CCE2301—MATLAB: Practical 3

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Part I

Linear Algebraic Equations

Objective

The objective of this part is to solve some linear equations.

Procedure

Use MATLAB to solve the following systems of equations. First, check whether each system has no exact solutions, one unique solution, or infinite solutions.

If the system has no exact solutions, solve the system in a least-squares sense. If the system has infinite solutions, reduce the system using `rref`, and write down a reduced system of equations.

1.

$$v_1 = 4\text{V},\, v_2 = 5\text{V},\, R_1 = 200\Omega,\, R_2 = 300\Omega,\, R_3 = 350\Omega$$
$$v_1 = R_1 i_1 + R_3 i_3$$
$$v_2 = R_2 i_2 + R_3 i_3$$
$$i_3 = i_1 + i_2$$

2.

$$\begin{aligned} x + 4y &= 5 \\ 2x + 3y &= 0 \\ x - y &= -5 \end{aligned}$$

3.

$$\begin{aligned} x + 4y &= 5 \\ 2x + 3y &= 3 \\ x - y &= 10 \end{aligned}$$

4.

$$\begin{aligned} 2x - 3y + 4z &= 21 \\ 3x - 2y + 6z &= 19 \\ x + y + 2z &= -1 \end{aligned}$$

5.

$$\begin{aligned} 2x + 4y + 2z &= 1 \\ 3x + 5y - 2z &= 2 \\ x + 3y + 6z &= 3 \end{aligned}$$

Report

Your report should include any MATLAB commands that you wrote, the results you obtained, and any observations and comments.

Part II
Random Numbers and Statistics

Objective

The objective of this part is to investigate statistics for random numbers.

Procedure

1. The probability distribution function of the normal distribution, also known as the Gaussian distribution, is given by:

$$\varphi_{\mu,\sigma^2}(x) = \frac{1}{\sigma\sqrt{2\pi}}\, e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

where μ is the mean,
σ is the standard deviation,
σ^2 is the variance,
φ_{μ,σ^2} is the probability density function.

Write a function to return this probability density function. The function should have the following definition:

```
function p = normal_pdf(x, mu, sigma)
```

2. Plot $\varphi_{2,1/3}$ for $x \in [-1, 5]$.

3. Using the `randn` function, create an array of 10,000 random numbers distributed normally with $\mu = 2$ and $\sigma^2 = \frac{1}{3}$.

4. Using the `hist` command, distribute the array into bins. Select an adequate number of bins. Once you are satisfied with the number of bins, use `hist` with two output arguments `n` and `x`, to store your bins for further processing.

5. Plotting `n` against `x` using `plot` should produce a curve similar to that for the probability density function. However the area under the curve would not be equal to one. Find the area under the curve using the `trapz` function, and divide `n` by the area.

6. Now plotting `n` against `x` should produce the probability density function, with the area under the curve equal to one. On the same axis:

   (a) Plot `n` against `x` to produce the curve for the probability density function.

   (b) Plot $\varphi_{2,1/3}$.

Adding several random variables together should give a new random variable with a distribution approaching the normal distribution.

Suppose U, V, W and X are four independent random variables. Each of them is uniformly distributed between 0 and 1. Let another random variable $Y = U + V + W + X$. Y should be a random variable with a distribution similar to a normal distribution with $\mu = 2$ and $\sigma^2 = \frac{1}{3}$.

7. Using the `rand` and `sum` functions, create an array of 10,000 values for the random variable Y above. Each of the 10,000 values should be the sum of four random numbers with a uniform distribution between 0 and 1.

8. Repeate steps 4–6 for this array.

Report

Your report should include any MATLAB scripts and functions that you wrote, the plots, and any observations and comments. Note that printed plots should be labelled properly.