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MAIN EXAMINATION

MAY – JULY 2018 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

PART TIME PROGRAMME

MAT 608: MATHEMATICAL PROGRAMMING

Date: JULY 2018	**Duration: 2 ½ Hours**
INSTRUCTIONS: Answer Question ONE and any other TWO Questions	

Q1. a) The data bellow shows the number of HIV patients in a particular country.

Year	2008	2009	2010	2011	2012
Number of HIV patients	49	45	43	40	35

Write a programme in maple to draw a graph of the number of HIV patients against the years. (**8 marks)**

b) A dietitian plans to provide a patient with a meal that has $\mathbf{70}\boldsymbol{g}$ of protein, $\mathbf{100}\boldsymbol{g}$ of carbohydrates, and$\mathbf{820}\ \boldsymbol{mg}$ of calcium. The available food is fish, vegetable, and energy drinks. Each serving of fish contains $\mathbf{28}\ \boldsymbol{g}$ of protein,$\mathbf{36}\ \boldsymbol{g}$ of carbohydrates, and $\mathbf{270}\ \boldsymbol{mg}$ of calcium. Each serving of vegetable contains $\mathbf{6}\ \boldsymbol{g}$of protein, $\mathbf{36}\ \boldsymbol{g}$of carbohydrates, and $\mathbf{12}\ \boldsymbol{mg}$ of calcium. Each serving of the energy drink contains $\mathbf{11}\ \boldsymbol{g}$, $\mathbf{10}\ \boldsymbol{g}$, and $\mathbf{400}\ \boldsymbol{mg}$ of proteins, carbohydrates, and calcium respectively.

i) Write out the summary of the Dietician information in a table form (**4 marks)**

ii) Write a maple programme to determine the amount of serving of fish, vegetable, and energy drinks in order to meet the protein, carbohydrates, and calcium requirements. **(6 marks)**

iii) Write the output of the programme. **(3 marks)**

c) A $(2x2)$ square matrix is represented by; $\boldsymbol{P} = \begin{pmatrix} \mathbf{2} & \mathbf{1} \\ \mathbf{-5} & \mathbf{-4} \end{pmatrix}$.Outline a maple programme that would compute the following;

i) The eigenvalues of the matrix P. **(5 marks)**

ii) Write the values of the eigenvalues. **(2 marks)**

iii) The values of the eigenvectors. **(2 marks)**

Q2. a) Two functions are defined by;

(i) $f(x) = x^2 + 2x + 1$

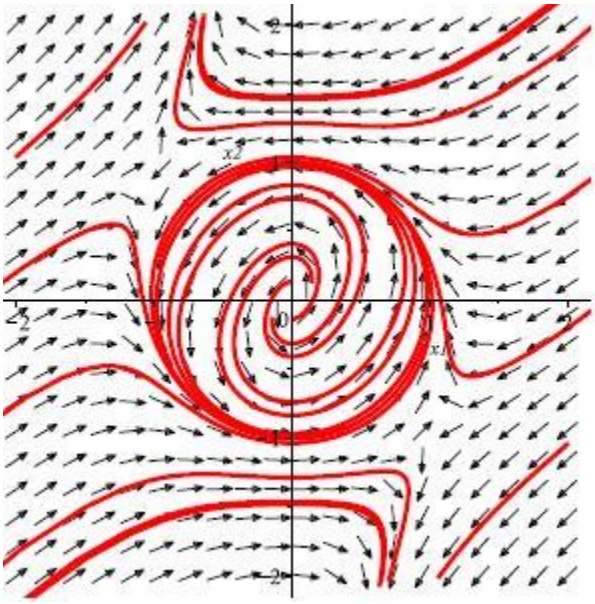
(ii) $g(x) = -x^2 - 1$

Write a programme in maple to plot the graphs of the individual functions and a combined graph of the two functions. **(12 marks)**

b) A differential equation is represented by; $\frac{\mathbf{d}}{\mathbf{dt}}\mathbf{I(t)} = \mathbf{0.5S(t)} - \mathbf{0.6I(t)}$.

Outline a programme in maple to draw the graph of the differential equation with the default settings in DE tools. **(8 marks)**

Q3. a) The maple output bellow is the phase portrait of the system of differential equations given by; $\frac{\mathbf{dx}}{\mathbf{dt}} = -\mathbf{y} + \mathbf{x}(\mathbf{1} - \mathbf{x^2} - \mathbf{y^2})$, $\frac{\mathbf{dy}}{\mathbf{dt}} = \mathbf{x} + \mathbf{x}(\mathbf{1} - \mathbf{x^2} - \mathbf{y^2})$



Outline a programme in maple that gave the above diagram. **(12 marks)**

b) A linear system of equations is given by;

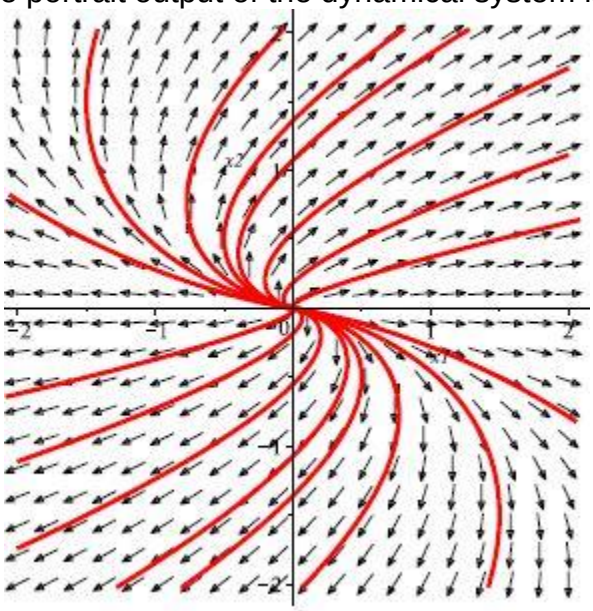
$$2x + 4y + 6z = 6$$
$$-3x + y + 5z = -9$$
$$5x + 8y + z = 5$$

i) Outline a maple programme to solve the linear system of equations **(8 marks)**

ii) Write the out of the linear system of equations.

Q4. a) Consider a dynamical system; $\frac{dx}{dt} = x + y$
$\frac{dy}{dt} = y$

The phase portrait output of the dynamical system is given bellow;



Write the maple programme that gave out the above phase portrait. **(6 marks)**

b) Write a programme in maple to compute the following and hence write out the outputs of those values; **(6 marks)**

i) $\sqrt{(x^2 + y^2)}$ **(ii)** $(x^2 + y^2)^{\frac{1}{2}}$

Where $x = 3$ and $y = 4$.

c) Write a programme in maple for factorising the following functions and hence write out the factors;

(i) $(a^2 - b^2)$ **(4 marks)**

(ii) $x^2 - 2a - 15 = 0.$ **(4 marks)**

Q5. a) A biologist has two solutions of 30% and 70%acid. The biologist needs $60\ litres$ of 45% acid. How many litres of each solution should the biologist mix to obtain the desired amount?

i) Write a maple programme that would help the biologist to solve his problem. **(6 marks)**

ii) Write the output of the required concentrations of the biologist desires. **(2 marks)**

b) A quadratic equation is of the form; $\mathbf{ax^2 + bx + c = 0}$. Write a programme in maple to compute the roots of the quadratic equation and hence write out the roots. **(5 marks)**

c) The difference between two distinct numbers is negative one and twice the first number plus the second number is seven.

i) Write a programme in maple to compute the two distinct numbers. **(5 marks)**

ii) Write out the values of the two numbers. **(2 marks)**

END