UNIVERSITY OF SWAZILAND

MAIN EXAMINATION, 2020/2021

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. Start each new major question (A1, B2 – B6) on a new page and clearly indicate the question number at the top of the page.

5. You can answer questions in any order.

6. For questions that involve writing codes, you may use any programming language of your choice unless if specified.

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 -xx): Write your answer as TRUE if the statement is entirely true or FALSE if the statement is not entirely true.

    i. The semicolon instructs Octave or Matlab to not print the result of a command.

    ii. Octave is an open source software.

    iii. Indexes and references are automatically generated in LaTeX.

    iv. \int is a command in LaTeX for integer.

    v. The % sign is used for commenting in Octave.

    vi. The title page of a thesis must include references.

    vii. A *while loop* repeats a statement or a group of statements with conditions based on the loop variable.

    viii. The command **DSolve** is used for solving ordinary differential equations in LaTeX.

    ix. Every command in LaTeX begins with a backward slash.

    x. **amsfonts** is a package in LaTeX.

    xi. Every Octave code must begin with the statement **begin document**.

    xii. In LaTeX, there is no command for italicising text.

    xiii. An empty line starts a new page in LaTeX.

    xiv. % is a special character in LaTeX. One would need to use a forward slash before the character if they intend to use it.

    xv. The command $\frac{\partial^2 y}{\partial x^2}$ generates $\frac{\partial^2 y}{\partial x^2}$ in LaTeX.

xvi. The command $\displaystyle{\lim_{x\to\infty}f(x)}$ generates $\displaystyle{\lim_{x\to\infty}f(x)}$ in LaTeX.

xvii. R is a pragramming language that is mainly used for data visualisation and analysis.

xviii. Plagiarism is an act of fraud in academia.

xix. Paraphrasing, inacurate citation and failure to acknowledge assitance are all forms of plagiarism.

xx. An abtract of a thesis must contain figure captions.

[20 marks]

(b) Given the mathematical equation

$$\sum_{i=1}^{n} f(\xi_i)(x_i - x_{i-1}) = \sum_{i=1}^{n} \xi_i \frac{1}{n}.$$

    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]

(c) Using a *for loop*, write a code to build a k by j matrix with entries

$$a_{kj} = \frac{1}{k^2 + j^2 - 0.5}, \quad k, j \in [0, 10].$$

[6 marks]

(d)   i. Define the term *plagiarism* as used in scientific writing.   [2 marks]

    ii. State four (4) components of a *title page of a thesis*.   [4 marks]

SECTION B: ANSWER ANY *THREE* QUESTIONS

QUESTION B2 [*20 Marks*]

B2 (a) Write a code (or pseudo-code) for summing the first N odd numbers. [10 marks]

(b) State, with concise explanations, five (5) advantages of typesetting documents with LaTeX. [10 marks]

QUESTION B3 [*20 Marks*]

B3 (a) Outline ten (10) components of an ideal thesis. [10 marks]

(b) Write a code (or pseudo-code) that reads an integer a and writes 'Integer is divisible by 3, 7 or 11' if its divisible by 3, 7 or 11 otherwise it should return 'Not divisible'. [10 marks]

QUESTION B4 [*20 Marks*]

B4 (a) State five (5) attributes of a good dissertation. [10 marks]

(b) Write a code (or pseudo-code) that inputs a natural number N and calculates its factorial. [10 marks]

QUESTION B5 [*20 Marks*]

B5 (a) Define the following terms as used in scientific writing:

   i. *Thesis*

   ii. *Nominalisation*

   iii. *Hypothesis*

[6 marks]

(b) Consider the prey-predator system below:

$$\ddot{x} = 10x\left(1 - \frac{x}{50} - 20xy\right),$$
$$\dot{y} = -5xy + \frac{xy}{100},$$
$$x(0) = 100, \ y(0) = 200, \ t \in [0, 100].$$

   i. Write the system in LaTeX form, using the *align environment*. [4 marks]

   ii. Write a code for numerically solving the system. [10 marks]

QUESTION B6 [20 Marks]

B6 (a) Outline any seven (7) forms of plagiarism. [7 marks]

(b) Re-write the excerpt 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

$$x'(t) = f(t, x(t), x(t - \tau), v(t)), \quad t \in [0, t_f],$$
$$x(t) = \phi(t), \quad t \in [-\tau, 0]$$

where J is the objective function and L(.) is Lagrangian objective function and $V(t)$ is called an admissible control if and only if it fulfils the condition of $a \le v(t) \le b$, $t \in [0, t_f]$ 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. [13 marks]

——————-The End——————-