



SUPPLEMENTARY EXAMINATION, 2019/2020

BASS IV, B.Ed (Sec.) IV, B.Sc IV

Title of Paper : COMPUTATIONAL METHODS

Course Number : MAT415

Time Allowed : Three (3) Hours

Instructions

1. This paper consists of SIX (6) questions in TWO sections.
2. Section A is **COMPULSORY** and is worth 40%. Answer ALL questions in this section.
3. Section B consists of FIVE questions, each worth 20%. Answer ANY THREE (3) questions in this section.
4. Show all your working.
5. Start each new major question (A1, B2 – B6) on a new page and clearly indicate the question number at the top of the page.
6. You can answer questions in any order.
7. Indicate your program next to your student ID.

Special Requirements: NONE

THIS EXAMINATION PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR.

SECTION A [40 Marks]: ANSWER ALL QUESTIONS

QUESTION A1 [40 Marks]

- A1 (a) For each of the following statements (i -xv): Write your answer as TRUE if the statement is entirely true or FALSE if the statement is not entirely true.
- i. LaTeX is an open source software.
 - ii. Citations are automatically generated in LaTeX.
 - iii. `\quad` is a command in LaTeX for quadratic.
 - iv. The `%` sign is used for commenting in MATLAB.
 - v. The title page of a thesis must include the title of the dissertation.
 - vi. A *while loop* repeats a statement or a group of statements with conditions based on the loop variable.
 - vii. The command **NDSolve** is used for solving ordinary differential equations in LaTeX.
 - viii. Every command in LaTeX begins with a forward slash.
 - ix. `amsmath` is a package in LaTeX.
 - x. Every MATLAB code must begin with the statement **begin document**.
 - xi. In LaTeX, layout standards are contained in class files which have **.toc** as their names.
 - xii. An empty line starts a new page in LaTeX.
 - xiii. `%` is a special character in LaTeX. One would need to use a backslash before the character if they intend to use it.
 - xiv. The command `\frac{\partial y}{\partial x}` generates $\frac{\partial y}{\partial x}$ in LaTeX.
 - xv. The command `\int_a^b f(x) dx` generates $\int_a^b f(x) dx$ in LaTeX.

[15 marks]

(b) Define the following terms as used in scientific writing:

- i. *Dissertation*
- ii. *Appendix of a thesis*
- iii. *Plagiarism*

[6 marks]

(c) What is the difference between a *for loop* and a *while loop* as used in MATLAB or OCTAVE?
[4 marks]

(d) i. Define the term *thesis* as used in scientific writing. [2 marks]
ii. State four (4) components of an **abstract of a thesis**. [4 marks]

(e) Given the mathematical equation

$$H = qN + su + \lambda \left(A + \sum_{j=1}^m U_j B_j \right) N.$$

- i. Write the equation in LaTeX form using an appropriate environment. [6 marks]
- ii. State two (2) disadvantages of typesetting documents with LaTeX. [2 marks]

(f) Write a code for summing the first N even numbers in any programming language of your choice. [4 marks]

94

SECTION B: ANSWER ANY THREE QUESTIONS

QUESTION B2 [20 Marks]

B2 (a) State a substitute for each of the following words ensuring simplicity and preciseness.

- i. Commence
- ii. Disseminate
- iii. Proximity
- iv. Enumerate

[8 marks]

(b) Consider the prey-predator system below:

$$\begin{aligned}\frac{dx}{dt} &= 10x \left(1 - \frac{x}{10} - 20xy\right), \\ \frac{dy}{dt} &= -5xy + \frac{xy}{20}, \\ x(0) &= 100 \quad y(0) = 200 \quad t \in [0, 100].\end{aligned}$$

- i. Write the system in LaTeX form, using the *align* environment. [4 marks]
- ii. Write a MATLAB or OCTAVE script for numerically solving the system using Euler's method or any method of your choice. [8 marks]

QUESTION B3 [20 Marks]

B3 (a) Re-write the following text following the norms of good scientific writing, for example, preciseness, conciseness and clarity.

The existence of optimal control problem and the optimality system were established with an excellent optimal control problem formulated as follows below:

$$\max_{x,V} \max J(x, V) = \psi(x(t_f)) + \int_0^{t_f} L(t, x(t), V(t)) dt$$

subject to the following conditions shown below

$$\begin{aligned}x'(t) &= f(t, x(t), x(t - \tau), v(t)), \quad t \in [0, t_f], \\ x(t) &= \phi(t), \quad t \in [-\tau, 0]\end{aligned}$$

where J is the objective function and $L(\cdot)$ is Lagrangian objective function and $V(t)$ is called an admissible control if and only if it fulfils the condition of $a \leq v(t) \leq b$, $t \in [0, t_f]$ with the set of admissible controls (admissible set or an admissible set of controls) denoted as V_{ad} . An efficient and effective numerical technique employing forward and backward approximation schemes to the adjoint system was use to solve the optimality problem and identify the best combination treatment strategy. Numerically results showed and surely confirmed and affirmed that indeed optimality treatment strategies can for sure decrease the loading of tumour cells and result in an increment of effector cells just after a few days of treatment. [16 marks]

(b) State four (4) characteristics of a good thesis. [4 marks]

QUESTION B4 [20 Marks]

- B4 (a) State, with concise explanations, five (5) disadvantages of typesetting documents with LaTeX. [10 marks]
- (b) List ten (10) components of an ideal thesis. [10 marks]
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QUESTION B5 [20 Marks]

B5 Consider the dynamical system

$$\begin{aligned}\dot{x} &= x^2 - y - 1, \\ \dot{y} &= (x - 2)y.\end{aligned}$$

- (a) Determine the nullclines and fixed points of the system. [5 marks]
- (b) By using the Jacobian matrix of the system, determine the linear stability of all the fixed points. [10 marks]
- (c) On the same axes, draw all the nullclines of the system and sketch its phase portrait. [5 marks]
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QUESTION B6 [20 Marks]

- B6 Explain, using atleast five (5) examples, how you can avoid *plagiarism*. [20 marks]
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END OF EXAMINATION