POKHARA UNIVERSITY

Semester: Fall

Year : 2013
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Level: Bachelor
Programme: BE
Course: Numerical Method

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1) Find a positive root of the equation $f(x)=\cos x-3x+1$ correct up to 3 decimal places using Bisection Method. 7

2) Calculate the root of non-linear equation $3x=\cos x+1$ using Secant Method. 8

3) Find a real root of the equation: $x\log_{10}x=1.2$ by using Newton-Raphson (NR) method such that the root must have error less than 0.0001%. 7

4) Use appropriate method of interpolation to get Sin 0 at 45° from the given table 8

0	10	20	30	40	50
Sin0	0.1736	0.3420	0.5000	0.6428	0.7660

5) From the following data 7

X	1	2	3	4	5
y	0.5	2	4.5	8	12.5

Fit a power function model of the form $y=ax^b$

6) a) Evaluate the integral $I=\int_0^{\pi/2}\sqrt{\sin x}\,dx$ compare the result in both condition for Simpson 1/3 and 3/8 rule. 8

b) Find the inverse of the given matrix by applying Gauss Elimination Method (GEM) with partial pivoting technique. 8

$$A=\begin{bmatrix}4 & 1 & 2\\ 2 & 3 & -1\\ 1 & -2 & 2\end{bmatrix}$$

7) Solve the following system of equations by applying Gauss-Seidel interative method. Carry-out the interactions upto 6th stage. 7

$28x+4y-z=32$

$x+3y+10z=24$

$2x+17y+4z=35$

5. a) The voltage 'V' across a capacitor at a time 'T' seconds is given by the following table. Use the principle of least squares to fit the curve of the form: $V = ae^{bT}$ to the data. 7

T	0	2	4	6	8
V	150	63	28	12	5.6

b) Solve: $dy/dx = y - 2x/y$, $y(0)=1$ in the range $0 \le x \le 0.2$ by using (1) Euler's method and (2) Heun's method. Comment on the results. Take h=0.2. 8

6. a) Using Runge Kutta method of order 4, solve the equation:

$\frac{d^2y}{dx^2} = 6xy^2 + y, y(0) = 1$ and $y'(0) = 0$ to find $y(0.2)$ and $y'(0.2)$. take h=0.2. 7

b) The steady-state two dimensional heat flow in a metal plate of size 30x30cm is defined by $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$. Two adjacent sides are placed at 100°c and other side at 0°c. Find the temperature at inner points, assuming the grid size of 10x10cm. 8

7. Write short notes on: (Any two)

a) Romberg Integration. 2×5

b) Laplacian Equation.

c) Advantage of pivoting over Gauss Elimination method.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2013
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) Find the root of $\sin x = 1/x$ up to 2 decimal places using bracketing method. 7

b) Solve $f(x) = 3x + \sin x - e^x$ by secant method up to 5th iteration. 8

2. a) If P is pull required to lift a load W by means of a pulley, find a linear law of the form $P = mW + c$, using the following data 7

P	12	15	21	25
W	50	70	100	120

Where P and W are taken in Kg.

b) Estimate the value of $\sin\theta$ at $\theta = 25$ using Netwon- Gregory divide difference formula with the help of the following table. 8

θ	10	20	30	40	50
sinθ	0.1736	0.3420	0.5000	0.6428	0.7660

3. a) Evaluate the integral $I = \int_0^6 \frac{1}{1+x^2} dx$. Compare the absolute error in both conditions for Simpson $\frac{1}{3}$ rule and Simpson's $\frac{3}{8}$ rule. 8

b) Find the Integral value 'I' = $\int_0^1 \frac{dx}{1+x^2}$ correct to three decimal place using Romberg Integration. 7

4. a) Solve the following system of equations using Gauss elimination 7

$$10x_1 - 7x_2 + 3x_3 + 5x_4 = 6$$
$$-6x_1 + 8x_2 - x_3 - 4x_4 = 5$$
$$3x_1 + x_2 + 4x_3 + 11x_4 = 2$$
$$5x_1 - 9x_2 - 2x_3 + 4x_4 = 7$$

method

b) Determine the highest Eigen value and its corresponding eigen vector for the following matrix using power method. $A = \begin{bmatrix} 1 & 3 & -1 \\ 3 & 2 & 4 \\ -1 & 4 & 10 \end{bmatrix}$ 8

5. a) Use the Runge - Kutta 4th order method to estimate y(0.2) of the following equation with h = 0.1. 8

$$y^1(x) = 3x + \frac{1}{2}y, \quad y(0) = 1$$

b) Solve the following equation by picards method 7
$y^1(x) = x^2 + y^2$, $y(0) = 0$ and estimate y(0.1), y(0.2) and y(1)

6. a) Solve the Poisson equation $\nabla^2 f = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 \le y \le 3$ with f = 0 on the boundary and h = 1. 8

b) Using Factorization method, solve the following system of linear equations. 7

$$3x - 2y + 7z = 4$$
$$2x + 3y + z = 5$$
$$3x + 4y + z = 7$$

7. Write short notes on: *(Any Two)* 2×5

a) Error in numerical calculations

b) Cubic spline

c) Laplacian Equation.

POKHARA UNIVERSITY

Semester: Fall

Year : 2014
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Level: Bachelor
Programme: BE
Course: Numerical Method

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1) The flux equation of an iron core electric circuit is given by $f(\Phi) = 10 - 2.1\Phi - 0.01\Phi^3$. The steady state value of flux is obtained by solving the equation, $f(\Phi) = 0$. By using any close-end method, estimate the steady state value of "Φ" correct to 3 decimal places. 8

2) Evaluate one of the real roots of the given equation: $x.e^x - \cos(x) = 0$ by NR- method correct to at least 4 decimal places. 7

3) Find the missing term in the following table using suitable interpolation 7

X	0	1	2	3	4
Y	1	3	9	?	81

4) The following table gives the heights, x(cm) and weights, y(kg) of five persons. 8

x	175	165	160	155	145
y	68	58	55	52	48

Assuming the "linear relationship" between x and y, obtain the regression line(x on y). Also obtain 'x' value for y=40.

5) The following table gives the displacement, x(cms) of an object at various of time, t(seconds). Find the velocity and acceleration of the object at t=1.6 sec. Using suitable interpolation method. 8

T	1.0	1.2	1.4	1.6	1.8
X	9.0	9.5	10.2	11.0	13.2

6) Find the real root of the equation $X \log_{10} X - 1.2 = 0$ correct to four 7

places of decimal using Bracketing method.

4. a) Solve the following system of equations by applying Gauss Elimination Method(GEM) with partial pivoting technique. And also determine the determinant value. 8

$$2x+2y+z=6$$
$$4x+2y+3z=4$$
$$x-y+z=0$$

b) Find the largest eigen value and the corresponding eigen vector correct upto 3 decimal places using power method for the matrix $A =$ 7

$$\begin{Bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{Bmatrix}$$

5. a) Solve the following system by using Gauss Seidel method: 7

$$10x - 5y - 2z = 3; x + 6y - 10z = -3; 4x - 10y + 3z = -3.$$

b) Given: $\frac{dy}{dx} = \frac{2x+e^x}{x^2+xe^x}$; y(1)=0. Solve for y at x=1.04, by using Euler's method(take h=0.01). 8

6. a) Solve: $\frac{dy}{dx} = 1 + xz, \frac{dz}{dx} = -xy$ for y(0.6) and z(0.6) given that y=0, z=1 at x=0 by using Heun's method. Assume, h=0.3. 7

b) Torsion on a square bar of size 9cm*9 cm subject to twisting is governed by : $\nabla^2 u = -4$, with Dirichlet boundary condition of u(x, y)=0 and h=1.Calculate the steady state temperatures at interior points. Assume a grid size of 3cm*3cm. Iterate until the minimum difference at any point is correct to two decimal places by applying Gauss-Seidel method. 8

7. Write short notes on: **(Any Two)** 2×5

a) Monotonic and oscillatory divergence in fixed point iteration method

b) An algorithm for Lagrange's interpolation polynomial

c) Relaxation method.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2014
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable
The figures in the margin indicate full marks.
Attempt all the questions.

a) The equation: $\alpha \tan\alpha = 1$ occurs in theory of vibrations. 8

i. How many roots does it have in the interval (-6,6)?What is the assumption being made?

ii. Find one of the positive real roots by using any close-end method, correct to at least three decimal places.

b) Find a root of the equation $f(x) = x^2-3x+2$ in the vicinity of x=0, using Newton Raphson method. 7

a) Find the square root of 7 using Newton Raphson method and Fixed Point Iteration method Correct Up to 4- decimal digit. 7

b) The following table gives the population of a town during the last six censuses. Estimate the increase in the population during the period from 1976 to 1978. 8

year:	1941	1951	1961	1971	1981	1991
pop^n:	12	15	20	27	39	52

a) The pressure and volume of a gas are related by the equation $PV^Y=C$, where Y and C being constants. Fit this equation to the following set of observations. 7

P(kg/cm^2):	0.5	1.0	1.5	2.0	2.5	3.0
V(litres):	1.62	1.00	0.75	0.62	0.52	0.46

b) Evaluate the integral $\int_0^{\pi/2} (1+3\cos^2 x)dx$ by 8

i. Trapezoidal rule.

ii. Simpson's 3/8 rule, taking number of intervals (n)= 6.

a) Use Gauss Elimination Method to solve the equation. Use partial pivoting method where necessary 7

places of decimal using Bracketing method.

4. a) Solve the following system of equations by applying Gauss Elimination Method(GEM) with partial pivoting technique. And also determine the determinant value. 8

$$2x+2y+z=6$$
$$4x+2y+3z=4$$
$$x-y+z=0$$

b) Find the largest eigen value and the corresponding eigen vector correct upto 3 decimal places using power method for the matrix $A = \begin{Bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{Bmatrix}$ 7

5. a) Solve the following system by using Gauss Seidel method: 7

$$10x - 5y - 2z = 3; x + 6y - 10z = -3; 4x - 10y + 3z = -3.$$

b) Given: $\frac{dy}{dx} = \frac{2x+e^x}{x^2+xe^x}$; y(1)=0. Solve for y at x=1.04, by using Euler's method(take h=0.01). 8

6. a) Solve: $\frac{dy}{dx} = 1 + xz, \frac{dz}{dx} = -xy$ for y(0.6) and z(0.6) given that y=0, z=1 at x=0 by using Heun's method. Assume, h=0.3. 7

b) Torsion on a square bar of size 9cm*9 cm subject to twisting is governed by : $\nabla^2 u = -4$, with Dirichlet boundary condition of u(x, y)=0 and h=1.Calculate the steady state temperatures at interior points. Assume a grid size of 3cm*3cm. Iterate until the minimum difference at any point is correct to two decimal places by applying Gauss-Seidel method. 8

7 Write short notes on: **(Any Two)** 2×5

a) Monotonic and oscillatory divergence in fixed point iteration method

b) An algorithm for Lagrange's interpolation polynomial

c) Relaxation method.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2014
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

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

The figures in the margin indicate full marks.

Attempt all the questions.

a) The equation: $\alpha \tan\alpha = 1$ occurs in theory of vibrations. 8

i. How many roots does it have in the interval (-6,6)? What is the assumption being made?

ii. Find one of the positive real roots by using any close-end method, correct to at least three decimal places.

b) Find a root of the equation $f(x) = x^2-3x+2$ in the vicinity of x=0, using Newton Raphson method. 7

a) Find the square root of 7 using Newton Raphson method and Fixed Point Iteration method Correct Up to 4- decimal digit. 7

b) The following table gives the population of a town during the last six censuses. Estimate the increase in the population during the period from 1976 to 1978. 8

year:	1941	1951	1961	1971	1981	1991
pop^n:	12	15	20	27	39	52

a) The pressure and volume of a gas are related by the equation $PV^\gamma = C$, where γ and C being constants. Fit this equation to the following set of observations 7

P(kg/cm^2)	0.5	1.0	1.5	2.0	2.5	3.0
V(litres)	1.62	1.00	0.75	0.62	0.52	0.46

b) Evaluate the integral $\int_0^{\pi} (1 + 3\cos^2 x)dx$ by 8

i. Trapezoidal rule.

ii. Simpson's 3/8 rule, taking number of intervals (n) 6.

a) Use Gauss Elimination Method to solve the equation. Use partial pivoting method where necessary

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$4x_1+5x_2-6x_3=28$
$2x_1-7x_3=29$
$-5x_1-8x_2=-64$

b) Solve the following by Gauss Siedal method. 8

$b+3c+2d=19$
$3b+2c+2d=20$
$a+4b+2d=17$
$-2a+2b+c+d=9$

5. a) Find the largest eigenvalue λ and the cooresponding eigen vector X of the matrix. 7

$$A=\begin{bmatrix}1 & 2 & 0\\ 2 & 1 & 0\\ 0 & 0 & -1\end{bmatrix}$$

b) Using R-K fourth order method solve the given differential equation $d^2y/dx^2 + 2dy/dx - 3y = 6$, $y(0)=0$, $y'(0)=1$, with $h=0.2$ for $y(0.4)=?$ 8

6. a) Given the boundary value problem: $y''=6x$ with $y(1)=2$ and $y(2)=9$. Solve it in the interval(1,2)by using RK method of second order (take, h= 0.5 and guess value=3.25). 7

b) Solve the Poisson's equation $\nabla^2 u = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 < y < 3$ with boundary condition of u(x, y) = 0 and h= 1 using Gauss-Seidel method. 8

7. Write short notes on: **(Any two)** 2×5

a) Errors in numerical calculations.
b) Ill conditioned system.
c) An algorithm for NR-method.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Fall

Year : 2015
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

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

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Define root with example. Determine the root of $e^x = x^3 + \cos 25x$ using Secant method correct to four decimal place. 7

b) The current i in an electric circuit is given by $i = 10e^{-x}\sin 2\pi x$ where x is in seconds. Using N-R method, find the value of x correct up to 3 decimal places for $i = 2amp$. 8

2. a) Solve the equation logx-cosx=0 correct to three significant digits after decimal, using Bracketing Method. 7

b) The following table gives the population of a town during the last six censuses. Estimate the increase in the population during the period from 1976 to 1978. 8

year:	1941	1951	1961	1971	1981	1991
pop^n:	12	15	20	27	39	52

3. a) The pressure and volume of a gas are related by the equation $PV^\gamma = C$, γ and C being constants. Fit this equation to the following set of observations. 7

P(kg/cm^2):	0.5	1.0	1.5	2.0	2.5	3.0
V(litres):	1.62	1.00	0.75	0.62	0.52	0.46

b) Evaluate the integral $I = \int_0^{\frac{\pi}{2}} \sin x\,dx$ for n=6 and Compare the result in both conditions for Simpson1/3 and 3/8 rule. 8

63

4. a) Solve the following set of equation using LU factorisation method. 8

$3x + 2y + z = 10$

$2x + 3y + 2z = 14$

$x + 2y + 3z = 14$

b) Use Gauss-Seidal iterative method to solve given equations. 7

$40x-20y-10z=390$

$10x-60y+20z=-280$

$10x-30y+120z=-860$

5. a) Using Euler's method solve the given differential equation $d^2y/dx^2 + 2dy/dx - 3y = 6$, $y(0)=0$, $y^1(0)=1$, with $h=0.2$ for $y(0.4)=?$ 7

b) Solve the following differential equation within $0 \le x \le 0.5$ using RK 4th order method. $20\frac{d^2y}{dx^2}+2\frac{dy}{dx}-4y=5$, $y(0)=0, y^1(0)=0$. Take $h=0.25$. 8

6. a) Solve the Poission equation. $\nabla^2 f = (2+x^2y)$, over the square domain of $0 \le x \le 3$ and $0 \le y \le 3$ with $f=0$ on the boundary and $h=1$. 8

b) Find the eigen value and corresponding eigen vector of given matrix 7

$$\begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}$$

7. Write short notes on: **(Any two)** 2×5

a) Convergence of Newton Raphson methods

b) Linear Interpolation

c) Romberg Integration Method

POKHARA UNIVERSITY

Level: Bachelor Semester: Spring Year : 2015

Programme: BE Full Marks: 100

Course: Numerical Methods Pass Marks: 45

Time : 3hrs.

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

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Find the root of the equation $x-1.5\sin x-2.5=0$ using Newton Raphson's Method so that relative error is less than 0.01%. 8

b) Find the root of the equation $xe^x = \cos x$ using the secant method correct to four decimal places.

2. a) Using the bisection method, find an approximate root of the equation $\sin x = 1/x$, that lies between $x=1$ and $x=1.5$(in radians). Carry out computations up to 7th stage. 8

b) For the following set of data, fit a parabolic curve using Least Square Method and find f(2).

x_i	0.5	1	1.5	4.5	6.5	7.5
$f(x_i)$	2.5	2.7	3.5	6.5	8.4	9.5

3. a) The following table gives the population of a town during the last six censuses. Estimate the increase in the population during the period from 1976 to 1978. 8

Year:	1941	1951	1961	1971	1981	1991
Pop^n:	12	15	20	27	39	52

b) Use following table of data to estimate velocity at $t = 7$sec

Time, t(s)	5	6	7	8	9
Distance Travelled, s(t)(km)	10.0	14.5	19.5	25.5	32.0

Hint: Velocity is first derivative of s(t)

4. a) Find the largest Eigen-value and the corresponding Eigen-vector of the following square matrix using Power method.

$$\begin{bmatrix} 3 & 1 & 4 \\ 1 & 2 & 3 \\ 4 & 3 & 5 \end{bmatrix}$$

b) Solve the following system of equation by the process of Gauss elimination (Use partial pivoting if necessary) 8

$3x+2y+z=10$
$2x+3y+2z=14$
$X+2y+3z=14$

5 a) Use Gauss-Seidel iteration method to solve 7

$$2x + y + z = 5$$
$$3x + 5y + 2z = 15$$
$$2x + y + 4z = 8$$

b) Solve the following differential equation within $0 \le x \le 0.5$ using RK 4th order method. $10\frac{d^2y}{dx^2}+2\frac{dy}{dx}-4y=5$, $y(0)=0, y^1(0)=0$. Take h=0.25. 8

6. a) How can shooting method be used to solve boundary value problems. Explain each steps of the algorithm with a suitable example. 8

b) Solve the Poisson equation $\nabla^2 f=2x^2+y$, over the square domain $1 \le x \le 3$, $1 \le y \le 3$, with f=1 on the boundary. Take h=k=1 25

7. Write short notes on: **(Any two)**

a) Romberg integration formulas
b) Taylor Series for solving ordinary differential equations
c) Hyperbolic equations

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Fall

Year : 2016
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

a) What is the fixed point of a non-linear equation? Find a real root of the equation: $xe^x=3$ by using any bracketing method correct to three decimal places (Take $x_1=1$ and $x_2=1.5$). 8

b) Obtain a real root of the equation: $\sin x+1=2x$ by using Secant method such that the real root must have relative error less than 0.0001. 7

a) Find the root of the equation $x\sin x+\cos x=0$ using Newton Raphson's Method so that relative error is less than 0.1. 7

b) The following table gives the population of a town during the last six censuses. Estimate the increase in the population during the period from 1976 to 1978. 8

Year:	1941	1951	1961	1971	1981	1991
Pop^n:	12	15	20	27	39	52

a) Evaluate the integral $I = \int_0^{10} \exp\left(\frac{-1}{1+x^2}\right)dx$, using Gauss quadrature formula with n = 2 and n = 3. 7

b) What is pivot element? Solve the following system of equations by using Gauss-elimination method with partial pivoting technique.

$x+y+z+w=2$
$x+y+3z-2w=-6$
$2x+3y-z+2w=7$
$x+2y+z-w=-2$

a) Solve the following system of equations by using Crout's algorithm. 7

$2x-3y+10z=3$
$-x+4y+2z=20$
$5x+2y+z=-12$

A = LU

b) Find the largest eigen value and corresponding eigen vector of given matrix using power method. 8

$$\begin{bmatrix} 4 & 6 & 0 \\ 0 & 5 & 3 \\ 2 & 0 & 3 \end{bmatrix} \begin{bmatrix} b \\ 1 \\ 0 \end{bmatrix}$$

5. a) Solve the given differential equation by RK-4th order method $y'' - xy' + y = 0$ with initial condition $y(0) = 3, y'(0) = 0$, for $y(0.2)$ taking $h = 0.2$. 8

b) Solve the differential equation $y^1 = x + y$ using appropriate method within $0 \le x \le 0.2$ with initial condition $y(0) = 1$ and step size $h=0.1$. 7

6. a) Given the Poisson's equation: $\Delta^2 f = -10(x^2+y^2+10)$ over the square domain: $0 \le x \le 3$ and $0 \le y \le 3$ with Dirichlet boundary condition of $f(x, y)=0$ and $h=1$. Calculate the steady state temperatures at the interior nodes by using Gauss-Seidel method.. 8

b) The pressure and volume of a gas are related by the equation $PV^Y=C$, 7

Y and C being constants. Fit this equation to the following set of observations.

P(kg/cm²):	0.5	1.0	1.5	2.0	2.5	3.0
V(litres):	1.62	1.00	0.75	0.62	0.52	0.46

7. Write short notes on: **(Any two)**
   a) Solution of 2nd order differential equation
   b) numerical Differention
   c) Laplacian equation.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2016
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) What are the limitations of New-Raphson method? Using Newton- Raphson method find a root of the equation $xe^x = 2$. 3+5

b) Find a real root of the $\cos x = 3x - 1$, correct to three decimal places, using fixed point method. 7

2. a) Use Newton's divided difference formula to find f(3) from the following data: 8

x:	0	1	2	4	5	6
f(x)	1	14	15	5	6	19

b) By the method of least square methods, find the straight line that best fits the following data: 7

x:	1	2	3	4	5
y:	14	27	401	55	68

3. a) Using forward interpolation formula derive differentiation formula for the first and second derivative of a function f(x). 7

b) Evaluate the integral $\int_0^{0.6} e^{x^2} dx$, using Simpson 1/3 rule and Simpson 3/8 rule, dividing the interval into six parts. 8

4. a) Using Gauss Seidel method solve the following system of linear equations: 7

$$10x_1 + 6x_2 - 5x_3 = 27$$
$$3x_1 + 8x_2 + 10x_3 = 27$$
$$4x_1 + 10x_2 + 3x_3 = 27$$

b) Find the largest eigen value and corresponding eigen vector of the matrix: $\begin{bmatrix} 1 & 3 & -1 \\ 3 & 2 & 4 \\ -1 & 4 & 10 \end{bmatrix}$ 8

5. a) Employ Taylor's method to obtain approximate value of y at $x = 0.2$ for the differential equation: $y' = 2y + e^x, y(0) = 0.$ 7

b) Using Runge-Kutta second order method solve the differential equation $y'' = xy' - y;\ y(0) = 3,\ y'(0) = 0$ for $x = 0(0.2)0.4$. 8

6. a) Write an algorithm to find a real root of a non linear equation using secant method. 7

b) Write a program in any high level language (C or C++) to solve a system of linear equation, using Gauss elimination method. 8

7. Write short notes on: **(Any two)** 2×8

a) Ill-Conditioned systems

b) Errors in numerical calculation

c) Laplace equation

POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2017
Programme: BE | Full Marks: 100
Course: Numerical Methods | Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) Find a positive root of the equation $x \sin x - 1 = 0$ using any closed end method up to four decimal place. 8

b) Solve $f(x) = 3x + \text{six} - e^x$ by secant method. 7

2. a) Find the number of students securing marks between 50-55 using appropriate interpolation technique. 8

Mark Obtained	20-30	30-40	40-50	50-60
No. of students	10	20	30	40

b) The voltage v across a capacitor at time t seconds is given by following table. 7

Time t(sec)	0	2	4	6	8	4
voltage v	150	63	28	12	5.6	124

If the relationship between voltage v and time t is of the form $v = e^{at}$. Using least-square approximation estimate the temperature at t=2.6 minute.

3. a) Estimate the following Integrals by 8

i. Simpson's 3/8 method

ii. Simpson's 1/3 method and compare the result.

$$\int_2^4 \frac{e^x . dx}{x}$$ (Assume n =4)

b) Apply Romberg's method to evaluate 7

$$\int_0^{\frac{\pi}{2}} \frac{\cos x}{\sqrt{1+\sin x}} . dx$$

4. b) Solve the system $3x_1+2x_2+x_3=10$
$2x_1+3x_2+2x_3=14$
$x_1+2x_2+3x_3=14$
By using Do-Little method.

b) Find the inverse of the matrix by using Gauss Jorden method.

$$A=\begin{pmatrix}1 & -1 & 2\\ 3 & 0 & 1\\ 1 & 0 & 2\end{pmatrix}$$

5. a) Determine the largest eigenvalue and the corresponding eigenvector of the matrix: $A=\begin{bmatrix}2 & -1 & 0\\ -1 & 2 & -1\\ 0 & -1 & 2\end{bmatrix}$ using the power method.

b) Solve the differential equation $y' = y + \sin x$ using appropriate method within $0 \le x \le 0.2$ with initial condition $y(0) = 2$ and step size h=0.1.

6. a) Apply R-K-4 method to solve y(0.2) for the given equation $\frac{d^2y}{dx^2} + x\frac{dy}{dx} = y$ given that y=1 and $\frac{dy}{dx} = 0$ when x=0. (Assume h=0.2.)

b) Solve the parabolic equation $2f_x(x,t) = f_t(x,t)$ $0 \le t \le 1.5$ and given initial condition $f(x,0) = 50(4-x), 0 \le x \le 4$ with boundary condition $f(0,t) = 0 = f(4,t)$ $0 \le t \le 1.5$

7. Write short notes on: **(Any two)**
a) Gauss Seidel Method of Iteration
b) Cubic Spline
c) Laplace method for partial Differential

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2017
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) Discuss the application of Numerical methods in the field of science and engineering. Find a real root of $e^{\cos x}-\sin x-1=0$ correct to 4 decimal places using False position method. 8

b) Find the root of the equation $3x=\cos(x)+1$ using NR method with the tolerance is 10E-5. 7

2. a) The Growth of bacteria (N) in a culture after t hours is given by the following table. 8

Time t(hr.)	0	1	2	3	4	4
Bacteria(N)	32	47	65	92	132	124

If the relationship between bacteria N and time t is of the form $N = ab^t$. Using least-square approximation estimate the N at t=5 hr.

b) The following table give the percentage of criminals for different age groups. Using interpolation formula, find the percentage of criminals under the age of 35. 7

Under age	25	30	40	50
% of Criminals	52	67.3	84.1	94.4

3. a) A slider in a machine moves along a fixed straight rod. Its distance x (cm) along the rod is given below for various values of time t seconds. Find the velocity and the acceleration of the slider when t=0.2. 8

t	0	0.1	0.2	0.3
x	30.13	31.62	32.87	33.95

b) The velocity 'v' of a particle at a distance 's' from a point on its path is given by the following table. 7

s(metre)	0	10	20	30	40	50	60
v(metre/sec)	47	58	64	65	61	52	38

POKHARA UNIVERSITY

Level: Bachelor | Semester: Fall | Year : 2018
Programme: BE | Full Marks: 100
Course: Numerical Methods | Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) Derive an iterative formula for NR-method Find a positive real root of the equation $x \times \log_{10}(x) = 1.2$ by using this formula correct to four significant digits. 7

   b) Using Secant method find a root of the equation $e^x \, Sin\, x - x^2 = 0$ correct to three decimal places. 8

2. a) Generate a Lagrange's interpolating polynomial for the function: $y = \cos\pi x$, taking the pivotal points 0, ¼ and ½. 8

   b) Fit a curve of the form: $y=1/(a+bx)$ by using the method of Least Square with the following data points. 7

x	1	2	3	4	5
f(x)	3.33	2.20	1.52	1.00	.91

3. a) Evaluate the integral $I = \int_0^{\frac{\pi}{2}} (1+3\cos 2x)dx$. Compare the result in both conditions for Simpson1/3 and 3/8 rule. 10

   b) The following data gives corresponding values of pressure 'P' and specific volume 'V' of stem. 5

P	105	42.7	25.3	16.7	13
V	2	4	6	8	10

Find the rate of change of volume when pressure is 105 and 13.

Estimate the time taken to travel 60 metres by using Simpson's 1/3 rule and Simpson's 3/8 rule.

4. a) Solve the following set of equation using LU factorization method 8

$$5x-2y+z=4$$
$$7x+y-5z=8$$
$$3x+7y+4z=10$$

   b) Solve the equation by Gauss-Jacobi method: 7

$20x + y - 2z = 17,\ 3x + 20y - z = -18,\ 2x - 3y + 20z = 25$

5. a) Determine the largest eigenvalue and the corresponding eigenvector of the matrix: $A=\begin{bmatrix} 15 & -4 & -3 \\ -10 & 12 & -6 \\ -20 & 4 & -2 \end{bmatrix}$ using the power method. 8

   b) Use RK-4 Method to find y(0.2) for $\frac{d^2y}{dx^2} = x\frac{dy}{dx} - y$ given that y=1 and $\frac{dy}{dx} = 0$ when x=0. 7

6. a) Given the Poisson's equation: $\nabla^2 u = -10(x^2+y^2+z^2)$ over the square domain such that $0 \le x \le 3$ and $0 \le y \le 3$ with Dirichlet boundary condition of u(x,y)= 0.Calculate the steady state temperatures at interior points by using Successive over relaxation method upto 5th iteration. Assume, h=k=1. 8

   b) Write a program in any higher level language for solution of ordinary differential equation using Euler's method. 7

7. Write short notes on: **(Any two)** 2×5
   a) Boundary Value problem
   b) Parabolic equation
   c) Elliptical equations

4. a) Find the inverse of matrix using gauss Jordan method.

$$A=\begin{bmatrix}1 & 1 & 3\\ 3 & 3 & -3\\ -2 & -4 & -4\end{bmatrix}$$

b) Find the largest Eigen-value and the corresponding Eigen-vector of the following square matrix using Power method.

$$\begin{bmatrix}15 & -4 & -3\\ -10 & 12 & -6\\ -20 & 4 & -2\end{bmatrix}$$

5. a) Solve the given differential equation by RK-4th order method $y''-x^2y'-2xy=0$ with initial condition $y(0)=1, y'(0)=0$, for $y(0.1)$ taking $h=0.1$

b) Solve the differential equation $y'=y-\frac{2x}{y}$ using appropriate method within $0\le x\le 0.2$ with initial condition $y(0)=1$ and step size $h=0.1$

6. a) Solve the equation $\nabla^2 u=-10(x^2+y^2+10)$ over the square mesh $0\le x\le 3,\quad 0\le y\le 3$ with $u=0$ on the boundary and mesh length $h=k=1$

b) Solve the following system of equation

$$6x_1-2x_2+x_3=4$$
$$-2x_1+7x_2+2x_3=5$$
$$x_1+2x_2-5x_3=-1$$

Using gauss factorization method.

7. Write short notes on: **(Any two)**
   a) Importance of Numerical Methods in Engineering
   b) Algorithm for Lagrange's Interpolation method
   c) Laplace method for partial Differential

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2018
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

a) Find the root of $e^x\tan x=1$ by creating iterative formula of Newton Raphson method.

b) Solve $f(x)=xe^x-1$ by secant method for tolerance value 0.0001.

a) Determine the constants a and b by the method of least squares such that $y=ae^{bx}$

X	2	4	6	8	10
Y	4.077	11.084	30.128	81.897	222.62

b) From the following table, find the number of students who obtained less than 45 marks

Marks	30-40	40-50	50-60	60-70	70-80
No. of students	31	42	51	35	31

a) From the following table of values of x and y, obtain $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for x = 1.2

x	1.0	1.2	1.4	1.6	1.8
y	2.7183	3.3201	4.0552	4.9530	6.0496

b) Find the Integral value $I=\int_0^1 \frac{dx}{1+x^2}$ correct to three decimal place using Romberg Integration.

a) Solve the following system of equations using Factorization method
$2x+3y+z=9$

$x + 2y + 3z = 6$

$3x + y + 2z = 8$

b) Determine the highest Eigen value and its corresponding eigenvector for the following matrix using power method. $A = \begin{bmatrix} 1 & 3 & -1 \\ 3 & 2 & 4 \\ -1 & 4 & 10 \end{bmatrix}$

5. a) Use the Runge - Kutta 4th order method to solve $10\frac{dy}{dx} = x^2 + y^2$, $y(0) = 1$ for the interval $0 \le x \le 0.4$ with $h = 0.1$

b) Solve the boundary value problem

$y''(x) = y(x)$,

$y(0) = 0$ and $y(1) = 1.1752$ by shooting method, taking $m_0 = 0.8$ and $m_1 = 0.9$

6. a) Solve the Poisson equation $\nabla^2 f = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 \le y \le 3$ with $f = 0$ on the boundary and $h = 1$.

b) Write a program to solve a system of linear equations by Gauss seidal method.

7. Write short notes on: **(Any two)**

a) Convergence of fixed point iteration method

b) Cubic spline

c) Algorithm of Euler Methods.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Fall

Year : 2019
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

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

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) Find where the graph of $y = x-3$ and $y = \ln(x)$ intersect using bisection method. Get the intersection value correct to four decimal places. 8

b) Find value of $\sqrt{18}$ using Newton Raphson method. 7

2. a) The function $y = f(x)$ is given at the points (7, 3), (8, 1), (9, 1)and (10, 9) Find the value of y for $x = 9.5$ using Lagrange Interpolation formula. 7

b) The following table shows pressure and specific volume of dry saturated steam. 8

V	38.4	20	8.51	4.44	3.03
P	10	20	50	100	150

Fit a curve of the form: $PV^a = \beta$ by using least square method.

3. a) Evaluate $\int_{-2}^{2} \frac{x}{x + 2e^x}\,dx$ by using Trapezoidal, Simpson's 1/3 and 3/8 rule with $n = 6$. 7

b) Using three-point Gaussian Quadrature formula, evaluate

$$\int_0^1 \frac{dx}{(1+x)}$$

4. a) Find inverse of the matrix, using Gauss Jordan method. 8

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$$

b) Determine the largest eigenvalue and the corresponding eigenvector 7

of the matrix: $A=\begin{bmatrix} 1 & -3 & 2 \\ 4 & 4 & -1 \\ 6 & 3 & 5 \end{bmatrix}$ using the power method.

5. a) Use Picard's method to approximate the value of y when x= 0.1, x = 0.2 and x = 0.4, given that y =1 at x = 0 and dy/dx =1+xy correct to three decimal places (Use upto second approximations).

b) Using Runge- Kutta method of second order (RK-2), obtain a solution of the equation $y'' = y + xy'$ with initial condition $y(0) = 1$, $y'(0) = 0$ to find y(0.2) and y'(0.2), taking h=0.1

6. a) Use Relaxation method to solve the given systems of equations:

$20x+y-2z=17$
$3x+20y-z=18$
$2x-3y+20z=25$

b) Given the Poisson's equation: $\Delta^2 f = 4x^2y^2$ over the square domain: $0 \le x \le 3$ and $0 \le y \le 3$ with Dirichlet boundary condition of f(x, y) =100 and h=k=1. Calculate the steady state temperatures at the interior nodes by using Gauss-Seidel method. Iterate until the successive values at any point is correct to two decimal places.

7. Write short notes on: **(Any two)**

a) Errors in numerical computations

b) Obtain divided difference table for the given data set:

X	-1	2	5	7
Y	-8	3	1	12

c) Write an algorithm for Romberg's integration method.

POKHARA UNIVERSITY

Level: Bachelor
Programme: BE
Course: Numerical Methods

Semester: Spring

Year : 2019
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

1. a) Using **Secant** method, find the zero of function $f(x) = 2x - \log_{10} x - 7$ correct up to three decimal places. 8

b) Find the root of the equation logx – cosx = 0 correct to three decimal placed by using N-R method. 7

2. a) The voltage v across a capacitor at time t seconds is given in following table. 8

Time t(sec)	0	2	4	6	8	10
voltage v	150	63	28	12	5.6	12.4

If the relationship between voltage v and time t is of the form $v = ae^{kt}$. Using least-square approximation estimate the temperature at t=2.6 minute.

b) From the following table, estimate the number of students who obtained marks between 40 and 45. 7

Marks:	30-40	40-50	50-60	60-70	70-80
No. of students	31	42	51	35	31

3. a) The following table gives the velocity of a vehicle at various points of time. 7

Time, t(seconds)	1	2	4	5
Velocity, v(m/sec)	0.25	1	2.2	4

Find the acceleration of the vehicle at t = 1.1 second and t = 2.5 second using any suitable differential formula.

b) Evaluate $\int_0^{\frac{\pi}{2}} \frac{\sin u}{u}\, du$ by using Trapezoidal, Simpson's 1/3 and 3/8 rule with n=6 8

POKHARA UNIVERSITY

Level: Bachelor
Programme: B E
Course: Numerical Methods

Semester: Fall

Year : 2020
Full Marks: 100
Pass Marks: 45
Time : 3hrs.

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.
Attempt all the questions.

a) Find the positive real root of the equation $\cos x + e^x + x^2 = 3$ using False position method, correct to 3 decimal places. 7

b) Discuss the drawbacks of Newton – Raphson method. Find the real root of the equation $x \sin x - \cos x = 0$ using Newton – Raphson method, correct to 3 decimal places. 8

a) From following experimental data, it is known that the relation connects v and t as $v = at^b$. Find the possible values of a and b. 8

V	350	400	500	600
T	61	26	7	2.6

b) The following table gives the viscosity of oil as the function of temperature. Use Lagrange's interpolation formula to find the viscosity of oil at a temperature of 140 degree Celsius. 7

T(degCelsius)	110	130	160	190
Viscosity	10.8	8.1	5.5	4.8

a) Integrate the given integral using Romberg integration. 8

$$\int_1^2 \frac{1}{1+x^3}\,dx$$

4. a) Determine the largest Eigen value and corresponding Eigenvector for the matrix using power method correct up-to 3-decimal places. 7

$$A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$

b) Obtain the solution of the following system using the Dolittle LU decomposition method. 8

$$3x_1 + 2x_2 + x_3 = 10$$
$$2x_1 + 3x_2 + 2x_3 = 14$$
$$x_1 + 2x_2 + 3x_3 = 14$$

5. a) Solve the given differential equation by Heun's method $y'' - y' - 2y = 3e^{2x}$ with initial condition $y(0) = 0, y'(0) = -2$, for y(0.2) taking h = 0.1 8

b) Solve: $y' = y + e^x$, $y(0) = 0$ for y(0.2) and y(0.4) by RK-4th order method. 7

6. a) Solve the poison's equation $U_{xx} + U_{yy} = 243(x^2 + y^2)$ over a square domain $0 \le x \le 1, 0 \le y \le 1$ with step size $h = \frac{1}{3}$ with $u = 100$ on the boundary. 8

b) Use Gauss-Legendre 2-point and 3-point formula to evaluate 7

$$\int_{0.5}^{1.5} e^{x^2}\,dx$$

7. Write short notes on: **(Any two)** 2×5

a) Ill conditioned Method
b) Algorithm of bisection method
c) Cubic splines

b) Compute the integral using Gaussian 3 – point formula. 7

$$\int_2^5 \frac{e^x + \sin x}{1 + x^2} dx$$

4. a) Solve the equation by Relaxation method: 7

$9x - y + 2z = 9$, $x + 2y - 2z = 15$, $2x - 2y - 13z = -17$

b) Determine the largest eigenvalue and the corresponding eigenvector of the matrix: $A = \begin{bmatrix} 1 & 4 & 4 \\ 4 & 1 & 8 \\ 4 & 8 & 1 \end{bmatrix}$ using the power method 8

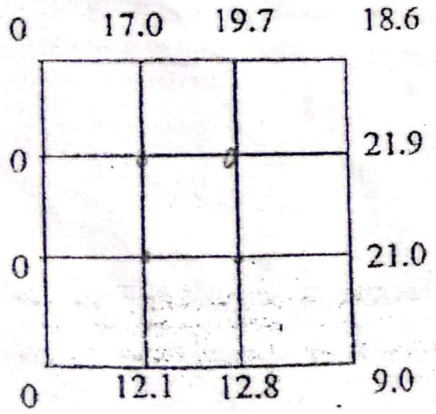
5. a) Apply Runge – Kutta fourth order method to find an approximate value of y when x = 0.3 give that: $y' = 2.5y + e^{0.3x}$; with an initial $y(0) = 1$, taking h= 0.3 7

b) Solve the Boundary Value Problem (BVP) using Shooting method by dividing into four sub-interval employing Euler's method. 8

$$y'' + 2y' - y = x$$

subject to boundary condition $y(1) = 2$ and $y(2) = 4$

6. a) Solve the Poisson equation $\nabla^2 f = 4x^2y + 3xy^2$, over the square domain $1 \le x \le 3$, $1 \le y \le 3$, with f on the boundary is given in figure below. Take h=k=1 8



b) Solve the following set of equations by using LU decomposition method. 7

$3x + 2y + 7z = 32, 2x + 3y + z = 40, 3x + 4y + z = 56$

Write short notes on: **(Any two)** 2×5

a) Finite differences

b) Picard's iterative formula.

c) Algorithm for second order Runge – Kutta (RK-2) method

NM-2020 Fall

POKHARA UNIVERSITY

Semester – Spring

Level: Bachelor
Program: BE
Course: Numerical Methods

Year: 2020
Full Marks: 70
Pass Marks: 31.5
Time: 2 hrs

Candidates are required to answer in their own words as far as practicable
The figures in the margin indicate full marks

Attempt all the questions.

Group - A: (5×10=50)

Q. N. 1 Which one do you prefer bracketing or non bracketing methods for solving nonlinear equations? Using a root bracketing method, find a positive real roots of the equation $x^3-3x+1=0$, correct to 4 decimal places.

Q. N. 2 Monthly faculty salary in three universities is given below. Assuming that the salary for particular category is same in all the universities, calculate the salary of each category of faculty by using appropriate method

Department	Number of Faculty			Total Salary (in thousands)
	Professor	Asst. Professor	Lecturer	
P	2	2	4	60
Q	3	1	2	50
R	1	4	3	60

OR

Using an iterative method, solve the system correct to three decimal places:

$$-3x_1+22x_2+2x_3=47$$
$$5x_1+x_2+20x_3=67$$
$$45x_1+2x_2+3x_3=58$$

Given a reason for the choice of your method. Write name of any two other iterative methods which can be used to solve the given system.

Q. N. 3 The angular displacement θ of simple pendulum is given by equation $\frac{d^2\theta}{dt^2}+\frac{g}{l}\sin\theta=0$ where l = 98cm and g = 980cm/sec². If $\theta=0.2$ and $\frac{d\theta}{dt}=4.47$ at t=0, use any numerical method to find θ and $\frac{d\theta}{dt}$ when t =1 with step size h=0.2.

POKHARA UNIVERSITY

Level: Bachelor | Semester: Spring | Year : 2021
Programme: BE | Full Marks: 100
Course: Numerical Methods | Pass Marks: 45
Time : 3 hrs.

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

The figures in the margin indicate full marks.

Attempt all the questions.

1. a) What is the difference between the bisection method and false position even though both are bracketing methods? Find the real root of the given non-linear equation correct up to three decimal place using Newton Raphson method.

   b) Define error and write its different types in numerical methods with examples. If $x = 1.350253$ is rounded off to four significant digits, find the absolute and relative errors.

2. a) By using Least square method find the straight line that best fit the following data:

x:	1	2	3	4	5
y:	14	27	40	55	68

   b) Find the cubic spline interpolation formula for the following data:

x	1	2	3	4	5
f(x)	1	0	1	0	1

3. a) Evaluate $\int_4^{5.2} \log x \, dx$ from the following data

x	4.0	4.2	4.4	4.6	4.8	5.0	5.2
y	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

by using

   i) Trapezoidal Method
   ii) Simpson 1/3 Method
   iii) Simpson 3/8 Method

b) Evaluate $\int_0^2 \frac{x^2+2x+1}{1+(x+1)^4}\,dx$ by using Gaussian Integration formula for n=2, n=3 and compare their values with exact solution. 7

4. a) Solve the following system of equations by using relaxation method correct to two decimal places. 8

$$9x-y+2z = 9$$
$$x+10y-2z = 15$$
$$2x-2y-13z = -17$$

b) Using Dollittle LU decomposition method, solve the following system equations: 7

$$3x + 2y + z = 10$$
$$2x + 3y + 2z = 14$$
$$x + 2y + 3z = 14$$

5. a) Use Runge-kutta of order four to find the solution of the given differential equation at x=1.5 taking a step size of h=0.25. 8

$$\frac{dy}{dx} + 2y = x^2, y(1) = 5$$

b) Find the solution of the given ordinary differential equation at x=0.5 using the step size of h=0.25 using Heun's method. 7

$$\frac{dy}{dx} + 0.4y = 3e^{-x}, y(0) = 5$$

6. a) Determine the steady-state heat distribution in a thin square metal plate with dimensions 0.5 m by 0.5 m using n = m = 4. Two adjacent boundaries are held at 0°C, and the heat on the other boundaries increases linearly from 0°C at one corner to 100°C where the sides meet. 7

b) The following table gives the corresponding values of pressure and specific volume of superheated steam. 8

V	2	4	6	8
P	105	42.07	25.3	16.7

(i) Find the rate of change of pressure with respect to volume when V= 2.

(ii) Find the rate of change of volume with respect to pressure when P= 105.

7. Write short notes on: **(Any two)** 2×5

a) Ill-conditioned systems

b) Laplacian equation

c) Classification of Second Order Partial Differential Equation