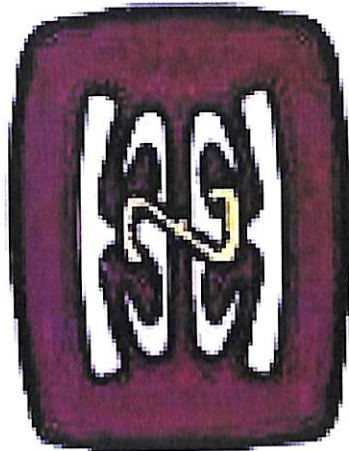


**PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY  
DEPARTMENT OF MECHANICAL ENGINEERING**

**EXAMINATION QUESTION PAPERS**



**MM 503  
NUMERICAL METHODS**

**SEMESTER ONE - 2024**



PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY (PNGUOT)  
MECHANICAL ENGINEERING

**MM503: Numerical Methods**  
**First Semester Examination, 2024**  
**Master's Mechanical Engineering**  
**Thursday, May 30<sup>th</sup>, 2024, 10:00 AM- 12:00 PM**  
**Location: MCR**

**Time Allowed: 2 Hrs**

**Instructions:**

- 1. You have 10 minutes to read the paper. Do not write anything during this time.*
- 2. Write your name clearly on the front-page using Capital letters.*
- 3. There is total five (5) questions. Answer any four (4) questions.*
- 4. All questions carry equal marks.*
- 5. All questions must be answered only in the booklet provided.*
- 6. Calculators are permitted in the examination room.*
- 7. Any student found cheating will be disqualified.*



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**Question 1: (25 Marks)**

**PART-A (5 Marks)**

A. Define types of errors that occur in numerical methods?

**PART-B (20 Marks)**

B. Given the following equation:

$$x^4 + x - 10 = 0$$

- (a) Use Newton-Raphson method to find the root correct to three decimal places with initial guess as  $x_0 = 2$ .  
(b) Determine the approximate relative error after each iteration.

**Question 2: (25 Marks)**

A. Solve the system of linear equations using Gauss-elimination method with pivoting [15 Marks]

$$\begin{aligned}x_1 + x_2 - x_3 &= 2 \\2x_1 + 3x_2 + 5x_3 &= -3 \\3x_1 + 2x_2 - 3x_3 &= 6\end{aligned}$$

(b) Use Matrix Inversion method to solve the above system of linear equations [10 Marks]

**Question 3: (25 Marks)**

A. The following data defines the sea-level concentration of dissolved oxygen for fresh water as a function of temperature:

T °C	8	16	24	32
o, mg/L	11.843	9.870	8.418	7.305

Estimate o (27) using

- (a) Fit a Linear curve to the given data and find o (27) (10 Marks)  
(b) Using Lagrange interpolating polynomial find o (27), and (10 Marks)  
(c) Calculate the percent True error for (a) and (b). Note that the exact result is 7.986 mg/L (5 Marks)



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**Question 4: (25 Marks)**

A. Use the power method to determine the dominant eigenvalue and corresponding Eigen vector. Continue the iteration up to percent relative error is 0.001. (25 Marks)

$$A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

**Question 5: (25 Marks)**

A. Compute  $y(1)$  round to four decimals, where  $y(0)=1$ .

$$\frac{dy}{dt} = t^3 + y$$

- (a) Euler's method with  $h=0.5$
- (b) Fourth order RK method with  $h=0.5$ .
- (c) Compare (a) and (b) with true value of 3.0279



**Helpful Hints:**

1.  $P_n(x) = \sum_{i=0}^n f_i l_i(x) \dots (v)$   
 $l_i(x) = \prod_{j=0, j \neq i}^n \left( \frac{x-x_j}{x_i-x_j} \right) \dots (vi)$

2.  $y_{i+1} = y_i + f(x_i, y_i) \cdot h$

3.  $m_1 = f(x_i, y_i)$   
 $m_2 = f\left(x_i + \frac{h}{2}, y_i + \frac{m_1 h}{2}\right)$   
 $m_3 = f\left(x_i + \frac{h}{2}, y_i + \frac{m_1 h}{2}\right)$   
 $m_4 = f(x_i + h, y_i + m_1 h)$

Then, the general form of extrapolation equation (i) will be:

$$y_{i+1} = y_i + \frac{h}{6}(m_1 + 2m_2 + 2m_3 + m_4) \dots (ii)$$

4.  $I = \frac{h}{3}(f_0 + 4f_1 + f_2)$

5.  $y = a + bx$

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \dots (iv)$$

$$\& \quad a = \frac{\sum y_i}{n} - b \frac{\sum x_i}{n}$$

Good luck!!!