

**National University of Singapore, ECE Department**  
**EE2012 Analytical Methods in ECE**

Experiment II: Verification of Theory of Probability (1/3 of the grade for experiments)

Report Due Date: 5 pm Last week of classes for the current semester

Report Contents: (1) Your activities, (2) Results, (3) Interpretation of results (4) Soft copy of the code developed on a diskette/CD.

Make and state any assumptions that you need to make.

Software simulation tool to be used: MATLAB

Task 1 (MATLAB). Write a simple program to generate  $N$  sample values of uniformly distributed rv  $X$  in the interval  $[0, 1]$ . Let these sample values be  $x_1, x_2, \dots, x_N$ .  $N$ , in general, can take a large value (several million samples may need to be taken).

Hint: Check to see if such a program/function is already available in MATLAB.

Task 2 (Analytical). Derive an expression to obtain a functional transformation  $Y = f(X)$ , where  $X$  is a rv uniformly distributed in  $[0, 1]$  and  $Y$  is a rv having pdf  $\mathbf{N}(0, 1)$ .

Task 3 (MATLAB). Using values in Task 1, find the samples of a rv  $Z$  having pdf  $\mathbf{N}(0, 1)$ .

Task 4 (MATLAB). Use the sample values to estimate the pdf of  $Z$  and plot it.

Task 5 (Analytical). Derive an expression to obtain a functional transformation  $Y = f(X)$ , where  $X$  is a rv uniformly distributed in  $[0, 1]$  and  $Y$  is a binary rv with pdf  $p(Y = 0) = 1 - p$ ,  $p(Y = 1) = p$ .

Task 6 (MATLAB). For the samples values of  $X$  in Task 1, find the corresponding sample values of  $Y$  in Task 5 for  $p = 0.2$  and  $0.5$ .

Task 7 (MATLAB). Based on the sample values in Task 6, verify that the pdf of a rv  $V$  that measures the number of successes in  $n$  Bernoulli trials is indeed binomial. Use  $n = 100$  and  $p = 0.2$ .

Task 8 (MATLAB). Verify that the pdf of a rv  $S$  that measures the number of successes in  $n$  Bernoulli trials is indeed binomial. Here  $n = 200$ ,  $p = 0.5$ . Use completely **different set of sample values** for  $S$ .

Task 9 (Analytical & MATLAB). Given  $V$  in Task 7 and  $S$  in Task 8, let  $T = V + S$ . Derive analytically the exact pdf of  $T$  and verify using MATLAB that  $T$  has Gaussian PDF (Hint: Remember CLT).

Task 10 (MATLAB). Verify that the pdf of a rv  $W$  that measures the number of successes in  $n$  Bernoulli trials is indeed binomial. Here  $n = 200$ ,  $p = 0.5/(n - 100)$ . Repeat this task for  $n = 500$ ,  $5000$  and  $10,000$ . Use completely **different set of sample values** for  $W$  for each  $n$ . When  $n$  gets large, verify using MATLAB that  $T$  has Poisson PDF.