Exam Questions

Problem 1:

a. Kirchoff's 1st and 2nd laws explain the ways in which current and voltage behave in circuits throughout loops and junctions. The 1st Law states that, due to Conservation of Charge, all current that enters a junction must also exit that junction. There is no net gain or loss of total current, so the current split among all paths must sum to constant amount. The 2nd Law states that, due to Conservation of Energy, potential in a closed circuit is conserved. This means that all voltage drops or gains within a closed loop in a circuit must sum to the total amount of electric potential originally in the system, which is 0.

b. Nyquist Frequency is the largest frequency that can be used to accurately record a sample's signal. It is equal to half of a given sample rate and, to avoid aliasing distortion can only be increased if the sample rate is increased by twice the same amount.

c. The Sifting Property is an attribute of the unit impulse function that allows for particular values of a continuous function to be taken out and evaluated at given times while ignoring evaluation of the impulse function anywhere else as it is equal to 0 at these non-sifted times.

Problem 2:

c. MATLAB mean: 7.99
MATLAB var: 3.96

d. $E(s_t) = 4 + 0.5(s_t) + 2e_t$

$E(s_t) = 4 + 0.5_{E(s_t)} + 0$

$E(s_t) = 4/0.5 =$ 8 No Change

$Var(s_t) = (0.5)(0.5)\,Var(s_t) + 2e_t$

$Var(s_t) = 0.25\,var_{(s_t)} + 2(1)$

$Var(s_t) = 2/.75 =$ 2.67 Doubled Vars_t

System has increased variance (doubled) and a slightly higer Signal to Noise Ratio

-> from HW #6

$SNR = \log(Var(s_t) + E(s_t)^2)$

$= \log(2.67 + 8^2)$

= 1.824 dB greater than 1.815 found in #6

MATLAB mean = 7.98
MATLAB var = 16.2

e. The assumption made would not work if the coefficient for S_{t-1} were greater than 1. This is because the equation would quickly begin to increase exponentially so there would be a significant difference between a point and the one preceding it over many time steps. The slope difference between points gets smaller and eventually converges to 0 when the coefficient is < 1. It goes to infinity when the coefficient is > 1.