ECE 1511, Hw # 5 [redacted]

Problem Let $x[n] = d[n] + v[n]$

where $d[n] = \sin(0.015\pi n + \varphi)$ where $\varphi \sim U[-\pi, \pi]$, and $v[n]$ is white noise, zero mean, unit variance, uncorrelated with $d[n]$. We wish to recover $d[n]$ from the noisy observations $x[n]$, $n = 0, 1, \ldots, N-1$ by using a Kalman filtering procedure.

a) Derive the "state equation" and the "Observation equation". To derive the state equation express

$$d[n] = \sin(0.015\pi n + \varphi) = \sin(0.015\pi(n-1) + 0.015\pi + \varphi)$$

$$= \ldots = A\,d(n-1) + B\,d(n-2)$$

where A, B are appropriate constants to be determined

b) Generate 500 samples of $x[n]$, $n = 0, \ldots, 499$

c) Use a Recursive Kalman filter implementation to estimate $d[n]$ from $x[n]$. What initialization should you use for the state vector $\hat{d}(0/0)$ and the covariance matrix $P(0/0)$? Plot your estimate and compare it to $x[n]$.

d) Rewrite the state equation as follows:

$$\underline{d}[n] = \underline{A}\,\underline{d}(n-1) + \underline{w}[n]$$

where, $\underline{w}[n]$ a white noise vector of unknown variance σ_w^2.

Repeat part c and compare for different values of σ_w^2.