FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

School of Electrical & Electronics Engineering

Bachelor of Engineering

EEB604 – Electrical Engineering Modeling

FINAL EXAMINATION

Semester 2, 2018

Date: As per Exam Time Table

Time: As per Exam Time Table

Venue: As per Exam Timetable

Duration of Exam: 3 Hours 10 Minutes

Instructions to Students

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Create a folder on the desktop by the name \EEB610 Exam". Open MATLAB and change the current directory to the folder created. This is your working folder. Create a new M-File by your ID number. Example if your ID number is 2009001687, the filename should be s2009001687.m. Write your student ID number at the top of the M-File as a comment.
3. Attempt all questions in the M-File. Use cell mode to separate the questions.
4. Use a Figure command to start a new plot. After completing all the questions, publish the M-File in PDF.
5. For questions that ask you to create a function, you can create the function in a separate M-File but later copy the code of the function as comments in your main M-File.

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Question 1 ***(15 marks)***

a) The maximum height h achieved by an object thrown with a speed v at an angle θ to the horizontal axis is

$$h = \frac{v^2 \sin^2 \theta}{2g}$$

Create a Table showing the maximum height for the following values of v and θ:

$v = 10, 12, 14, 16, 18, 20\ m/s$
$\theta = 50°, 60°, 70°, 80°$

The rows in the Table should correspond to the speed values, and the columns should correspond to the angles. Convert the values in the Table to two decimal places.

(7 marks)

b) An ideal diode blocks the flow of current in the direction opposite to that of the diodes arrow symbol. It can be used to make a half-wave rectifier as shown in Figure 1. For the ideal diode, the voltage V_L across the load R_L is given by:

$$V_L = \begin{cases} V_s, & if\ V_s > 0.7 \\ 0, & if\ V_s \leq 0.7 \end{cases}$$

Suppose the supply voltage is

$$V_s(t) = 6e^{-\frac{t}{3}} \sin(\pi t)$$

where time t is in seconds. Plot the voltage V_L versus t, and V_S versus t for $0 \leq t \leq 10$s.

(8 marks)

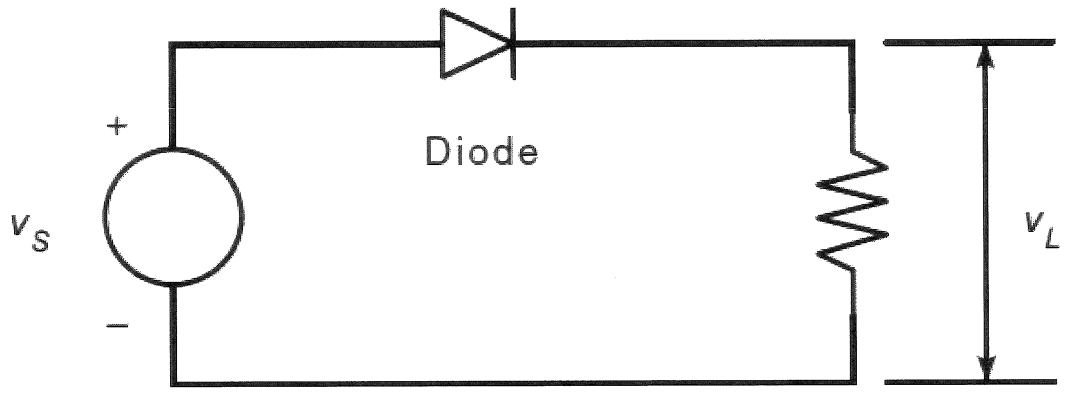

Figure 1

Please Turn Over

Question 2 ***(15 marks)***

a) Make a vector of 500 random numbers normally distributed with mean of 3 and standard deviation of 6. After you generate the vector, verify that the sample mean and standard deviation of the vector are close to 3 and 6, respectively. Do this in a script file randVariables.m. ***(6 marks)***

b) A fence around a field is shaped as shown in Figure 2. It consists of a rectangle of length L and width W, and a right triangle that is symmetrical about the central horizontal axis of the rectangle. Suppose the width W is known (in meters) and the enclosed area A is known (in square meters). Write a user-defined function with W and A as inputs. The outputs are the length L required so that the enclosed area is A and the total length of the fence required. Test your function for the values $W = 7m$ and $A = 80m^2$.

(9 marks)

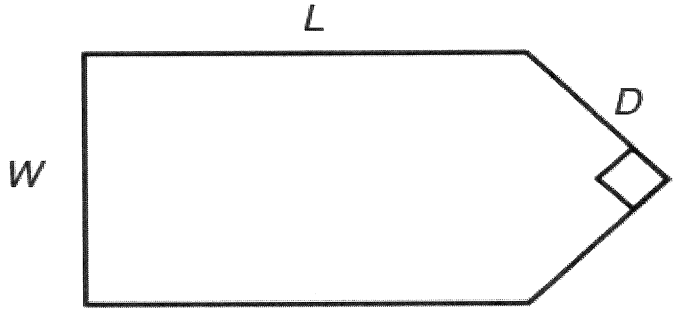

Figure 2

Question 3 ***(15 marks)***

a) Determine how many terms in the series 2^{k+1} are required for the sum of the terms to exceed 2000. The value of k varies from 1 to an infinite value. What is the sum for this number of terms. ***(5 marks)***

b) In each of the Table (Table 1 and Table 2), determine the best function $y(x)$ to describe the data. Plot the function on the same plot with the data. Label and format the plots appropriately. ***(10 marks)***

Table 1

x	25	30	35	40	45
y	5	260	480	745	1100

Table 2

x	2.5	3	3.5	4	4.5	5	5.5	6	7	8	9	10
y	1500	1220	1050	915	810	745	690	620	520	480	410	390

Please Turn Over

Question 4 ***(15 marks)***

a) Solve the following system of equations. Useful MATLAB commands include (rank, rref, pinv). Compute and display the solutions for a, b and c. Comment on your answer. Do this question in a script linearEq.m. ***(7.5 marks)***

$$a - c = 1$$
$$2a + b = 1$$
$$3a + 2b + c = 1$$

b) What is the value of the following:

$$\int_0^{10} xe^{-5x}\, dx$$

Use trapz or quad. Compute and display the difference between your numerical answer and the analytical answer. ***(7.5 marks)***

Question 5 ***(15 marks)***

a) The model of the RC circuit shown in Figure 3 can be found from Kirchhoffs voltage law and conservation of charge. It is $C\dot{y} + y = v(t)$. Suppose the value of RC is 0.1. Use a numerical method to find the free response for the case where the applied voltage is zero and the initial capacitor voltage is $y(0) = 2\,V$. Compare the results with the analytical solution, which is $y(t) = 2e^{-10t}$. ***(10 marks)***

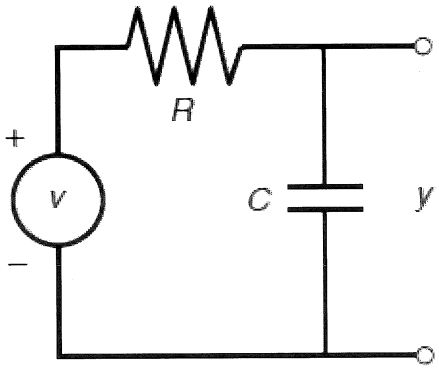

Figure 3

b) Compute the unit-step response for zero initial conditions of the following reduced-form model. Comment on the characteristics of the response. ***(5 marks)***

$$5\ddot{x} + 7\dot{x} + 5x = 5\dot{f} + f$$

Please turn over

Question 6 (*25 marks)*

a) For the following data:

$x = 1, 2, 3, 4, 5, 6, 7, 8, 9.$
$y = 5, 6, 10, 20, 28, 33, 34, 36, 42.$

i) Compute the first to fourth degree polynomials to fit the data. ***(5 marks)***
ii) Plot the data and the polynomials on the same plot. ***(3 marks)***
iii) Determine the quality of the curve fit by computing $J, S,$ and r^2 as defined below. Comment on computed $J, S,$ and r^2 values for each polynomial. ***(7 marks)***

$$J = \sum_{i=1}^{m} (f(x_i) - y_i)^2$$

$$S = \sum_{i=1}^{m} (y_i - \bar{y})^2$$

$$r^2 = 1 - \frac{J}{S}$$

In the equations, m is the number of data points.

b) Create a surface plot of the function z given below for $-2 \leq x \leq 2$ and $-2 \leq y \leq 2$. ***(10 marks)***

$$z = xe^{-\left[\left(x-y^2\right)^2+y^2\right]}$$

THE END

ALL THE BEST FOR THE EXAMINATION