Syllabus ECE 4345

1. Review of Probability
    - 1.1.1. Definitions of probability
    - 1.1.2. Classical definition
        - 1.1.2.1. Bertrand's paradox
        - 1.1.2.2. The Monte Hall problem
        - 1.1.2.3. Monte Hall problem #2
    - 1.1.3. Relative frequency definition
    - 1.1.4. Monte Carlo simulation
        - 1.1.4.1. Compute π by throwing darts
        - 1.1.4.2. Buffon's needle
    - 1.1.5. Classical definition
        - 1.1.5.1. Axioms
  - 1.2. Fundamentals
    - 1.2.1. Independence & mutually exclusive events
    - 1.2.2. Conditional probability
    - 1.2.3. Universal set partition
    - 1.2.4. Theorem of total probability
    - 1.2.5. Bayes theorem
  - 1.3. Random variables
    - 1.3.1. Definition
    - 1.3.2. Cumulative distribution functions
        - 1.3.2.1. Properties
        - 1.3.2.2. Probabilities from CDF's
    - 1.3.3. Probability density functions
        - 1.3.3.1. Definition
        - 1.3.3.2. Properties
        - 1.3.3.3. Histograms
        - 1.3.3.4. Conditional PDF's and CDF's
    - 1.3.4. Discrete random variables
    - 1.3.5. Mixed random variables
    - 1.3.6. Common random variable pdf's
        - 1.3.6.1. Bernoulli
        - 1.3.6.2. Binomial
        - 1.3.6.3. Geometric
        - 1.3.6.4. Negative binomial
        - 1.3.6.5. Poisson
        - 1.3.6.6. Uniform
            - 1.3.6.6.1. Discrete
            - 1.3.6.6.2. Continuous

1.3.6.7. Gaussian (normal)
1.3.6.7.1. Erf function
1.3.6.7.2. Variations
1.3.6.8. Exponential
1.3.6.8.1. The ageless exponential
1.3.6.9. Cauchy
1.3.6.10. Laplace
1.3.6.11. Gamma
1.3.6.12. Other
2. Transformation of a random variable
2.1. Effects of nonlinearities
2.1.1. Strictly increasing
2.1.2. $Y = g(X)$
2.1.2.1. Uniqueness
2.1.3. Synthesis & Inversion
2.2. Expected Values
2.3. Central tendency and dispersion measures
2.4. Moments
2.4.1. Mean & variance
2.5. Characteristic functions
2.5.1. Properties
2.5.2. Pdf convolution
2.5.3. Second characteristic functions
2.5.4. Moment generating functions
2.5.5. Probability generating functions
2.5.6. Examples
2.5.6.1. Bernoulli
2.5.6.2. Binomial
2.5.6.3. Geometric
2.5.6.4. Negative binomial
2.5.6.5. Poisson
2.5.6.6. Uniform
2.5.6.7. Gaussian
2.5.6.8. Exponential
2.5.6.9. Laplace
2.5.6.10. Gamma
2.5.7. Tail inequalities
2.5.7.1. Markov's inequality
2.5.7.2. Chebyshev inequality
2.5.7.3. The Chernoff bound
3. Information & entropy (ADD)
3.1. Defining information

7.6.4. Sum processes
7.6.5. Autocovariance
7.6.6. Poisson random processes
7.6.6.1. Telegraph signal
7.6.6.2. Poisson points
7.6.6.3. Shot noise
7.6.7. Weiner processes
7.6.7.1. Modelling stock prices

8. Stationarity (AO)
   - 8.1. Strict
   - 8.2. Wide sense
     - 8.2.1. Average power
     - 8.2.2. Autocorrelation Properties
   - 8.3. Cyclostationary processes
   - 8.4. Gaussian random processes
     - 8.4.1. SSS vs. WSS
9. Ergodicity (AP)
   - 9.1. Mean ergodicity
   - 9.2. Autocorrelation ergodicity
10. Processing of random signals (AQ)
    - 10.1. Power spectral density
      - 10.1.1. Properties
    - 10.2. Of discrete random processes
    - 10.3. White noise
      - 10.3.1. Discrete & Continuous
11. Filtering stochastic processes (RA)
    - 11.1. Linear & LTI filtering
      - 11.1.1. LTI filtering
      - 11.1.2. Nonstationary
      - 11.1.3. Stochastic differential equations
    - 11.2. Filtering WSS stochastic processes
    - 11.3. Power spectral density characterization
      - 11.3.1. Positivity proof
      - 11.3.2. Derivatives
      - 11.3.3. ARMA