Kalman Filter Exercises

The provided code consists of a Kalman filter with the following configuration:

- Target state is $\mathbf{x}_k = (x, y, \dot{x}, \dot{y})'$
- Measurements are positions: $\mathbf{z}_k = (x, y)'$
- Measurement error standard deviation $\sigma_x = \sigma_y = 5$ and so

$$\mathbf{R} = \begin{bmatrix} \sigma_x^2 & 0 \\ 0 & \sigma_y^2 \end{bmatrix}$$

- Continuous velocity dynamic model with a process noise intensity $\tilde{q} = 0.01$

Task 1 – Complete the state transition matrix and the transition noise covariance matrix, in the same way as in the exercise on statistical models

Task 2 – Complete the measurement matrix and the measurement noise covariance in the same way as in the exercise on statistical models

Task 3 – Complete the functions kalmanPrediction and kalmanUpdate

Task 4 – For time step t=4, plot the prior pdf and the posterior pdf as surface plots, make sure you use the same scales for the axis of both plots. (mvnpdf can help)
Which of the estimators from the parameter estimation lecture should be used to get an estimate from the pdf?

Task 5 - Plot the true target state, the measurements and the state estimates.
What is the state estimate at time 60?
Based on what can be seen in this plot, what is the benefit of tracking (state estimation)?

Task 6 - Plot the Kalman filter gain in x (i.e. $\mathbf{W}(1,1)$) over the simulation time.
What does the Kalman filter gain represent and how does it change over time?

Task 7 - Change the process noise intensity to 20 and plot the true target state, the measurements and the state estimates.
How is the Kalman filter gain different to task 6? How does this track differ from the track produced for Task 5?