Part 1:

Provide a discussion of how the values of parameters β and γ effect the results. Explain whether your results make sense intuitively, taking into account what parameters β and γ physically represent in a disease spread model.

Ans:

The parameters β and γ play an important role in the SIR model. β which is the transmission rate shows how frequently a disease is spread. A higher β leads to faster disease spread. γ is the recovery rate, this represents the rate at which infected people recover. A higher γ reduces the time period of infection for people.

These results are consistent with the physical interpretations of β and γ, and they align themselves with real-world data for the modeled diseases in this project. For example, Measles ($\beta=2.0, \gamma=0.2$) exhibits rapid spread and recovery, leading to a very short but intense outbreak, whereas Seasonal Influenza ($\beta=0.3, \gamma=0.1$) spreads more gradually, with a longer duration and lower peak infections.

Part 2:

Comment which form of interpolation provides smaller errors.

Ans:

This part of the code used quadratic interpolation to provide smaller errors compared to linear interpolation. Quadratic interpolation uses higher orders of polynomials to give a closer approximation. Linear interpolation means the function will be linear between two coarse time steps and it performs better if the function is almost linear as well. However, larger errors can happen if the function has a significant curve. Quadratic interpolation can oscillate if the data changes abruptly.

The reason quadratic interpolation is the best answer is because it uses three points, which more easily captures the change between coarse time steps.

Part 3

Do the estimates of I(0) and Beta improve compared to true parameters?

Answer:

The values of Beta and infected at 0 days are higher when estimating using 30 and 10 days mainly because fewer people have recovered at this time. Beta being the transmission rate would be much higher if less time were given because people are more susceptible at the beginning of an epidemic. As for the initially infected individuals, the reason it is much larger using a smaller number of days is that it uses a line of best fit since the least square regression is a linear model rather than nonlinear.

Part 4:

Do you observe any periodic fluctuations in the signals due to the periodicity of β?

Yes, all of the signals fluctuate periodically due to the periodic transmission rate though the recovered line fluctuates far less than the other two. It is more noticeable on the graph where $\omega = 2\pi \times 100/365$.

Observe the frequency peak(s) and comment on what you see. Does it make sense physically?

The frequency peaks at 1. This does make sense physically and shows that 1 is the dominant frequency meaning it is the frequency where the infected cases fluctuate the most.