

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

(Main Campus)

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

EXAMINATION

THIRD YEAR FIRST SEMESTER SPECIAL/SUPLIMENTARY EXAMINATIONS

FOR THE DEGREE OF

BACHELOR SCIENCE IN: GEOSPATIAL INFORMATION SCIENCE

COURSE CODE: DPG 300

COURSE TITLE: NUMERICAL METHODS

DATE: 28/7/2022

TIME: 8 - 10AM

Instructions to Candidates

• This paper contains **FIVE** (5) questions

• Answer ALL questions in Section A and ANY TWO in Section B

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over →

SECTION A: Answer ALL questions [30 Marks]

Ouestion ONE

- a) 1 Divide a polynomial $f(x) = x^4 5x^3 + 5x^2 + 5x 6$ by the monomial factor x 2. Is x = 2 a root? [3 Marks]
- b) Given the data

0.90 1.42 1.30 1.55 1.63 1.32 1.35 1.47 1.95 1.66 1.96 1.47 1.92 1.35 1.05 1.85 1.74 1.65 1.78 1.71 2.29 1.82 2.06 2.14 1.27

Determine

- i. the mean, [3 Marks]
- ii. the standard deviation, [3 Marks]
- iii. the variance, [1 Mark]
- iv. the coefficient of variation, [2 Marks]
- v. the 95% confidence interval for the mean. [3 Marks]
- vi. construct a histogram using a range from 0.6 to 2.4 with intervals of 0.2. [5 Marks]
- c) Use least-squares regression to fit a straight line to

x	0	2	4	6	9	11, 7	12	15	17	19
у	5	6	7	6	9	8	7	10	12	12

Along with the slope and intercept, compute the standard error of the estimate and the correlation coefficient. [10 Marks]

SECTION B: Answer any TWO questions [40 Marks]

Question TWO

Given the system of equations

$$-3x_2 + 7x_3 = 2$$
$$x_1 + 2x_2 - x_3 = 3$$
$$5x_1 - 2x_2 = 2$$

- (a) Compute the determinant. [4 Marks]
- (b) Use Cramer's rule to solve for the x's. [6 Marks]
- (c) Use Gauss elimination with partial pivoting to solve for the x's. [8 Marks]
- (d) Substitute your results back into the original equations to check your solution [2Marks]

Question THREE

Employ inverse interpolation to determine the value of x that corresponds to f(x) = 0.85 for the following tabulated data:

X	0	1	2	3	4	5
У	0	0.5	0.8	0.9	0.941176	0.961538

Note that the values in the table were generated with the function

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

- i). Determine the correct value analytically. [1 Marks]
- ii). Use cubic interpolation of x versus y. [5 Marks]
- iii). Use inverse interpolation with quadratic interpolation and the quadratic formula. [6 Marks]
- iv). Use inverse interpolation with cubic interpolation and bisection. [6 Marks]
- v). For parts (ii) through (iv) compute the true percent relative error. [2 Marks]

Question FOUR

Linear algebraic equations can arise in the solution of differential equations. For example, the following differential equation derives from a heat balance for a long, thin rod (Fig. 4-1).

$$\frac{d^2T}{dx^2} + h'(T_{\alpha} - T) = 0 {(4-1)}$$

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Figure 4-1. A noninsulated uniform rod positioned between two walls of constant but different temperature. The finite difference representation employs four interior node.

where T = temperature (${}^{0}C$), x = distance along the rod (m), h' = a heat transfer coefficient between the rod and the ambient air (m^{-2}), and T_a = the temperature of the surrounding air (${}^{0}C$). This equation can be transformed into a set of linear algebraic equations by using a finite divided difference approximation for the second derivative,

$$\frac{d^2T}{dx^2} = \frac{T_{i+1} - 2T_i + T_{i-1}}{\Delta x^2} \tag{4-2}$$

where T_i designates the temperature at node i. This approximation can be substituted into Eq. (4-1) to give

$$T_{i+1} - 2T_i + T_{i-1} + h' \Delta x^2 (T_a - T) = 0 (4-3)$$

This equation can be written for each of the interior nodes of the rod resulting in a tridiagonal system of equations. The first and last nodes at the rods ends are fixed by boundary conditions.

- a) Develop an analytical solution for Eq. (4-1) for a 10-m rod with $T_a = 20$, T(x = 0) = 40, T(x = 10) = 200 and h' = 0.02.
- b) Develop a numerical solution for the same parameter values employed in (a) using a finite-difference solution with four interior nodes as shown in Fig. 4-1 (x = 2 m)

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