Philadelphia University **Student Name:**

Faculty of Engineering **Student Number:**

Dept. of Mechatronics Engineering

Final Exam, Second Semester: 2023/2024

Course Title: Advanced Engineering Mathematics	**Date: 1/6/2024**
Course No: (640711) – MSc. Course	**Time Allowed: 3 Hours**
Lecturer: Dr. Mohammed Mahdi	**No. of Pages: 8**

Q1 / 30	*Q2 / 20*	*Q3 / 20*	*Q4 / 30*	*Total / 100*	*Total / 40*

Question 1: Part - 1 Multiple Choice Questions (12 /40 marks) 30%

1. When adding two skew-symmetric matrices the resultant matrix is also skew matrix.

A) Always true B) Sometimes true C) Always false D) Sometimes false

2. Given $A=\begin{bmatrix} 4 & 7 \\ -9 & 9 \end{bmatrix}$ then it is:

A) Orthogonal B) Symmetric C) Hermitian D) None of the given

3. For $f(t) = (3 + 4\,t^2)$, F(s) equals to:

A) $\frac{3s^2+8}{s^3}$ B) $\frac{3s^2-8}{s^3}$ C) $\frac{3s+8}{s^3}$ D) None of the given

4. For $F(s) = \frac{2s-7}{s^2+25}$, f(t) is:

A) 2sin 5t - 7/5 sin5t **B)** 2cos 5t - 7/5 sin5t C) 2cos 5t - 7/5 cos5t D) None of the given

5. The sum of the Eigen values of the matrix $A=\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$ is:

A) 15 B) 18 C) 16 D) None of the given

6. The quadratic form related to the matrix $A=\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ is:

A) Negative definite B) Positive definite C) Positive semi definite D) Indefinite

7. Cayley – Hamilton theorem can be applied to obtain exponential matrix for:

A) Distinct Eigen values B) Multiple Eigen values C) Single Eigen value D) All given choices

8. A second order Lagrange interpolating polynomial that passes through points (17, 25), (19, 38), (24, 40) is fL2(x) = Lo(x)*(25) + L1(x)*(38) + L2(x)*(40) then Lo (21) is:

A) 0.4285 B) - 0.4285 C) - 0.5285 D) None of the given

9. To find the function y = Ax + B, linear regression is applied to the following data (0, -4), (1, 2), (2, 8), (3, 14), then the value of B is found to be:

A) -6 B) -4 C) 6 D) None of the given

10. Non-linear regression model is found to be $\mathbf{4.5e^{0.2x}}$, and then the related value of B in the linearized model is:

A) 1.504 B) -1.504 C) 90.0171 D) None of the given

11. Applying Euler numerical integration method to integrate $\frac{dy}{dt} = y$, with step size h = 0.5, and y (1) = 0.3678. Y (1.5) is found to be:

A) 0.4417 B) 0.5517 C) 0.7517 D) None of the given

12. Using Newton-Raphson iterative method, the first iteration root approximation of the equation $\mathbf{e^x = 4x}$ with xo=2 is:

A) 2.183 B) 0.2183 C) 0.3517 D) None of the given

Part – 2 (28/40 Marks) 70 %

Note: Show all calculations

Question 2: **(20 % Marks)**

Objectives: This question is about complex numbers and solving difference equations.

A) Find real x and y if (x – iy) (3 + 5i) is the conjugate of – 6 – 24i. (10 Ms)

B) Given the following difference equation **x(k+2) +0.4 x(k+1) – 0.32 x (k) = u(k)** with **x (0) =0, x (1) = 1** with **u(k) is a unit step change of input**. It is required to find x(kT) then evaluate x (∞) using two methods. (10 Ms)

Question 3: **(20 % Marks)**

Objectives: This question is about matrices and McLaurin series

A) Given the following (3x3) matrix A = $\begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & 1 \\ 0 & 1 & 1 \end{bmatrix}$ it is required to find:

1. Eigen values. 2. Definiteness 3. Show relationship between trace(A) and its Eigen values. 4. Find Eigen values of A^4. (10 Ms)

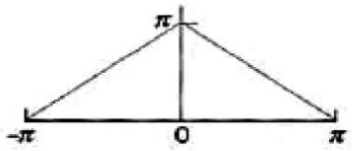
B) Find the McLaurin series of f(x) = cos(x). (10 Ms)

Question 4: **(30 % Marks)**

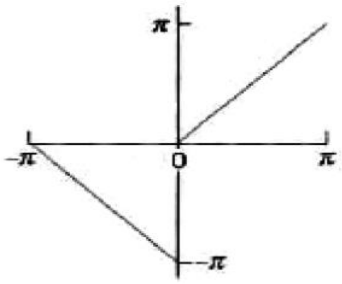
c)

Objectives: This question is about series and Fourier Transform.

A) Find the constant Fourier series coefficients (a_o) for the following periodic functions: (15 Ms)



(1)



(2)

B) For the following series determine the Center, radius and limits of convergence. (15 Ms)

$$\sum_{n=1}^{\infty} \frac{6^n}{n}(4x-1)^{n-1}$$