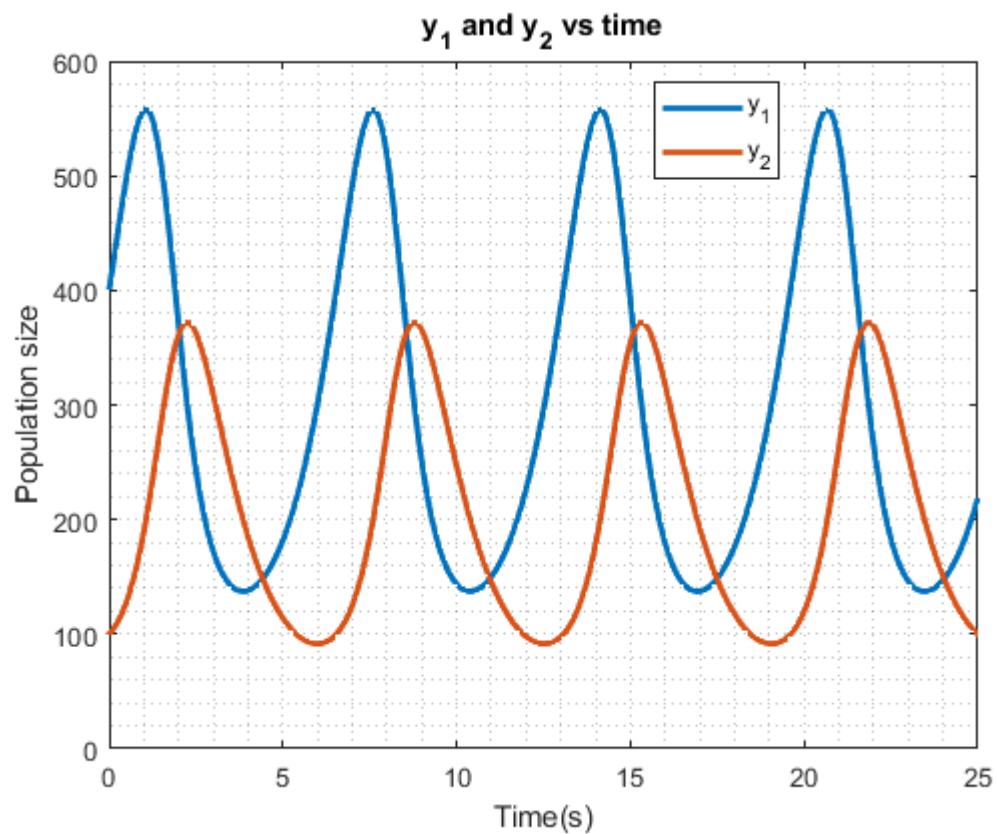


Figure X. Output of the system for 25 second with given initial conditions

- c) As can be seen from the figure in part b, the system is showing fully oscillatory behavior. Oscillations are periodic, and phase shifted from each other. They look like distorted sinusoids. In real life RLC circuits could have the similar response or many other things.

d)

- e) At the equilibrium point

$$\frac{dy_1}{dt} = \frac{dy_2}{dt} = 0$$

This means that size of both populations remain constant, by putting this condition to given equations, we can obtain that,

$$y_2 = n_2 \text{ and } y_1 = n_1$$

Since we have given $n_1 = 300$ and $n_2 = 200$, we know that

$$y_{1,\text{equilibrium}} = 300 \text{ and } y_{2,\text{equilibrium}} = 200$$

Since we asked to choose the points close to the equilibrium point, we are selecting initial conditions as, $y_{1,\text{initial}} = 295$ and $y_{2,\text{initial}} = 205$.

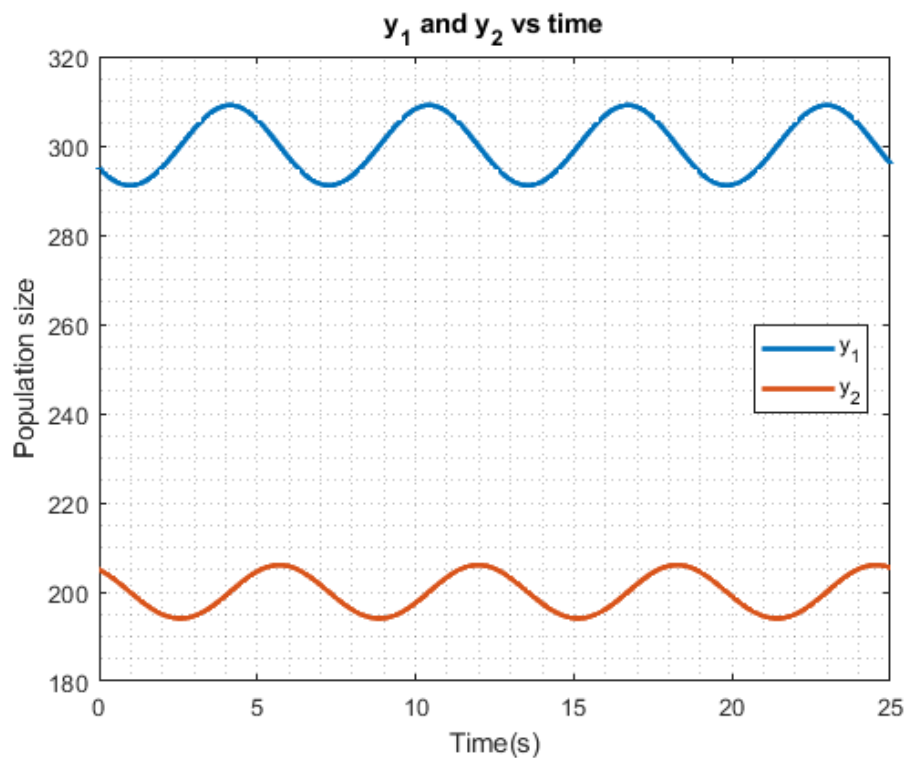


Figure X. Output of the system for 25 second with given initial conditions near equilibrium point

As can be seen from the figure above, when we give initial conditions near the equilibrium point, size of the oscillations are reduced, shape is closer to the sinusoid and the period is slightly increased. If we choose initial conditions directly at the equilibrium point, then size of the populations will be a flat line.

f) Modified model can be seen below.

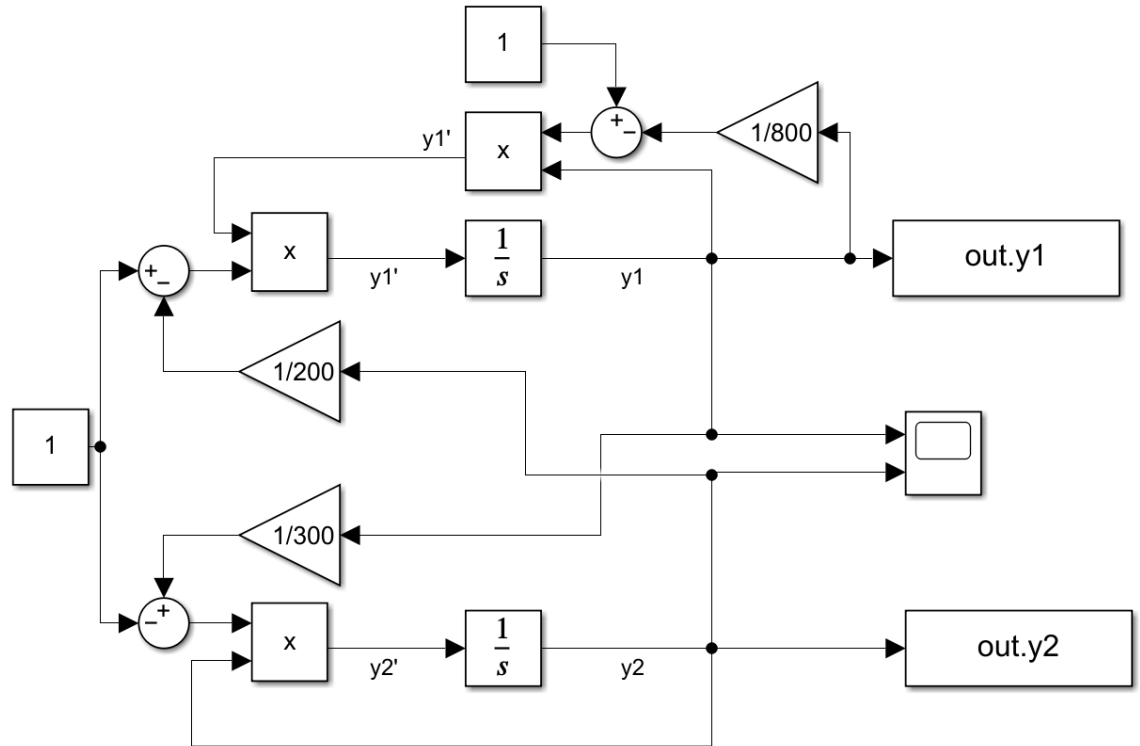


Figure X. Modified model for part f

g)

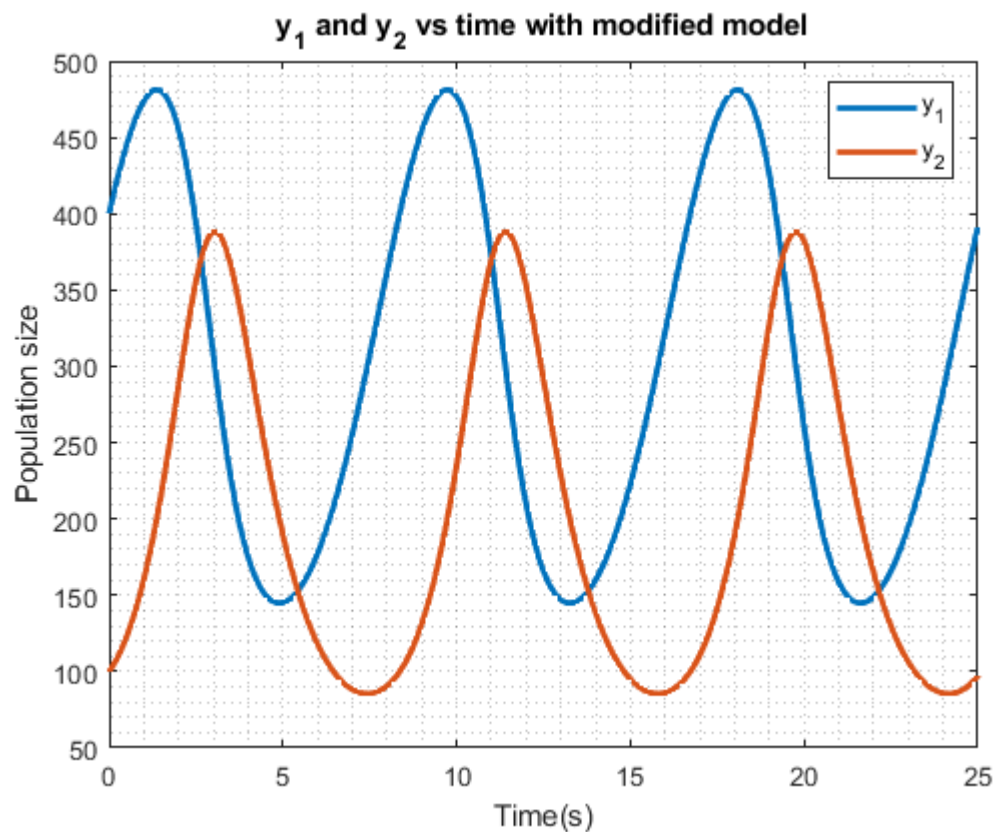


Figure X. Output of modified system with given initial conditions

Response of the system with modified simulink model shown above, as can be seen from the figure, size of the population look like sinusoids. It still shows periodic oscillatory behavior, however even though the initial conditions are the same, the period of the oscillations has changed, we can see that the period of oscillations are larger than the non-modified case(frequency of oscillations decreased). Peak to peak values of the y1(pre population) is smaller, however the peak to peak values of the y2(predator population) is larger.