

Use separate answer
Script for each Unit

M.A./M.Sc. Examination 2019

Semester - IV

Mathematics

**Elective Course: MME-41(Applied Stream)
(Electromagnetic Theory and Programming in Matlab)**

Time: Three Hours

Full Marks: 40

Questions are of value as indicated in the margin.
Notations and symbols have their usual meanings.

Unit-I (Electromagnetic Theory)

Answer *any two* questions.

1. a) State and explain the Coulomb's law in electrostatics for two point charges. 1+2
b) Define electric field and potential at a point for a charged particle of charge q . Find the electric field near a long uniformly charged cylindrical rod of radius a . (1+1)+3
c) State Gauss' law in integral form and hence derive its differential form. 2
2. a) Define electrostatic energy of a point charge q in an electric field E . Show that for a continuous charge distribution the energy density of E is given by $u_e = \frac{1}{2} \epsilon_0 |E|^2$. 1+3
b) Derive the equation of continuity for a steady state current of electric charges. What is Ohm's law? Hence show that in the case of a steady state current, the continuity equation reduces to the Laplace equation for the electrostatic potential ϕ . 2+1+1
c) What is Lorentz force? Define the magnetic scalar potential ϕ_m . 1+1
3. a) Explain the phenomenon of electromagnetic induction and hence establish the differential form of Faraday's law. 2+2
b) Write down the Maxwell's equations (in SI units) of electromagnetic theory. 4
c) When the fields are time dependent, express the electric field E in terms of the scalar (ϕ) and vector (A) potentials. 2

Unit-II (Programming in Matlab)

Answer *Question No. 1* and *any three* questions from the rest.

1. Attempt *any five* questions (choose the correct alternative): 5x1=5
 - a) What does MATLAB stand for?
 - (i) Math Library (ii) Matrix Laboratory (iii) Matrix Library (iv) Matric Library.
 - b) Which command is used to clear a command window?
 - (i) clear (ii) clear all (iii) clc (iv) clcr.
 - c) What would be the output of the following code in editor or command window?
 $A = [0 \ 1; 1 \ 0]; B = 2; C = A + B$
 - (i) $C = \begin{bmatrix} 2 & 3 \\ 3 & 2 \end{bmatrix}$ (ii) $C = \begin{bmatrix} 2 & 1 \\ 3 & 0 \end{bmatrix}$ (iii) $C = \begin{bmatrix} 0 & 3 \\ 1 & 2 \end{bmatrix}$ (iv) $C = \begin{bmatrix} 2 & 1 \\ 1 & 0 \end{bmatrix}$.
 - d) Which function is preferable to find the magnitude of a complex number:
 - (i) abs() (ii) mod() (iii) absolute() (iv) MATLAB does not support complex arguments.
 - e) All MATLAB computations are done in
 - (i) Single precision (ii) Double precision (iii) Linear accuracy (iv) Multi-level precision.

P.T.O.

- f) Which symbol is used to initialize a variable?
 (i) = (ii) → (iii) == (iv) init.
- g) What is the difference between the expressions $(9 * 1 - 8)$ and $(9 - 1 * 8)$?
 (i) Computational difference (ii) No difference (iii) Final results are different
 (iv) Cannot be determined.
- h) Which function is used to generate a vector x of 10 evenly spaced points in between 0 and 1?
 (i) linspace() (ii) zeros() (iii) ones() (iv) eye().
2. a) Write programs in MATLAB to (i) plot the function $\sin x$, $0 \leq x \leq 2\pi$ (ii) compute the sum of successive pairs: $b_i = a_i + a_{i+1}$, $i = 1, 2, \dots, n-1$. 2+2
 b) Write the output of $A = [[1 \ 2 \ 3]' [4 \ 5 \ 6]']$ in command window. 1
3. a) Use MATLAB code to find the roots of the polynomial $z^4 + 3Z^2 + Z - 4 = 0$. 1
 b) What will be displayed when you run the following code in MATLAB window?
 $a = 0;$
 while $a < 10$
 $a = a + 3;$ 2
 end
 disp(a)
- c) Use FFT to find the frequency spectrum of a signal buried in noise. You can form a signal containing a 100 Hz sinusoid of amplitude 1. 2
4. Write a program in MATLAB to solve the following Lotka-Volterra equations:

$$\frac{dx}{dt} = ax - bxy, \quad \frac{dy}{dt} = -cx + dxy$$
 with the initial conditions $x(0) = y(0) = 2$. Here, the constants are $a = 1.5$, $b = 1$, $c = 3$ and $d = 1$. 5
5. Write a program in MATLAB to solve the following coupled nonlinear equations:
 $x = y + \cos(x + y), \quad y = x + \sin(xy)$. 5
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