ELE2035 Mathematics– Coursework

This coursework covers the probability and statistics part of the ELE2035 Mathematics module. All solutions must be obtained using MATLAB which is available on the University open access computers and here.

Submission: **Coursework solutions must be uploaded to Canvas by 5 pm on Friday 25th April 2025.** A zero mark will be applied for late submission.

Please note the following:

1. This coursework is **worth 20% of the overall module marks**.
2. You should prepare a PDF or Word document with answers for each question.

For each question, you must provide the following information:
(a) Any results, explanation and figures that you have been asked for;
(b) A MATLAB script that can executed to provide the solution to each part of the question.

Question 1: Download and import the attached MATLAB workspace file **coursework_data_x.mat**. It contains an unknown set of data, x, that we would like to perform an exploratory data analysis on. In MATLAB,	
a) determine the mean, variance, and skewness of x. Comment on the randomness and skewness of x,	[10 marks]
b) determine the probability that x belongs to the interval [0, 1.0],	[10 marks]
c) plot the PDF of x,	[10 marks]
d) compare the PDF of x with the PDF of an exponential distributed random variable having the same mean. What conclusion can you draw from this comparison?	[10 marks]
e) Download and import the another attached MATLAB workspace file **coursework_data_y.mat**. It contains an unknown set of data, y. Create a scatter plot to investigate the relationship between x and y Subsequently, comment on any relationship that might exist between them. Also calculate the covariance and correlation coefficient.	[10 marks]
Question 2: Let consider a multiple-input single-out (MISO) system where a transmitter equipped with M antennas transmits signal to a receiver equipped with a single antenna. Channel between the transmitter and the receiver is a $M \times 1$ vector, denoted by $\boldsymbol{h}$. An (instantaneous) achievable rate (in bits/s/Hz) the transmission is given by $R = \log_2(1 + P\|\boldsymbol{h}\|^2) \quad \text{(bits/s/Hz)},$ where P is the normalized transmit power, $\|\boldsymbol{h}\|$ is the norm (length) of vector $\boldsymbol{h}$. The m-th element of $\boldsymbol{h}$ is denoted by h_m which follows complex Gaussian distribution, i.e., $h_m = \frac{1}{\sqrt{2}} h_{m,1} + \frac{j}{\sqrt{2}} h_{m,2},$ where $j = \sqrt{-1}$, $h_{m,1}$ and $h_{m,2}$ are two independent standard normal random variables. Assume that $M = 2, P = 10$, use MATLAB to implement the following tasks.	
a) Generate 100,000 realisations of R.	[10 marks]
b) Determine the mean value of the achievable rate R.	[10 marks]
c) Plot the CDF of R.	[10 marks]
d) The system is called “outage” if the achievable rate R is less than 1 bits/s/Hz. Determine the outage probability of the system. Comment on the result.	[10 marks]
e) Replace $M = 2$ with $M = 50$, plot the CDF of R and compare it with the one in c). What conclusion can you draw from this comparison?	[10 marks]