B.TECH/CSE/7TH SEM/MECH 4124/2021

ENGINEERING COMPUTATIONAL TECHNIQUES
(MECH 4124)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A mathematical model required to describe a physical system or process is [CO1 (Remember/LOCQ)]
(a) Formulation of equations (b) description of the system
(c) experimentation with the system (d) explanation of the result.

(ii) The number of significant digits in 3.0509 is [CO1 (Recognize/LOCQ)]
(a) 3 (b) 5 (c) 6 (d) 7.

(iii) True error can be calculated as [CO1 (Classify/LOCQ)]
(a) True value – measured value (b) measured value – true value
(c) True value + measured value (d) measured value + true value.

(iv) In LU decomposition method of solution The coefficient matrix is decomposed into [CO2 (Recognize /LOCQ)]
(a) lower and upper triangular matrix both
(b) lower triangular matrix only
(c) upper triangular matrix only
(d) none but constant coefficient matrix is decomposed into both.

(v) A flat plane can be fitted by [CO3 (Understand/LOCQ)]
(a) Linear regression method (b) polynomial regression method
(c) Multivariable regression method (d) cubic polynomial.

(vi) Partial pivoting is used during the application of [CO2 (Classify/LOCQ)]
(a) Gauss Jordon method (b) Gauss Seidel method
(c) Matrix inversion method (d) Gauss elimination method.

(vii) A 2nd order polynomial is used during the calculation of [CO4 (Remember/LOCQ)]
(a) Simpson's 3/8th rule (b) Simpson's 1/3rd rule
(c) Trapezoidal rule (d) Gauss quadrature.

(viii) The motion of a particle $x(t)$ moving along the x −axis, whose velocity at time$t$ is specified by the continuous function$f(t)$ and whose initial position is specified as $x(t = t_0) = x_0$, is described as [CO5 (Describe/LOCQ)]

(a) $x(t) = \int_{t_0}^{t} f(\tau)d\tau$ (b) $x(t) = x_0 + \int_{t_0}^{t} f(\tau)d\tau$

(c) $x(t) = \int_{t}^{t_0} f(\tau)d\tau$ (d) $x_0 = x(t) + \int_{t_0}^{t} f(\tau)d\tau$

(ix) Consider the general second-order PDE expressed as $A\frac{\partial^2 u}{\partial x^2} + B\frac{\partial^2 u}{\partial x \partial y} + CA\frac{\partial^2 u}{\partial y^2} + F\left(x, y, u, \frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}\right) + G = 0$. The equation is said to be linear and homogeneous if [CO6 (Classify/LOCQ)]

(a) F is non-linear; G ≠ 0 (b) F is non-linear; G = 0

(c) F is linear; G ≠ 0 (d) F is linear; G = 0.

(x) The order and degree of the ordinary differential equation $\frac{d^4y}{dx^4} + 3\left(\frac{dy}{dx}\right)^5 + 5y = 0$ are respectively [CO5(Identify/LOCQ)]

(a) 1; 5 (b) 4; 5 (c) 4; 1 (d) 5; 1.

Group – B

2. (a) Exponential growth of cell number N in human body can be expressed as shown in the equation, where μ is the growth rate (/day) of the cells and t is time in days.

$$\frac{dN}{dt} = \mu N$$

Find out the value of N at t = 2, 4, 6 and 8 days. The value of μ is 5.63×10^3 /day. Use Euler's numerical method to compute the value of N. [(CO1) (Apply/IOCQ)]

(b) Write down the expression of true error and relative true error. [(CO1)(Classify/LOCQ)]

8 + 4 = 12

3. (a) An electronic company produces transistors, resistors and computer chips. Each transistor, resistor and computer chip require copper, zinc and glass with the quantity written below.

Components	Copper	Zinc	Glass
Transistor	4	1	2
Resistors	3	3	1
Computer chips	2	1	3

In a week, total 940 units of copper, 530 units of zinc and 600 units of glass were used to produce the components. Using LU decomposition method find out the number of transistors, resistors and computer chips made in that week. [(CO2)(Solve/IOCQ)]

(b) A set of linear equations are written below.

$$5x - 3y - 3z = 18$$
$$-2x + 4y + 7z = 26$$
$$x + 6y - 4z = 32$$

Use Gauss elimination process to solve them up to 2 decimal places accurately. [(CO2) (Solve/IOCQ)]

7 + 5 = 12

Group – C

4. (a) Write down the equations applied for parabolic fitting under polynomial regression. [(CO3) (Use/IOCQ)]

   (b) Using polynomial regression fit a parabola through certain points and find out the equation of the parabola using the following data. [(CO3) (Solve/IOCQ)]

x	2	3.5	4	5.5	6	7.5
y	6.4	14.6	21.8	34.6	42.5	56.7

2 + 10 = 12

5. (a) The following data defines the sea level concentration of dissolved oxygen for fresh water as a function of temperature.

T (^{0}C)	0	8	16	24	32	40
C (mg/L)	14.62	11.84	9.87	8.42	7.31	6.41

Estimate C (29^{0}C) using Lagrange interpolating polynomial.
[(CO3) (Solve/IOCQ)]

   (b) Use linear regression to find out the equation of the straight line.
[(CO3) (Solve/IOCQ)]

x	2.5	4	5.5	6	7.5	9
y	12	17	21	28	34	37

7 + 5 = 12

Group – D

6. (a) Evaluate the definite integral of following function by two point Gauss quadrature formula from the limit 0 to 4.
$f(x) = 5 + 2x^2 - 3x^4$ [(CO4) (Apply/IOCQ)]

   (b) Using Trapezoidal rule, evaluate the following integral with 4 intervals.
$\int_0^3 (2 + 5sinx)dx$ [(CO4) (Use/LOCQ)]

7 + 5 = 12

7. (a) Obtain the approximate solution of the following IVP using Picard method:

$$\boldsymbol{y' = 1 + ty;\quad y(0) = 1}$$

Evaluate the expression $\boldsymbol{y_3(t)}$ by this method. [(CO5) (Solve/IOCQ)]

   (b) Evaluate the integral of the IVP $\boldsymbol{y' = x - y^2;\ y(0) = 1}$ by the Taylor series approximation method. Find $y(0.1)$. [Retain terms up to x^5]
Find the first approximate solution by the Picard's Method for solving the IVP $\frac{dy}{dx} = x^2 - y;\ y(x = 0) = 1$. [(CO5) (Solve/IOCQ)]

5 + (5 + 2) = 12

Group – E

8. (a) Evaluate the integral of the IVP $\boldsymbol{y' - y^2 = 0;\ y(0) = 1}$ by the Euler's predictor-corrector method at x = 0.1 and at x = 0.2. [(CO5) (Solve/IOCQ)]

(b) Use the classical 4th order Runge-Kutta method to find the solution of the IVP $\boldsymbol{y' = x + y;\ y(0) = 0}$ on [0,1]. Show the calculations clearly in tabular form till the 5th iteration step. Take $h = 0.2$. [(CO5) (Solve/IOCQ)]

5 + 7 = 12

9. (a) Solve the initial boundary-value problem $\frac{\partial f}{\partial t} = \frac{\partial^2 f}{\partial x^2}$; $0 \le x \le 1, t > 0$ by the Schmidt explicit method at t = 0.001 and t = 0.002.
The two boundary conditions are $f(x = 0, t) = 0$ and $f(x = 1, t) = 0$. The initial condition is $f(x, t = 0) = 2x$ when $0 \le x \le 0.5$ and $f(x, t = 0) = 2(1 - x)$ when $0.5 \le x \le 1$. Consider the spatial increment $h = 1$ and the time increment $k = 0.001$. [(CO6) (Formulate/HOCQ)]

(b) Write down the procedure for finite element analysis starting from a given differential equation. [(CO6) (Formulate/HOCQ)]

5 + 7 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	17.9%	70.8%	11.3%

Course Outcome (CO):

After the completion of the course students will be able to

CO 1: Apply mathematical models for numerical solutions and classify different types of error.

CO 2: Solve a system of linear algebraic equations by different methods and find out the roots.

CO 3: Implement the regression and interpolation methods for curve fitting and solve different types of optimization problems.

CO 4: Use different numerical integration methods for practical problems.

CO 5: Classify Initial and Boundary value problems to select appropriate solution strategies, and solve Eigenvalue problems applied to physical systems.

CO 6: Apply the Finite Difference Method and the Finite Element Method to formulate and develop solutions for one-dimensional and two-dimensional problems in partial differential equations.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	**Submission link:**
CSE	https://classroom.google.com/c/NDA1NDE0MTI5ODM4/a/NDYzODI2NTMzNjIz/details