UNIVERSITY OF ENGINEERING & MANAGEMENT,JAIPUR

Lecture-wise Plan

Subject Name: Numerical Methods **Subject Code-M(CS))401**
Year: 2nd Year **Semester: Fourth**

Module Number	Topics	Number of Lectures
1	**Approximation in numerical computation:**	**4L**
	Approximation of numbers	1
	Types of errors	2
	Calculation of errors	1
2	**Interpolation:**	**6L**
	Finite differences	1
	Newton forward/backward interpolation	2
	Lagrange’s method	1
	Newton’s divided difference Interpolation	2
3.	**Numerical integration:**	**3L**
	Trapezoidal rule	2
	Simpson’s 1/3 rule	1
4	**Numerical solution of a system of linear equations:**	**6L**
	Gauss elimination method	1
	Matrix inversion	1
	LU Factorization method	2
	Gauss-Seidel iterative method	2
5	**Numerical solution of Algebraic equation:**	**5L**
	Bisection method	2
	Regula-Falsi method	1
	Newton-Raphson method	2
6	**Numerical solution of ordinary differential equation:**	**8L**
	Euler’s method	2
	Runge-Kutta methods	2
	Predictor- Corrector methods	2
	FiniteDifference method	2

Assignment:
Module-1:

1. Find the relative error if 2/3 is approximated to 0.667.
2. Find the percentage error if 625.483 is approximated to three significant figures.
3. Find the relative error in taking ® = 3.141593 as 22/7.
4. The height of an observation tower was estimated to be 47 m, whereas its actual height was 45 m. calculate the percentage relative error in the measurement.

5. Two numbers are 3.5 and 47.279 both of which are correct to the significant figures given. Find their product.

Module-2:

1. Apply Newton's backward Interpolation to the data below, to obtain a polynomial of degree4 in x

$x:$	1	2	3	4	5
$f(x):$	1	-1	1	-1	1

2. Using Newton's backward Interpolation, find the value of $f(2)$ from the following table:

$x:$	1	3	4	5	6	7
$f(x):$	2.68	3.04	3.38	3.68	3.96	4.21

3. Using Newton's Forward Interpolation, the area A of a circle of diameter d .

$d:$	80	85	90	95	100
$A:$	5026	5674	6362	7088	7854

Calculate the area of a circle of diameter 105.

4. Estimate the value of $f(22)$ and $f(42)$ from the following available data:

$x:$	20	25	30	35	40	45
$f(x):$	354	332	291	260	231	204

Using Newton's Forward Interpolation

5. Find $f(x)$ as a polynomial in x for the following data by Newton's divided difference method:

$x:$	-4	-1	0	2	5
$f(x):$	1245	33	5	9	1335

6. Using Newton's divided difference method to find $f(x)$ from the following available data:

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

Module-3:

1. Apply trapezoidal rule to find the integral $I = \int_0^1 \sin® x\, dx.$
2. Find, from the following table the area bounded by the curve and the x-axis from $x = 7.47$ to $x = 7.52$,
$f(7.47) = 1.93,\ f(7.48) = 1.95,\ f(7.49) = 1.98,\ f(7.50) = 2.01,$
$f(7.51) = 2.03,\ f(7.52) = 2.06.$
3. Evaluate $I = \int_0^1 \frac{1}{1+x^2} dx,$ correct to three decimal places and also find the approximate value of ®.
4. A solid of revolution is formed by rotating about the x-axis the area between the x-axis, the lines $x = 0$ and $x = 1$ and a curve through the points with the following coordinates:
$(0,1),(0.25,0.9896)(0.5,0.9589),(0.75,0.9089),(1,0.8415).$

Module-4:

1. Solve the following system of equations:

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

by matrix-inversion method.

2. Solve the above system by matrix-inversion method:
   $x + y - z = 2$
   $2x + 3y + 5z = -3$
   $3x + 2y - 3z = 6$
3. The following system of equations are given:
   $4x + y + z = 4$
   $x + 4y - 2z = 4$,
   $3x + 2y - 4 = 6$
   Solve the above system by LU decomposition method.
4. Solve the given system of equations by LU decomposition method:

   $x + y - z = 2$
   $2x + 3y + 5z = -3$
   $3x + 2y - 3z = 6$

Module-5:

1. Find the root of the following equations correct three decimal places by the Regulafalsi method: $x^3 + x - 1 = 0$.
2. Using Regulafalsi method, compute the real root of the following equation correct to four decimal places: $xe^x = 2$.
3. Find the root of the following equations correct three decimal places by the Regulafalsi method: $x^6 - x^4 - x^3 - 1 = 0$.
4. Find the root of the following equations correct three decimal places by the bisection method : $x - e^x = 0$
5. Find the root of the following equations, using the bisection method correct three decimal places: $x - \cos x = 0$
6. Using the bisection method to find a root of the equation to four decimal places: $x^3 - 9x + 1 = 0$

Module-6:

1. Using Runge-kutta method of order 4, find $y(0.2)$ given that $\frac{dy}{dx} = 3x + \frac{1}{2}y, y(0) = 1$ taking $h = 0.1$.
2. Using Runge-kutta method of order 4, compute $y(0.2)$ and $y(0.4)$ from $10\frac{dy}{dx} = x^2 + y^2, y(0) = 1$ taking $h = 0.1$.
3. Using Milne's predictor-corrector method to obtain the solution of the equation $\frac{dy}{dx} = x - y^2$ at $x = 0.8$ given that $y(0) = 0.0000$, $y(2) = 0.0200$, $y(4) = 0.0795$ $y(6) = 0.1762$.

4. Given $2\frac{dy}{dx}=(1+x^2)y^2$ and $y(0)=1$, $y(0.1)=1.06$, $y(0.2)=1.12$, $y(0.3)=1.21$, evaluate $y(0.4)$ by Milne's predictor-corrector method.

UNIVERSITY OF ENGINEERING & MANAGEMENT,JAIPUR

Lecture-wise Plan

Subject Name: Values & Ethics in Profession **Subject Code-HU401**
Year: 2nd Year **Semester: Fourth**

Module Number	Topics	Number of Lectures
1	**Introduction:**	**19L**
	Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: Sustainable development	3
	Energy Crisis: Renewable Energy Resources Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics	5
	Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.	6
	Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.	5
2	**Ethics of Profession:**	**9L**
	Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals.	3
	Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond.	6
	Profession and Human Values	**8L**
3.		
	Values Crisis in contemporary society Nature of values: Value Spectrum of a good life	3
	Psychological values: Integrated personality; mental health Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.	5

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: **Fluid Mechanics** Subject Code: **CE-401**
Year: **2nd Year** Semester: **Fourth**

Module No.	Topics	Planned Lectures(H)
1.	**Fluid statics:**	**4H**
	1. Forces on plane and curved surfaces.	1 H
	2. Centre of pressure.	2H
	3. Stability of floating bodies, Metacentre .	1 H
2.	**Weirs and Notches:**	**5H**
	1. Rectangular, triangular, Cippoletti weir	3H
	2. sharp crested and broad crested weirs, submerged weir	2H
3.	**Turbulent flow in circular pipes:**	**5 H**
	1. Fluid friction in pipes,	1 H
	2. Head loss due to friction. Darcy-Weisbach equation	1 H
	3. Variation of friction factor with wall roughness – Moody's chart. Minor losses in pipes	2 H
4.	**Water Hammer:**	**3H**
	1. Speed of pressure wave, slow and rapid closure	2H
	2. use of surge tank.	1H
5.	**Steady uniform flow in open channel:**	**6 H**
	1. Characteristics, Chezy's, Manning's and Bazin's formulae.	1H
	2. Hydraulically efficient cross sections.	2H
	3. Flow through channels of circular cross sections	2 H
	4. Depths for maximum velocity and discharge.	1H
6.	**Varied flow through open channel:**	**9H**
	1. Gradually varied and rapidly varied flows. Definition, Specific Energy, Critical, Sub-critical and Super-critical flows.	2H
	2. Channel transitions - constricted or raised bed.	2H
	3. Establishment of critical flow, Venturi flume and Parshall flume.	2H
	4. Definition and diagram for Specific force	2H
	5. Hydraulic Jump	1H
7.	**Dimensional Analysis and Model studies:**	**4H**
	1. Dimensions and dimensional homogeneity, Importance and use of dimensional analysis.	1H

	2. Buckingham's Pi theorem with applications. Geometric, Kinematic and Dynamic similarity	2H
	3. Non Dimensional Numbers.	1H
8.	**Introduction to Hydraulic Turbines:**	**3 H**
	1. Working Principles of Pelton, Francis and Kaplan turbines	3H
9	**Pumps:**	**5H**
	1. Centrifugal pumps, performance characteristic graph – design flow rate	2H
	2. Working principles of positive displacement pumps, gear, reciprocating and vane pumps.	2H
	3. Hydraulic Ram	1H
	TOTAL LECTURE	**44 H**

Faculty In-Charge HOD, CE

Assignment :
Module : 1

Part :I

1. State & Derive Newton's Law of Viscosity

2. Practice problem related to viscosity.

3. Develop the expression for the relation between gauge pressure P inside a droplet of liquid and the surface tension.

4. Explain the following: (i) Newtonian & non- Newtonian fluid. (ii) Compressibility, (iii) Vapour pressure.

Part :II

1. Derive the pressure variation in a fluid at rest.

2. An open tank contains water up to a depth of 2m and above it an oil of sp. gravity 0.9 for a depth of 1 m. Find the pressure intensity (i) at the interface of the two liquids & (ii) at the bottom of the tank.

3. Draw a relation between absolute , gauge, atmospheric & vacuum pressure.

4. Draw & Explain all types of Manometer.

5. Practice problem related to manometer follow in the class& Exercise.

6. State & Prove Pascal's Law.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: **Fluid Mechanics** Subject Code: **CE-401**

Year: **2nd Year** Semester: **Fourth**

Part : III

1. Determine the total pressure on a circular plate of diameter 1.5m which is placed vertically in water in such a way that the centre of pressure is 3m below the free surface of water. Find the position of centre of pressure also.

2. A pipe line which is 4m in diameter contains a gate valve. The pressure at the centre of pipe is 19.6 N/cm^2. If the pipe is filled with oil of specific gravity 0.87, Find the force exerted by the oil upon the gate and position of centre of pressure.

3.A vertical sluice gate is used to cover an opening in a dam. The opening is 2m high & 1.2 m high. On the upstream of the gate , the liquid of sp. gr. 1.45, Lies up to a height of 1.5m above the top of the gate, whereas on the downstream side the water is available up to a height touching to the top of the gate. Find the resulting force acting on the gate & position of centre of pressure. Find also the force acting horizontally at the top of the gate which is capable of opening it. Assume that the gate is hinged at the bottom.

4. A caisson for closing the entrance to a dry dock is of trapezoidal form 16 m wide at the top & 10 m wide at the bottom and 6m deep. Find the total pressure & centre of pressure on the caisson if the water on the outside is just level with the top and dock is empty

Module :2

1. Broadly classify Notches & Weirs

2. Derive discharge over rectangular & triangular notch or weir

3. Derive discharge over trapezoidal & stepped notch or weir

4. Derive Cippolletti weir or notch.

5. Find the discharge of water flowing over rectangular notch of 3m length when the constant head of water over the notch is 40 cm . Take C_d= 0.6

6. Define Velocity approach. How does the velocity approach affect the discharge over weir?

7. A right angled V-Notch is used for measuring a discharge of 30 litres/sec. An error of 2mm was made in measuring the head over the notch. Calculate the percentage error in the discharge . Take C_d = 0.62

8. Define End Contraction of the weir? What is the effect of end contraction on the discharge through a weir?

Module:3

1. Derive Darcy-Weisbach formula for frictional loss.

2. Calculate the discharge through a pipe of diameter 200 mm when the difference of pressure head between the two ends of a pipe 500 m apart is 4m of water . Take the value of f= 0.009

3. Derive the minor energy losses considering at least four conditions.

4. A pipeline of 0.6 m diameter of 1.5 km long. To increase the discharge , another line of the same diameter is introduced parallel to the first in the second half of the length . Neglecting minor losses, Find the increase in discharge if 4f= 0.04 .The head at inlet is 300 mm.

5. Three reservoir A,B & C are connected by a pipe system . The lengths and diameters of pipes 1,2 & 3 are 800 m, 1000m, 800m, and 300m, 200m &150m respectively. Determine the piezometric head at junction D. Take f= .005

Module :4

1. Describe water hammer in pipes considering the various condition.

Module :5

1.Describe the Characteristicsof open channel, Chezy's, Manning's and Bazin's formulae.

2. Practice problem related to open channel.

3. Derive Depths for maximum velocity and discharge.

Module :6

1. Write short notes on Gradually varied and rapidly varied flows, Specific Energy, Critical, Sub-critical and Super-critical flows.

2. Define and describe Hydraulic Jump.

3. Practice problem related on Hydraulic jump.

Module :7

1. Describe dimensions and dimensional homogeneity.

2. Importance and use of dimensional analysis.

3. Describe Buckingham's Pi theorem with applications.

4. Describe Geometric, Kinematic and Dynamic similarity

Module :8

1. Describe the Working Principles of Pelton Francis and Kaplan turbines

2.A kaplan turbines developes 24647.6 kw power at an average head of 39 metres . Assume a speed ratio of 2, flow ratio of 0.6, diameter of the boss = 0.35 times the diameter of the runner and the overall efficiency of 90 %, calculate the diameter , speed and specific speed of the turbine?

3. What is draft tube ? Describe all the types of draft tube.

4. A Pelton Turbine develops 3000 KW under a head of 300 m . The overall effuiciency of the turbine is 83 % . If speed ratio = 0.46, Cv= 0.98and specific speed is 16.5 then find the diameter of the turbine, diameter of the jet.

Module :9

1. Describe Centrifugal pumps with its performance &characteristics.

2. Describe Working principles of positive displacement pumps, gear, reciprocating and vane pumps.

3. Write short notes on Hydraulic Ram.

4. Practice class problem.

UNIVERSITY OF ENGINEERING & MANAGEMENT,JAIPUR

Lecture-wise Plan

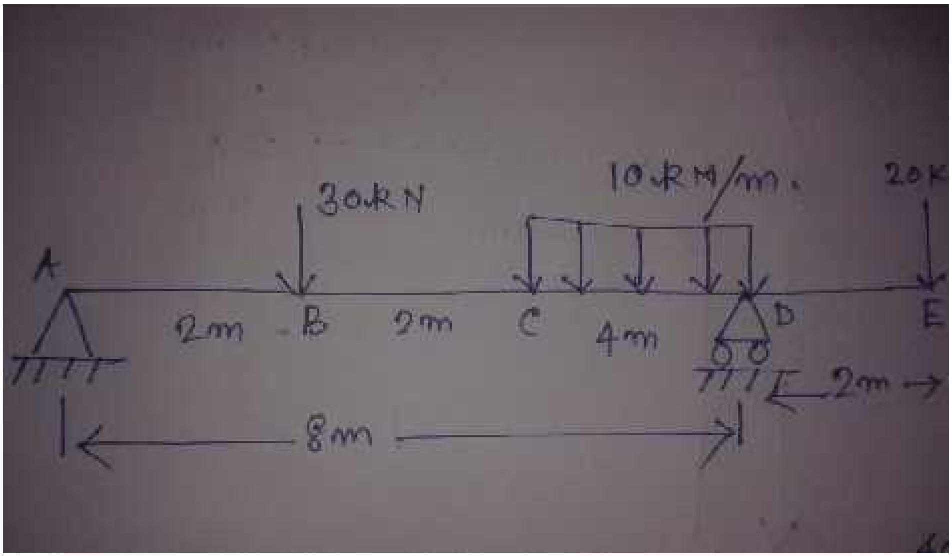
Subject Name: Structural Analysis **Subject Code-CE 402**
Year: 2nd Year **Semester: Fourth**

Module Number	Topics	Number of Lectures
1.	**Review of basic concept of mechanics**: Equilibrium,	**8 L**
	Free body diagram, Determinate andIndeterminate	**3L**
	structures, Degree of indeterminacy for different	**2L**
	types of structures: Beams, Frames, Trusses.	**3L**
2.	**Analysis of determinate structures**: Portal frames,	**8 L**
	arches, cables Strain energy: Due to axial load,	**2L**
	bending and shear, Torsion; Castigliano's theorems,	**2L**
	theorem of minimum potential energy, principle of	**2L**
	virtual work, Maxwell's theorem of reciprocal	**1L**
	deflection, Betti's law.	**1L**
3.	**Deflection of determinate structures:** Moment area	**9L**
	and Conjugate beam method, Energy methods,	**2L**
	Influence line diagrams: Statically determinate	**2L**
	beams and trusses under series of concentrated and	**1L**
	uniformly distributed rolling loads, criteria for	**1L**
	maximum and absolute maximum moments and	**1L**
	shears.Unit load method for beams, Deflection of	**1L**
	trusses and simple portal frames.	**1L**
4.	**Analysis of statically Indeterminate beams**:	**9L**
	Theorem of three moments, Energy methods, Force	**2L**
	method (method of consistent deformations) [for	**2L**
	analysis of propped cantilever, fixed beams and	**2L**
	continuous beams (maximum two degree of	**2L**
	indeterminacy) for simple loading cases], Analysis of two-hinged arch.	**1L**
5.	**Analysis of statically Indeterminate structures**:	**10L**
	Moment distribution method - solution of continuous	**2L**
	beam, effect of settlement and rotation of support,	**2L**
	frames with or without side sway. Slope Deflection	**2L**
	Method – Method and application in continuous	**2L**
	beams and Frames. Approximate method of analysis	**1L**
	of structures: Portal & Cantilever methods.	**1L**
Total Number Of Hours = 44		

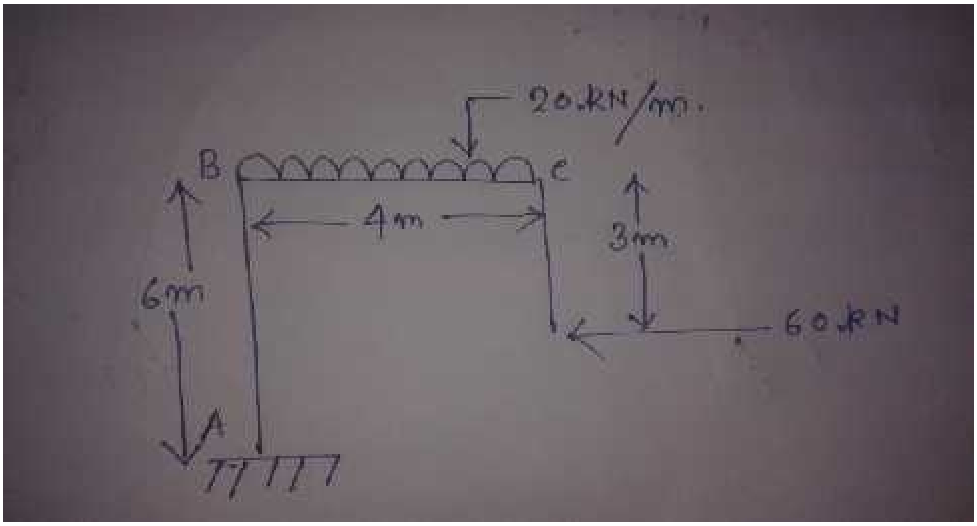
Faculty In-Charge HOD, CE Dept.

Assignment:
Module 1:

1. Determine the support reaction in the simply supported beam with overhang as shown in the figure –

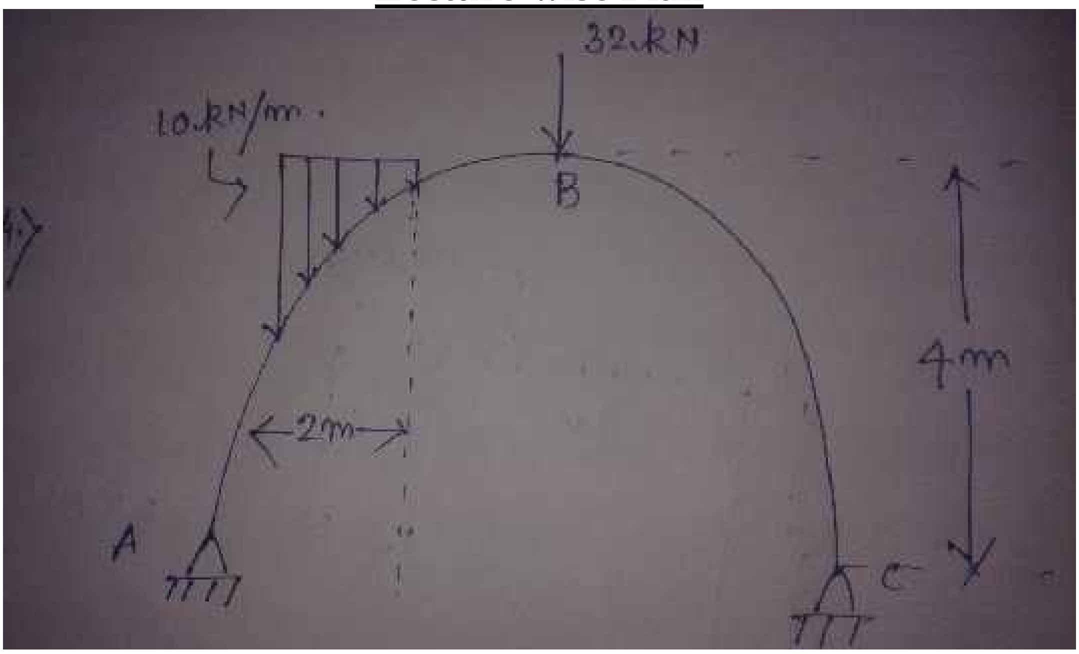


2. Find out the support reaction in the Rigid Jointed Cantilever frame as shown in the figure –



Module 2:

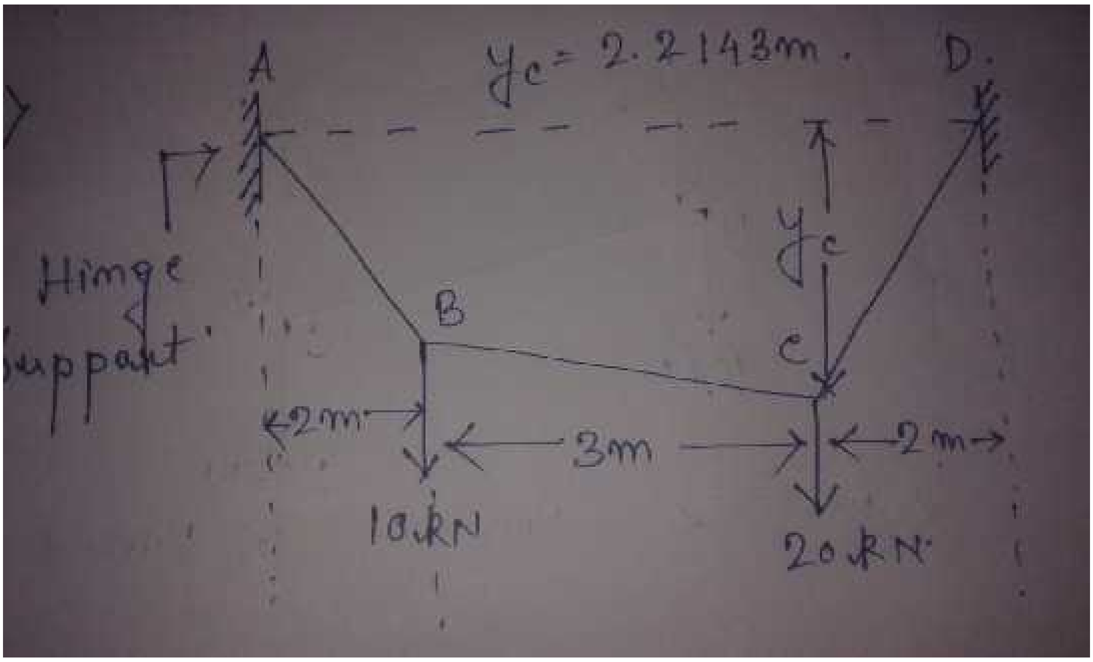
1. Determine the support reaction in the 3 hinged arch as shown in the figure –



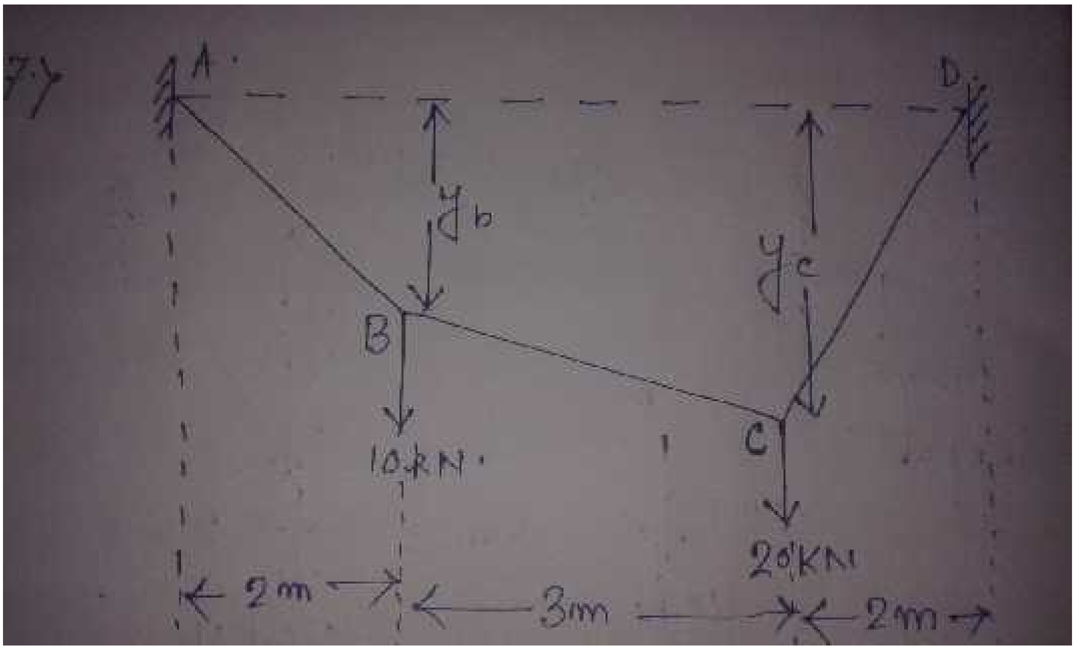
2. Describe the concept of Funicular polygon with the help of a diagram.

Module 3:

1. Find out the support reaction, cable tension, sag at the point B and the total length of the cable system as shown in the figure –



2. The total length of a cable system is given as 8.634. Analyze the cable to find the sag at C, and the horizontal tension H.



3. State and prove Eddy's Theorem with the help of a detailed diagram.

Module 4:

1.A parabolic arch hinged at the springing and the crown has a span of 20 m. The central rise of the arch is 4 m. It is loaded with a uniformly distributed load of intensity 2 kN/m on the left 8 m length. Calculate:

a) The direction and magnitude of the Reaction at the hinges.

b) The Bending Moment, Normal Thrust and Radial Shear at 4 m and 15 m from the left end.

c) Maximum positive and negative Bending Moment.

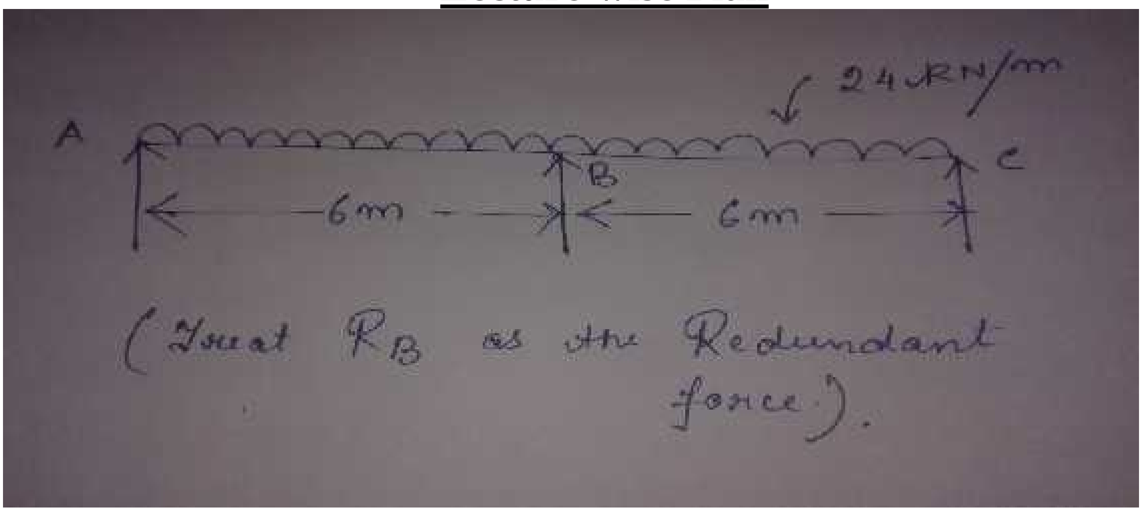
2. A three hinged parabolic arch of 20 m span and 4 m central rise carries a point load of 4 kN at 4 m horizontally from the left hand hinge. Calculate the normal thrust and shear force at the section under the load.Also calculate the Maximum Bending Moment positive and negative.

3.Analyze the continuous beam loaded as shown in figure- by the Strain energy Method. EI is constant –

(Treat R_B as the Redundant force)

UNIVERSITY OF ENGINEERING & MANAGEMENT,JAIPUR

Lecture-wise Plan



Module 5:

1. i) Define:

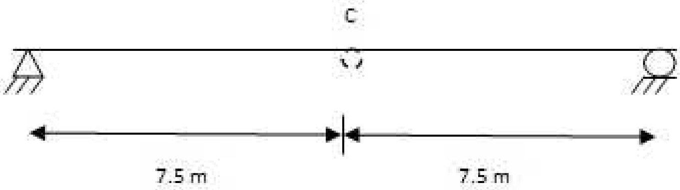
a. Influence Line Diagram

b. Castigliano'sTheorm

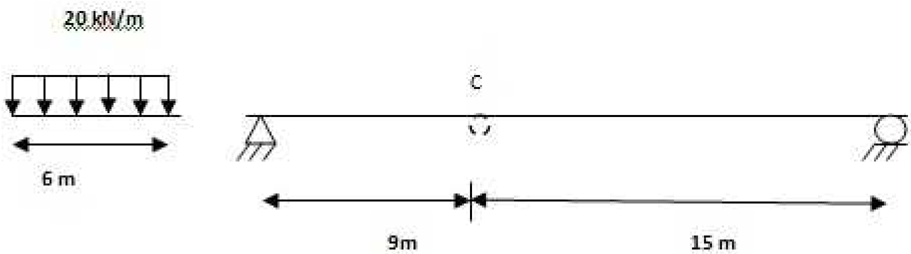
c. Carry over factor

d. Distribution factor

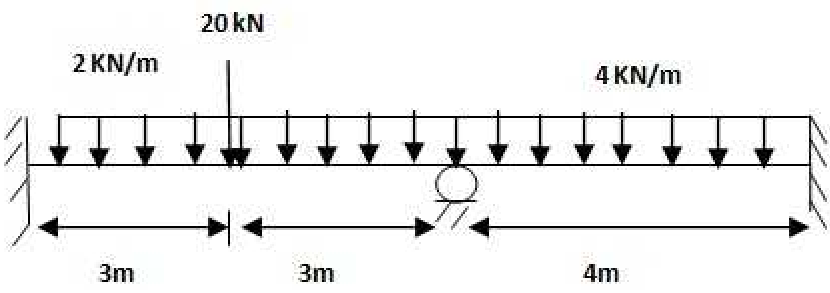
ii) Construct the influence line for shearing and moment at point c of the beam.



2. A simply supported beam has a span of 24 m. An UDL of intensity 20 kN/m and 6 m long crosses the beam. Using ILD, find the maximum shear force and bending moment at a section 9m from the left hand support.



3. Determine end moments and draw SFD of the given continuous beam by slope deflection method. The udl 4kN/m is extending from roller support to right hand fixed support.


20 kN
2 KN/m
4 KN/m
3m
3m
4m

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: **Soil Mechanics** Subject Code: **CE403**
Year**: 2nd Year** Semester: **Fourth**

Module Number	Topics	Number of Lectures
1	**Introduction**	**3L**
	1. Origin & formation of Soil: Types, Typical Indian Soil	1L
	2. Fundamental of Soil Structure, Clay Mineralogy	2L
2	**Physical & Index Properties of Soil**	**6L**
	1. Weight- Volume Relationships, Insitu Density, Moisture Content, Specific Gravity	2L
	2. Particle Size Distribution of soil: Sieving, Sedimentation Analysis, Relative Density	2L
	3. Atterberg's Limits, Soil Indices, consistency of soil	2L
3	**Identification & Classification of Soil**	**4L**
	1. Field identification of soil, Soil Classification: as per Unified Classification System	2L
	2. IS Code Recommendation, AASHTO classification	2L
4	**Flow through Soil**	**5L**
	1. Darcy's Law, Coefficient of permeability, laboratory and field determination of coefficient of permeability	2L
	2. Permeability for Stratified Deposits	1L
	3. Laplace's Equations, Flow nets, Flow through Earthen Dam, Estimation of Seepage, Uplift due to seepage	2L
5	**Effective Stress Principles**	**4L**
	1. Effective Stress, Effective pressure due to different conditions	1L
	2. Seepage force, Critical hydraulic gradient, quick sand condition	2L
	3. Design of filters, Capillarity in soil	1L
6	**Stress Distribution in Soil**	**6L**
	1. Normal and shear stresses, Stress due to point loads	1L
	2. Stress beneath Line, strip & uniformly loaded circular area & rectangular area	3L
	3. pressure bulbs, Newmark's charts- Use for determination of stress due to arbitrarily loaded areas	2L
7	**Compaction of Soil**	**3L**

	1. Principles of Compaction, IS Light & Heavy Compaction Test	2L
	2. Field Compaction, Various methods of field compaction and control	1L
8	**Compressibility & Consolidation of Soil**	**5L**
	1. Terzaghi's theory of one dimensional consolidation, Compression index, Coefficient of compressibility & volume change, Coefficient of consolidation, Degree & rate of consolidation	2L
	2. Laboratory method of one dimensional consolidation test, Determination of consolidation parameters, Secondary consolidation	3L
9	**Shear Strength of Soil**	**6L**
	1. Basic concepts, Mohr- Columb's Theory	1L
	2. Direct Shear, Tri-axial Test	2L
	3. Unconfined Compression, Vane Shear Test, Sensitivity & thixotropy of clay	3L
Total Number Of Hours = 42L		

Faculty In-Charge Debasmita Pal HOD, CE Dept.

Assignments:

Module-1(Introduction):

1. What are the major soil deposits in India? Explain their characteristics.
2. Discuss the characteristics and construction of Kaolinite, Montmorillonite and Illite mineral groups.
3. What are the different types of soil structure which can occur in the nature? Describe in brief.

Module-2 (Physical & Index Properties of Soil):

1. A sample of wet silty clay soil has a mass of 126 kg. The following data were obtained from laboratory tests on the sample: Wet density, ρ_t = 2.1 g/cm^3, G = 2.7, water content, w =15%. Determine (i) dry density, ρ_d, (ii) porosity, (iii) void ratio, and (iv) degree of saturation.

2. A soil sample in its natural state has, when fully saturated, a water content of 32.5%. Determine the void ratio, dry and total unit weights. Calculate the total weight of water required to saturate a soil mass of volume 10 m3. Assume G_s = 2.69

3. Derive Stoke's Law.

4. Liquid limit tests on a given sample of clay were carried out. The data obtained are as given below.

Test No.	**1**	**2**	**3**	**4**
Water content(%)	70	64	47	44
Number of blows, N	5	8	30	45

Draw the flow curve on semi-log paper and determine the liquid limit and flow index of the soil.

5. The laboratory tests on a sample of soil gave the following results: w_n - 24%, w_l = 62%, w_p = 28%, percentage of particles less than 2 JJL - 23%. Determine: (a) The liquidity index, (b) activity (c) consistency and nature of soil

Module-3 (Identification & Classification of Soil):

1. What is the classification of soils Discuss Indian standard Classification system
2. What is the difference between the classification based on particle size and textural classification? Discuss the limitation of these two systems.

Module-4 (Flow through Soil):

1. A sand sample of 35 cm2 cross sectional area and 20 cm long was tested in a constant head permeameter. Under a head of 60 cm, the discharge was 120 ml in 6 min. The dry weight of sand used for the test was 1 120 g, and Gs = 2.68. Determine (a) the hydraulic conductivity in cm/sec, (b) the discharge velocity, and (c) the seepage velocity
2. A sand deposit contains three distinct horizontal layers of equal thickness (Fig. 4.9). The hydraulic conductivity of the upper and lower layers is 10^{-3} cm/sec and that of the middle is 10^{-2} cm/sec. What are the equivalent values of the horizontal and vertical hydraulic conductivities of the three layers, and what is their ratio?
3. The data given below relate to two falling head permeameter tests performed on two different soil samples: (a) stand pipe area = 4 cm^2, (b) sample area = 28 cm^2, (c) sample height = 5 cm, (d) initial head in the stand pipe =100 cm, (e) final head = 20 cm, (f) time required for the fall of water level in test 1, t = 500 sec, (g) for test 2, t = 15 sec. Determine the values of k for each of the samples. If these two types of soils form adjacent layers in a natural state with flow (a) in the horizontal direction, and (b) flow in the vertical direction, determine the equivalent permeability for both the cases by assuming that the thickness of each layer is equal to 150 cm.
4. In order to compute the seepage loss through the foundation of a cofferdam, flownets were constructed. The result of the flownet study gave N_f= 6, N_d = 16. The head of

water lost during seepage was 19.68 ft. If the hydraulic conductivity of the soil is k = 13.12 x 10^{-5} ft/min, compute the seepage loss per foot length of dam per day.

Module-5 (Effective Stress Principles):

1. Define total stress, neutral stress and effective stress. What
2. A clay stratum 8.0 m thick is located at a depth of 6 m from the ground surface. The natural moisture content of the clay is 56% and G_s = 2.75. The soil stratum between the ground surface and the clay consists of fine sand. The water table is located at a depth of 2 m below the ground surface. The submerged unit weight of fine sand is 10.5 kN/m^3, and its moist unit weight above the water table is 18.68 kN/$m^{3.}$ Calculate the effective stress at the centre of the clay layer.
3. The porosity of a sample of sand in the loose state was 54% and at dense state, 38%. Find out the critical hydraulic gradient in both the states if the specific gravity of the soil grain was 2.60. Also find out the saturated densities in kg/m^3.

Module-6 (Stress Distribution in Soil):

1. A concentrated load of 1000 kN is applied at the ground surface. Compute the vertical pressure (i) at a depth of 4 m below the load, (ii) at a distance of 3 m at the same depth. Use Boussinesq's equation
2. Three parallel strip footings 3 m wide each and 5 m apart center to center transmit contact pressures of 200, 150 and 100 kN/m^2 respectively. Calculate the vertical stress due to the combined loads beneath the centres of each footing at a depth of 3 m below the base. Assume the footings are placed at a depth of 2 m below the ground surface. Use Boussinesq's method for line loads.
3. A rectangular raft of size 30 x 12 m founded on the ground surface is subjected to a uniform pressure of 150 kN/m^2. Assume the centre of the area as the origin of coordinates (0,0), and corners with coordinates (6, 15). Calculate the induced stress at a depth of 20 m by the exact method at location (0, 0).

Module-7 (Compaction of Soil):

1. What are factors affect compaction? Discuss in brief.
2. What is the effect of compaction on engineering properties of soil? How would you decide whether the soil should be compacted the dry of optimum or the wet of optimum?
3. What are the different methods of compaction adopted in the field? How would you select the type of roller to be used?

Module-8 (Compressibility & Consolidation of Soil):

1. A recently completed fill was 32.8 ft thick and its initial average void ratio was 1.0. The fill was loaded on the surface by constructing an embankment covering a large area of the fill. Some months after the embankment was constructed, measurements of the fill indicated an average void ratio of 0.8. Estimate the compression of the fill.
2. A 2.5 cm thick sample of clay was taken from the field for predicting the time of settlement for a proposed building which exerts a uniform pressure of 100 kN/m^2 over

the clay stratum. The sample was loaded to 100 kN/m^2 and proper drainage was allowed from top and bottom. It was seen that 50 percent of the total settlement occurred in 3 minutes. Find the time required for 50 percent of the total settlement of the building, if it is to be constructed on a 6 m thick layer of clay which extends from the ground surface and is underlain by sand

3. Soil investigation at a site gave the following information. Fine sand exists to a depth of 10.6 m and below this lies a soft clay layer 7.60 m thick. The water table is at 4.60 m below the ground surface. The submerged unit weight of sand yb is 10.4 kN/m3, and the wet unit weight above the water table is 17.6 kN/m3. The water content of the normally consolidated clay wn = 40%, its liquid limit wt = 45%, and the specific gravity of the solid particles is 2.78. The proposed construction will transmit a net stress of 120 kN/m2 at the center of the clay layer. Find the average settlement of the clay layer.

Module-9 (Shear Strength of Soil):

1. What is the shearing strength of soil along a horizontal plane at a depth of 4 m in a deposit of sand having the following properties?Angle of internal friction, ϕ = 35° Dry unit weight, γ= 7 kN/m^3 Specific gravity, G_s = 2.7.Assume the ground water table is at a depth of 2.5 m from the ground surface. Also find the change in shear strength when the water table rises to the ground surface.
2. A direct shear test, when conducted on a remoulded sample of sand, gave the following observations at the time of failure: Normal load = 288 N; shear load = 173 N. The cross sectional area of the sample = 36 cm2. Determine: (i) the angle of internal friction, (ii) the magnitude and direction of the principal stresses in the zone of failure**.** Solve it graphically.
3. A cylindrical sample of saturated clay 4 cm in diameter and 8 cm high was tested in an unconfined compression apparatus. Find the unconfined compression strength, if the specimen failed at an axial load of 360 N, when the axial deformation was 8 mm. Find the shear strength parameters if the angle made by the failure plane with the horizontal plane was recorded as 50°.
4. An unconfined cylindrical specimen of clay fails under an axial stress of 5040 lb/ft2. The failure plane was inclined at an angle of 55° to the horizontal. Determine the shear strength parameters of the soil.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Technical Report Writing & Language Lab
Course Code: HU481
L-T-P scheme: 0-0-2 **Course Credit: 2**

Objectives:
1. To inculcate a sense of confidence in the students.
2. To help them become good communicators both socially and professionally.
3. To assist them to enhance their power of Technical Communication.

Learning Outcomes:

Course Contents:
Exercises that must be done in this course are listed below:
Exercise No.1: Report Types (Organizational/Commercial/Business/Project)

Exercise No. 2: Report Format &Organization of Writing Materials

Exercise No. 3: Report Writing (Practice Sessions &Workshops)

Exercise No. 4: Introductory Lecture to help the students get a clearidea of Technical Communication& the need of Language Laboratory Practice Sessions

Exercise No. 5: Conversation Practice Sessions: (To be done as real life interactions)
a) Training the students by using Language Lab Device/Recommended Texts/cassettes/cd to get their Listening Skill & Speaking killhoned
b) Introducing Role Play & honing overall Communicative Competence

Exercise No. 6: Group Discussion Sessions:
a) Teaching Strategies of Group Discussion
b) Introducing Different Models & Topics of Group Discussion
c) Exploring Live/Recorded GD Sessions for mending students' attitude/approach & for taking remedial measure Interview Sessions;
d) Training students to face Job Interviews confidently and successfully
e) Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking skill in a formal situation for effective communication

Exercise No. 7: Presentation:
a) Teaching Presentation as a skill
b) Strategies and Standard Practices of Individual/Group Presentation
c) Media & Means of Presentation: OHP/POWERPOINT/Other Audio-Visual Aids

Exercise No. 8: Competitive Examination:
a) Making the studentsawareofProvincial/National/InternationalCompetitiveExaminations
b) Strategies/Tactics for success in Competitive Examinations
c) SWOT Analyse is and its Application in fixing Target

Text Book:
1. Nira Konar: English Language Laboratory: A Comprehensive Manual

D. Sudharani: Advanced Manual for Communication Laboratories& Technical Report Writing Pearson Education (W.B.edition), 2011PHI Learning,2011

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Numerical Methods Lab
Course Code: M(CS)491
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:

1. To give an overview of *what* can be done
2. To give insight into *how* it can be done
3. To give the confidence to tackle numerical solutions

An understanding of how a method works aids in choosing a method. It can also provide an indication of what can and will go wrong, and of the accuracy which may be obtained.To gain insight into the underlying physics.
"The aim of this course is to introduce numerical techniques that can be used on computers, rather than to provide a detailed treatment of accuracy or stability"

Learning Outcomes:
On completion of this course, the student will be able to:

1. Demonstrate skills in using computer programming tools for engineering calculations;
2. Demonstrate ability to construct simple computer algorithms using a programming tool;
3. Apply simple numerical methods to solve mathematical problems with relevance to civil engineering;
4. Appreciate the limitations and the applicability of the numerical methods;
5. Apply computer-based numerical methods for the solution of engineering problems.

Course Contents:
Exercises that must be done in this course are listed below:

1. Assignments on Newton forward /backward, Lagrange' s interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson' s 1/3 rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5. Assignments on ordinary differential equation: Euler' s and Runga-Kutta methods.

Text Book:

1. Introductory method of numerical analysis, Sastry S.S
2. Computer Programming in fortran 77, Rajaraman V
3. Numerical methods: for scientific and engineering computation,Mahinder Kumar Jain

.
Recommended Systems/Software Requirements:

1. Intel based desktop PC with minimum of 166 MHZ or faster processor with at least 64 MB RAM and 100 MB free disk space.
2. Turbo C or TC3 complier in Windows XP or Linux Operating System.

Experiment No: 1(a) Newton forward interpolation
Aim: Write a C program to implement the Newton forward interpolation.
Description:
Interpolation is the process of finding the values of y corresponding to the any value of x between x0 and xn for the given values of y=f(x) for a set of values of x. Out of the many techniques of interpolation, Newton's Forward and Backward Interpolation are two very widely used formulas. In this tutorial, we're going to discuss a C program for Newton Forward Interpolation along with its sample output.
Both of Newton's formulas are based on finite difference calculus. These formulas are very often used in engineering and related science fields. Before going through the source code for Newton Forward Interpolation, let's go through the forward interpolation formula and the variables used in the C program.

Newton’s forward interpolation formula contains y0 and the forward differences of y0. This formula is used for interpolating the values of y near the beginning of a set of tabulated values and extrapolation the values of y a little backward (i.e. to the left) of y0. The formula is given below:

$$P(x) = y_0 + q\,\Delta y_0 + \frac{q(q-1)}{2!}\Delta^2 y_{-1} + \frac{(q+1)q(q-1)}{3!}\Delta^3 y_{-1} + \frac{(q+1)q(q-1)(q-2)}{4!}\Delta^4 y_{-2} + \frac{(q+2)(q+1)q(q-1)(q-2)}{5!}\Delta^5 y_{-2} + \dots + \frac{(q+n-1)\dots(q-n+1)}{(2n-1)!}\Delta^{2n-1} y_{-(n-1)} + \frac{(q+n-1)\dots(q-n)}{(2n)!}\Delta^{2n} y_{-n},$$

Compared to forward interpolation, the backward interpolation formula contains yn and the backward differences of yn. This formula is used for interpolating the values of y near the end of a set of tabulated values and also for extrapolating the values of y a little ahead (i.e. to the right) of yn.

Algorithm:

1. Function NFI ()
2. Read n, x
3. For I = 1 to n by 1 do
4. Read x[i], y[i]
5. End for
6. If ((x < x[i] or (x > x[n]))
7. Print “Value lies out of boundary”
8. Exit
9. End if
10. //Calculating p
11. p = (x – x [1]) / (x [2]-x [1])
12. // Forward diff table
13. For j = 1 to (n-1) by 1 do
14. For i =1 to (n - j) by 1 do
15. If (j=1) Then
16. d[i][j] = y [i+1] – y[i]
17. Else
18. d[i][j] = d[i+1][j-1] – d[i][j-1]
19. End if
20. End For
21. End For
22. // Applying Formula
23. Sum =y [1]
24. For I = 1 to (n-1) by 1 do
25. Prod = 1
26. For j =0 to (i-1) by 1 do
27. Prod = prod * (p-j)
28. End for
29. m = fact(i)
30. Sum = sum + (d[1][i] * prod) / m
31. End For
32. Print “Ans is”, Sum
33. End Function

/* Program to implement Newton’s forward interpolation*/

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
#include<stdlib.h>
main()
{
  float x[20],y[20],f,s,h,d,p;
  intj,i,n;
```

```
    scanf("%d",&n);
    printf("enter the elements of x:");
    for(i=1;i<=n;i++)
     {
        scanf("%f",&x[i]);
         }
            printf("enter the elements of y:");
          for(i=1;i<=n;i++)
          {
         scanf("%f",&y[i]);
                  }
    h=x[2]-x[1];
    printf("Enter the value of f:");
    scanf("%f",&f);
  s=(f-x[1])/h;
  p=1;
  d=y[1];
  for(i=1;i<=(n-1);i++)
   {
            for(j=1;j<=(n-i);j++)
             {
                y[j]=y[j+1]-y[j];

             }
             p=p*(s-i+1)/i;
             d=d+p*y[1];
   }
  printf("For the value of x=%6.5f THe value is %6.5f",f,d);
   getch();
  }
```

OUTPUT:

how many record you will be enter: 5
enter the value of x0: 2.5
enter the value of f(x0): 9.75
enter the value of x1: 3
enter the value of f(x1): 12.45
enter the value of x2: 3.5
enter the value of f(x2): 15.70
enter the value of x3: 4
enter the value of f(x3): 19.52
enter the value of x4: 4.5
enter the value of f(x4): 23.75
Enter X for finding f(x): 4.25
u = -0.500
f(4.25) = 21.583750

Experiment No: 1(b) Newton backward interpolation

Aim: Write a C program to implement Newton backward interpolation.

Algorithm:

1. Function NBI ()
2. Read n, x
3. For I = 1 to n by 1 do
4. Read x[i], y[i]
5. End for

7. Print “Value lies out of boundary”
8. Exit
9. End if
10. //Calculating p
11. p = (x – x [1]) / (x [2]-x [1])
12. // Forward diff table
13. For j = 1 to (n-1) by 1 do
14. For i =1 to (n - j) by 1 do
15. If (j=1) Then
16. d[i][j] = y [i+1] – y[i]
17. Else
18. d[i][j] = d[i+1][j-1] – d[i][j-1]
19. End if
20. End For
21. End For
22. // Applying Formula
23. Sum =y [n]
24. For I = 1 to (n-1) by 1 do
25. Prod = 1
26. For j =0 to (i-1) by 1 do
27. Prod = prod * (p+j)
28. End for
29. m = fact(i)
30. Sum = sum + (d[n-1][i] * prod) / m
31. End For
32. Print “Ans is”, Sum
33. End Function

/* Program to implement Newton’s forward interpolation */

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
#include<stdlib.h>
main()
{
float x[20],y[20],f,s,d,h,p;
intj,i,k,n;
printf(“enter the value of the elements :”);
scanf(“%d”,&n);
printf(“enter the value of x: \n\n”);
for(i=1;i<=n;i++)
      {
scanf(“%f”,&x[i]);
                        }
printf(“enter the value of y: \n\n”);
for(i=1;i<=n;i++)
      {
scanf(“%f”,&y[i]);
                        }
                        h=x[2]-x[1];
printf(“enter the searching point f:”);
scanf(“%f”,&f);
s=(f-x[n])/h;
d=y[n];
p=1;
for(i=n,k=1;i>=1,k<n;i–,k++)
{
```

```
                {
y[j]=y[j]-y[j-1];
                            }
                            p=p*(s+k-1)/k;
                            d=d+p*y[n];
}
printf("for f=%f ,ans is=%f",f,d);
getch();
}
```

OUT PUT:

how many record you will be enter: 5
enter the value of x0: 2.5
enter the value of f(x0): 9.75
enter the value of x1: 3
enter the value of f(x1): 12.45
enter the value of x2: 3.5
enter the value of f(x2): 15.70
enter the value of x3: 4
enter the value of f(x3): 19.52
enter the value of x4: 4.5
enter the value of f(x4): 23.75
Enter X for finding f(x): 4.25

x(i)	y(i)	y1(i)	y2(i)	y3(i)	y4(i)
2.500	9.750				
3.000	12.450	2.700			
3.500	15.700	3.250	0.550		
4.000	19.520	3.820	0.570	0.020	
4.500	23.750	4.230	0.410	-0.160	-0.180

u = -0.500
f(4.25) = 21.583750 -

Experiment No: 1(c)Lagrange' s interpolation
Aim: Write a C program to implement Lagrange' s interpolation.

Algorithm:

1. Input number of Observation n
2. For i = 1 to n
3. Input Xi
4. Input Yi
5. Next i
6. Input xp at which yp to be computed
7. Initialize yp = 0
8. For i = 1 to n
9. t = 1
10. For j = 1 to n
11. If j ≠ i

13. End If
14. Next j
15. yp = yp + t * Yi
16. Next i
17. Print yp as output
18. Stop

/* Program to implement Lagrange' s interpolation*/

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
int main()
{
  float x[10],y[10],temp=1,f[10],sum,p;
  inti,n,j,k=0,c;

  printf("\nhow many record you will be enter: ");
  scanf("%d",&n);
  for(i=0; i<n; i++)
  {
   printf("\n\nenter the value of x%d: ",i);
   scanf("%f",&x[i]);
   printf("\n\nenter the value of f(x%d): ",i);
   scanf("%f",&y[i]);
  }
  printf("\n\nEnter X for finding f(x): ");
  scanf("%f",&p);

  for(i=0;i<n;i++)
  {
    temp = 1;
    k = i;
    for(j=0;j<n;j++)
    {
      if(k==j)
      {
        continue;
      }
      else
      {
        temp = temp * ((p-x[j])/(x[k]-x[j]));
      }
    }
    f[i]=y[i]*temp;
  }

  for(i=0;i<n;i++)
  {
     sum = sum + f[i];
  }
  printf("\n\n f(%.1f) = %f ",p,sum);
  getch();
}
```

OUTPUT:

enter the value of n 4
enter the value to be found 2.5

1 1
2 8
3 27
4 64
X = 2.500000
sum = 15.625000

Experiment No:2.Trapezoidal rule
Aim: Write a C program to implement Trapezoidal rule.
Description:
A number of definite integrals need to be solved in applied mathematics, physics and engineering. The manual analytical solution of definite integrals is quite cumbersome and time consuming. So, in this post I have presented source code in C program for Trapezoidal method as one of the computer-programming-based solutions of definite integrals. The techniques of numerical methods are used to solve this equation; it involves a number of calculations and efforts have been made to minimize error in the program.
The trapezium or trapezoidal rule can be used as a way of estimating the area under a curve because the area under a curve is given by integration. So, the trapezoidal rule gives a method of estimating integrals. This is useful when you come across integrals that you don't know how to evaluate. So, the program for trapezoidal method in C given here is applicable to calculate finite integral or area under a curve.
$h=(x_n - x_0)/n$
After that, the C source code for trapezoidal method uses the following formula to calculate the value of definite integral:

$$\int_{x_0}^{x_n} f(x)\,dx \qquad \frac{1}{2} h[(y_0 + y_n) - 2(y_1 + y_2 + \dots + y_{n-1})]$$

Algorithm:
1. Read x1, x2, e {x1 and x2 are the two end points of the internal the allowed error in integral is e}
2. h = x2 - x1
3. SI = (f(x1) + f(x2))/2;
4. I = h - si
5. i = 1 Repeat
6. x = x1 + h/2
7. for J= 1 to I do
8. SI = SI + f(x)
9. x = x + h
10. End for
11. i = 21
12. h = h/2 {Note that the internal has been halved above and the number of points where the function has to be computed is doubled}
13. i0 = i1
14. i1 = h.si. until / I1 - i0 / <= c./i1/
15. Write I1, h, i
16. **Stop.**

/* Program to to implement Trapezoidal rule */
```
#include<stdio.h>
#include<math.h>
main()
{
float h, a, b, n, x[20], y[20], sum = 0, integral;
int i;
clrscr();
```

```
scanf("%f %f %f", &a, &b, &n);
printf("enter the values of x:");
for(i = 0; i <= (n-1); i++)
 {
scanf("%f", &x[i]);
 }
printf("\n enter the values of y:");
for(i = 0; i <= (n-1); i++)
 {
scanf("%f", &y[i]);
 }
 h = (b-a)/n;
x[0] = a;
for(i = 1; i <= n-1; i++)
 {
x[i] = x[i-1] + h;
sum = sum + 2 * y[i];
 }
sum = sum + y[b];
integral = sum * (h/2);
printf("approximate integral value is: %f", integral);
getch();
}
```

OUTPUT :

```
enter the values of a, b, n
123
enter the values of x:
123
enter the values of y:
123
approximate integral value is 2.166667
```

Experiment No:2(a)Simpson' s 1/3 rule

AIM: Write a C Program to implement Simpson' s 1/3 rule.

Description:

n the source code below, a function *f(x) = 1/(1+x)* has been defined. The calculation using **Simpson 1/3 rule in C** is based on the fact that the small portion between any two points is a parabola. The program follows the following steps for calculation of the integral.

- As the program gets executed, first of all it asks for the value of lower boundary value of x i.e. x_0, upper boundary value of x i.e. x_n and width of the strip, h.
- Then the program finds the value of number of strip as $n=(x_n - x_0)/h$ and checks whether it is even or odd. If the value of 'n' is odd, the program refines the value of 'h' so that the value of 'n' comes to be even.
- After that, this C program calculates value of f(x) i.e 'y' at different intermediate values of 'x' and displays values of all intermediate values of 'y'.
- After the calculation of values of 'c', the program uses the following formula to calculate the value of integral in loop.
  Integral = $*((y_0 + y_n) + 4(y_1 + y_3 + \ldots\ldots\ldots + y_{n-1}) + 2(y_2 + y_4 + \ldots\ldots\ldots + y_{n-2}))$
- Finally, it prints the values of integral which is stored as 'ans' in the program.

If f(x) represents the length, the value of integral will be area, and if f(x) is area, the output of Simpson 1/3 rule C program will be volume. Hence, numerical integration can be carried out using the program below; it is very easy to use, simple to understand, and gives reliable and accurate results.

f(x) = 1/(1+x)

.

Algorithm:

2. h = (x2 - x1)/2
3. i = 2
4. si = f(x1) + f(x2)
5. s2 = 0
6. s4 = f(x1 + h)
7. I0 = 0
8. In = (s + 4s4).(h/3)
9. Repeat
10. s2 = s2 + s4 { s2 stores already computed functional value and s4 the value computed in the new nitration }
11. s4 = 0
12. x = x1 + h/2
13. for j = 1 to I do
14. s4 = s4 + f(x)
15. x = x + h
16. h = h/2
17. i = 2i
18. io = in
19. in = (s1 + 2s2 + 4s4) . (h/3)
20. until |In-Io|≤e. /in
21. Write In, h, i
22. STOP

/* Program to to implement Simpson' s 1/3 rule. */

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
main()
{
float h, a, b, n, x[20], y[20], sum = 0, itgl;
int i;
clrscr();
printf("enter the values of a, b, n");
scanf("%f%f%f", &a, &b, &n);
printf("enter the values of x");
for(i = 0; i <= n; i++)
 {
scanf("%f", &x[i]);
 }
printf("\n enter the values of y");
for(i = 0; i <= n; i++)
 {
scanf("%f", &y[i]);
 }
 h = (b - a)/n;
 a = x[0];
 b = x[n];
for(i = 0; i <= (n-2); i++)
 {
x[i] = x[i] + h;
if(i % 2 == 0)
  {
sum = sum + 4 * y[i];
  }
else
  {
```

```
  }
 }
itgl = sum * (h/3);
printf("integral value%f", itgl);
getch();
}
```

OUTPUT :

enter the values of a, b, n
123
enter the value of x
4567
enter the values of y
8912
integral value is 5.555556

Experiment No: 3(a)Gauss elimination.

AIM: Write a C Program to implement Gauss elimination method.

Description:

let us first consider the following three equations:

a1x + b1y + c1z = d1
a2x + b2y + c2z = d2
a3x + b3y + c3z = d3

Assuming a1 ≠ 0, x is eliminated from the second equation by subtracting (a2/ a1) times the first equation from the second equation. In the same way, the C code presented here eliminates x from third equation by subtracting (a3/a1) times the first equation from the third equation.

Then we get the new equations as:

a1x + b1y + c1z = d1
b’2y + c’2z = d’2
c’’3z = d’’3

The elimination procedure is continued until only one unknown remains in the last equation. After its value is determined, the procedure is stopped. Now, Gauss Elimination in C uses back substitution to get the values of x, y and z as:

z= d’’3 / c’’3
y=(d’2 – c’2z) / b’2
x=(d1- c1z- b1y)/ a1.

Algorithm:

1. Start
2. Declare the variables and read the order of the matrix n.
3. Take the coefficients of the linear equation as:

   Do for k=1 to n

   Do for j=1 to n+1

   Read a[k][j]

   End for j

   End for k

4. Do for k=1 to n-1
   Do for i=k+1 to n
   Do for j=k+1 to n+1
   a[i][j] = a[i][j] – a[i][k] /a[k][k] * a[k][j]
   End for j
   End for i
   End for k
5. Compute x[n] = a[n][n+1]/a[n][n]
6. Do for k=n-1 to 1
   sum = 0
   Do for j=k+1 to n
   sum = sum + a[k][j] * x[j]
   End for j
   x[k] = 1/a[k][k] * (a[k][n+1] – sum)
   End for k
7. Display the result x[k]
8. Stop

/* Program to to implement Gauss elimination method */

```
#include<stdio.h>
int main()
{
   inti,j,k,n;
   float A[20][20],c,x[10],sum=0.0;
   printf("\nEnter the order of matrix: ");
   scanf("%d",&n);
   printf("\nEnter the elements of augmented matrix row-wise:\n\n");
   for(i=1; i<=n; i++)
   {
      for(j=1; j<=(n+1); j++)
      {
         printf("A[%d][%d] : ", i,j);
         scanf("%f",&A[i][j]);
      }
   }
   for(j=1; j<=n; j++) /* loop for the generation of upper triangular matrix*/
   {
      for(i=1; i<=n; i++)
      {
         if(i>j)
         {
            c=A[i][j]/A[j][j];
            for(k=1; k<=n+1; k++)
            {
               A[i][k]=A[i][k]-c*A[j][k];
            }
         }
      }
   }
```

```
/* this loop is for backward substitution*/
for(i=n-1; i>=1; i--)
{
   sum=0;
   for(j=i+1; j<=n; j++)
   {
      sum=sum+A[i][j]*x[j];
   }
   x[i]=(A[i][n+1]-sum)/A[i][i];
}
printf("\nThe solution is: \n");
for(i=1; i<=n; i++)
{
   printf("\nx%d=%f\t",i,x[i]); /* x1, x2, x3 are the required solutions*/
}
return(0);
```

OUTPUT :

No of Equtions : 3
Enter Coefficients of Eqution
4 3 -2
1 1 1
3 -2 1
Enter Constant value
5 3 2
Eliminated matrix as :-
4.00 3.00 -2.00 5.00
0.00 0.25 1.50 1.75
0.00 0.00 28.00 28.00
Solution :
X3 = 1.00
X2 = 1.00
X1 = 1.00

Experiment No:3(b) Gauss-Seidel iterations.
AIM: Write a C Program to implement Gauss-Seidel iterations method.

Description:
The program for Gauss-Seidel method in C works by following the steps listed below:

When the program is executed, first of all it asks for the value of elements of the augmented matrix row wise.
Then, the program asks for allowed error and maximum number of iteration to which the calculations are to be done. The number of iterations required depends upon the degree of accuracy.
The program assumes initial or approximate solution as y=0 and z=0 and new value of x which is used to calculate new values of y and z using the following expressions:
x= 1/a1 (d1-b1y-c1z)
y=1/b2 (d2-a2x-c2z)
z=1/c3 (d3-a3x-b3y)

Algorithm:

1. Start
2. Declare the variables and read the order of the matrix n
3. Read the stopping criteria er

4. Read the coefficients aim as
   Do for i=1 to n
   Do for j=1 to n
   Read a[i][j]
   Repeat for j
   Repeat for i
5. Read the coefficients b[i] for i=1 to n
6. Initialize x0[i] = 0 for i=1 to n
7. Set key=0
8. For i=1 to n
   Set sum = b[i]
   For j=1 to n
   If (j not equal to i)
   Set sum = sum – a[i][j] * x0[j]
   Repeat j
   x[i] = sum/a[i][i]
   If absolute value of ((x[i] – x0[i]) / x[i]) >er, then
   Set key = 1
   Set x0[i] = x[i]
   Repeat i
9. If key = 1, then
   Goto step 6
   Otherwise print results

.

```
/* Program to implement Gauss-Seidel iterations method. */
#include<stdio.h>
#include<math.h>
#define X 2
main()
{
   float x[X][X+1],a[X], ae, max,t,s,e;
   inti,j,r,mxit;
   for(i=0;i<X;i++) a[i]=0;
   puts(" Eneter the elemrnts of augmented matrix rowwise\n");
   for(i=0;i<X;i++)
   {
   for(j=0;j<X+1;j++)
   {
   scanf("%f",&x[i][j]);
   }
   }
   printf(" Eneter the allowed error and maximum number of iteration: ");
   scanf("%f%d",&ae,&mxit);
   printf("Iteration\tx[1]\tx[2]\n");
   for(r=1;r<=mxit;r++)
```

```
        max=0;
        for(i=0;i<X;i++)
        {
            s=0;
            for(j=0;j<X;j++)
            if(j!=i) s+=x[i][j]*a[j];
            t=(x[i][X]-s)/x[i][i];
            e=fabs(a[i]-t);
            a[i]=t;
        }
        printf(" %5d\t",r);
        for(i=0;i<X;i++)
        printf(" %9.4f\t",a[i]);
        printf("\n");
        if(max<ae)
        {
            printf(" Converses in %3d iteration\n", r);
            for(i=0;i<X;i++)
            printf("a[%3d]=%7.4f\n", i+1,a[i]);
            return 0;
        }

        }
    }
```

OUTPUT :

```
Enter the number of equations: 3
Enter the co-efficients of the equations:
a[1][1]= 2
a[1][2]= 1
a[1][3]= 1
a[1][4]= 5
a[2][1]= 3
a[2][2]= 5
a[2][3]= 2
a[2][4]= 15
a[3][1]= 2
a[3][2]= 1
a[3][3]= 4
a[3][4]= 8

x[1] =2.500000
x[2] =1.500000
x[3] =0.375000

x[1] =1.562500
x[2] =1.912500
x[3] =0.740625

x[1] =1.173437
x[2] =1.999688
x[3] =0.913359

x[1] =1.043477
x[2] =2.008570
x[3] =0.976119
```

x[2] =2.004959
x[3] =0.994933

x[1] =1.000054
x[2] =2.001995
x[3] =0.999474

converges to solution
x[1]=1.000054
x[2]=2.001995
x[3]=0.999474

Experiment No: 4(a)Regular-falsi

AIM: Write a program to implement Regular-falsi method.

Description:
The C Program for regulafalsi method requires two initial guesses of opposite nature. Like the secant method, interpolation is done to find the new values for successive iterations, but in this method one interval always remains constant.

The programming effort for RegulaFalsi or False Position Method in C language is simple and easy. The convergence is of first order and it is guaranteed. In manual approach, the method of false position may be slow, but it is found superior to the bisection method.

- tr – a counter which keeps track of the no. of iterations performed
- maxmitr – maximum number of iterations to be performed
- x0, x1 – the limits within which the root lies
- x2 – the value of root at nth iteration
- x3 – the value of root at (n+1)th iteration
- allerr – allowed error
- x – value of root at nth iteration in the regula function
- f(x0), f(x1) – the values of f(x) at x0 and x1 respectively

f(x) = cos(x) – x*e^x

Algorithm:

1. Start
2. Read values of x0, x1 and e

   *Here x0 and x1 are the two initial guesses

   e is the degree of accuracy or the absolute error i.e. the stopping criteria*
3. Computer function values f(x0) and f(x1)
4. Check whether the product of f(x0) and f(x1) is negative or not.

   If it is positive take another initial guesses.

   If it is negative then goto step 5.
5. Determine:

   x = [x0*f(x1) – x1*f(x0)] / (f(x1) – f(x0))
6. Check whether the product of f(x1) and f(x) is negative or not.

   If it is negative, then assign x0 = x;

   If it is positive, assign x1 = x;

7. Check whether the value of f(x) is greater than 0.00001 or not.

   If yes, goto step 5.

   If no, goto step 8.

   Here the value 0.00001 is the desired degree of accuracy, and hence the stopping criteria.
8. Display the root as x.
9. Stop
10.

/* Program to implement Regular-falsi method */

```
#include<stdio.h>
#include<math.h>
float f(float x)
{
   returncos(x) - x*exp(x);
}
voidregula (float *x, float x0, float x1, float fx0, float fx1, int *itr)
{
   *x = x0 - ((x1 - x0) / (fx1 - fx0))*fx0;
   ++(*itr);
   printf("Iteration no. %3d X = %7.5f \n", *itr, *x);
}
void main ()
{
   intitr = 0, maxmitr;
   float x0,x1,x2,x3,allerr;
   printf("\nEnter the values of x0, x1, allowed error and maximum iterations:\n");
   scanf("%f %f %f %d", &x0, &x1, &allerr, &maxmitr);
   regula (&x2, x0, x1, f(x0), f(x1), &itr);
   do
   {
      if (f(x0)*f(x2) < 0)
         x1=x2;
      else
         x0=x2;
      regula (&x3, x0, x1, f(x0), f(x1), &itr);
      if (fabs(x3-x2) <allerr)
      {
         printf("After %d iterations, root = %6.4f\n", itr, x3);
         return 0;
      }
      x2=x3;
   }
   while (itr<maxmitr);
   printf("Solution does not converge or iterations not sufficient:\n");
   return 1;
}
```

OUTPUT :

Enter the value of x0: -1

Enter the value of x1: 1

```
-1.000000 1.000000 0.513434 -4.540302 1.459698 -0.330761
0.513434  1.000000 0.603320 -0.330761 1.459698 -0.013497
0.603320  1.000000 0.606954 -0.013497 1.459698 -0.000527
0.606954  1.000000 0.607096 -0.000527 1.459698 -0.000021
```

App.root = 0.607096

Experiment No: 4(b) Newton Raphson methods
AIM: Write a program to implement Newton Raphson methods.

Algorithm:

1. Start
2. Read x, e, n, d
   *x is the initial guess
   e is the absolute error i.e the desired degree of accuracy
   n is for operating loop
   d is for checking slope*
3. Do for i =1 to n in step of 2
4. f = f(x)
5. f1 = f'(x)
6. If ([f1] < d), then display too small slope and goto 11.
   [ ] is used as modulus sign
7. x1 = x – f/f1
8. If ([(x1 – x)/x1] < e), the display the root as x1 and goto 11.
   [ ] is used as modulus sign
9. x = x1 and end loop
10. Display method does not converge due to oscillation.
11. Stop

/* Program to implement Newton Raphson methods */

```
#include<stdio.h>
#include<math.h>
float f(float x)
{
   return x*log10(x) - 1.2;
}
floatdf (float x)
{
   return log10(x) + 0.43429;
}
```

```
{
   intitr, maxmitr;
   float h, x0, x1, allerr;
   printf("\nEnter x0, allowed error and maximum iterations\n");
   scanf("%f %f %d", &x0, &allerr, &maxmitr);
   for (itr=1; itr<=maxmitr; itr++)
   {
      h=f(x0)/df(x0);
      x1=x0-h;
      printf(" At Iteration no. %3d, x = %9.6f\n", itr, x1);
      if (fabs(h) <allerr)
      {
         printf("After %3d iterations, root = %8.6f\n", itr, x1);
         return 0;
      }
      x0=x1;
   }
   printf(" The required solution does not converge or iterations are insufficient\n");
   return 1;
}
```

OUTPUT :

```
ENTER THE TOTAL NO. OF POWER:::: 3

x^0::-3

x^1::-1

x^2::0

x^3::1

    THE POLYNOMIAL IS :::  1x^3 0x^2 -1x^1 -3x^0
    INTIAL X1---->3
 ITERATION    X1    FX1    F'X1
  1        2.192  21.000 26.000
 2        1.794  5.344  13.419
 3        1.681  0.980  8.656
 4        1.672  0.068  7.475
 5        1.672  0.000  7.384
THE ROOT OF EQUATION IS 1.671700
```

Experiment No:5(a)Euler’ s methods
AIM: Write a program to simulate Euler’ s method.

Description:
Solving an ordinary differential equation or initial value problem means finding a clear expression for y in terms of a finite number of elementary functions of x. Euler’s method is one of the simplest method for the numerical solution of such equation or problem. This **C program for Euler’s method** considers an ordinary differential equations, and the initial values of x and y are known. Mathematically, here, the curve of solution is approximated by a sequence of short lines i.e. by the tangent line in each interval. Using these information, the value of the value of ‘y_n’ corresponding to the value of ‘x_n‘ is to determined by dividing the length (x_n – x) into n strips.
Therefore, strip width= (x_n – x)/n and x_n=x_0+ nh.
Again, if m be the slope of the curve at point, $y_{1=}$ $y_{0\ +\ m}$(x_0 , y_o)h.
Similarly, values of all the intermediate y can be found out.
Below is a source code for **Euler’s method in C** to solve the ordinary differential equation **dy/dx = x+y**. It asks for the value of of x_0 , y_0 ,x_n and h. The value of slope at different points is calculated

The values of y are calculated in while loop which runs till the initial value of x is not equal to the final value. All the values of ‘y’ at corresponding ‘x’ are shown in the output screen.
dy/dx = x+y

Algorithm:

1. Start
2. Define function
3. Get the values of x0, y0, h and xn
   *Here x0 and y0 are the initial conditions
   h is the interval
   xn is the required value
4. n = (xn – x0)/h + 1
5. Start loop from i=1 to n
6. y = y0 + h*f(x0,y0)
   x = x + h
7. Print values of y0 and x0
8. Check if x <xn
   If yes, assign x0 = x and y0 = y
   If no, goto 9.
9. End loop i
10. Stop

```
/* Program to simulate Euler’ s method */
#include<stdio.h>
float fun(float x,float y)
{
   float f;
   f=x+y;
   return f;
}
main()
{
   floata,b,x,y,h,t,k;
   printf("\nEnter x0,y0,h,xn: ");
   scanf("%f%f%f%f",&a,&b,&h,&t);
   x=a;
   y=b;
   printf("\n  x\t  y\n");
   while(x<=t)
   {
      k=h*fun(x,y);
      y=y+k;
      x=x+h;
      printf("%0.3f\t%0.3f\n",x,y);
   }
}
```

OUTPUT :

Enter the value of range: 1 1.5

Enter the h: 0.1
y1 = 5.000

x = 1.000 => y2 = 5.500

x = 1.100 => y3 = 6.105

x = 1.200 => y4 = 6.838

x = 1.300 => y5 = 7.726

x = 1.400 => y6 = 8.808

x = 1.500 => y7 = 10.129

Experiment No:5(b)Runga-Kutta methods
AIM: Write a program to simulate Runga-Kutta methods.

/* Program to simulate Runga-Kutta methods*/
```
#include<stdio.h>
#include<math.h>
float f(float x,float y);
int main()
{
    float x0,y0,m1,m2,m3,m4,m,y,x,h,xn;
    printf("Enter x0,y0,xn,h:");
    scanf("%f %f %f %f",&x0,&y0,&xn,&h);
    x=x0;
    y=y0;
    printf("\n\nX\t\tY\n");
    while(x<xn)
    {
        m1=f(x0,y0);
        m2=f((x0+h/2.0),(y0+m1*h/2.0));
        m3=f((x0+h/2.0),(y0+m2*h/2.0));
        m4=f((x0+h),(y0+m3*h));
        m=((m1+2*m2+2*m3+m4)/6);
        y=y+m*h;
        x=x+h;
        printf("%f\t%f\n",x,y);
    }
}
float f(float x,float y)
{
    float m;
    m=(x-y)/(x+y);
    return m;
}
```

OUTPUT:
Enter the value of x0: 0

Enter the value of y0: 2

Enter the value of h: 0.05

Enter the value of last point: 0.1

k2 = 0.1025

y(0.0500) = 2.101

k1 = 0.1026

k2 = 0.1052

y(0.1000) = 2.205

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Fluid Mechanics Lab
Course Code: CE 491
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. The fluid mechanics lab serves as a fundamental platform to understand the basic principles of fluid flow.
2. The students will also develop a basic understanding of the Orifice Meter and find out the Orifice Co-Efficient.
3. The students will be able to calibrate the V Notch and the measurement of the velocity of water in open channels that is the concept of open channel flow.
4. The students will develop a clear concept of hydraulic jump.

Learning Outcomes: The students will have a clear understanding of the various fluid properties. The students will also develop an understanding of the various operations of hydraulic machines and the concept of efficiency of pumps and turbines. They will be able to differentiate between centrifugal pump, reciprocating pump, pelton wheel turbine, francis turbine and hydraulic ram. They will develop a clear concept of hydraulic jump.

Course Contents:
Practicals that must be done in this course are listed below:

1. Determination of Orifice co-efficient.
2. Calibration of Orifice meter.
3. Calibration of V- Notch.
4. Measurement of velocity of water in an open channel using a pitot tube.
5. Measurement of water surface profile for flow over Broad crested weir.
6. Preparation of discharge rating curve for a sluice.
7. Measurement of water surface profile for a hydraulic jump.
8. Determination of efficiency of a Centrifugal pump.
9. Determination of efficiency of a Reciprocating pump.
10. Determination of efficiency of a Pelton wheel Turbine.
11. Determination of efficiency of a Francis Turbine.
12. Determination of efficiency of a Hydraulic Ram.

Text Book:
1. Fluid Mechanics By R,K,Bansal Laxmi Publications Limited.

EXPERIMENT NO. 1

Aim: - To determine the co efficient of impact for vanes.

Apparatus Used:- Collecting tank, Transparent cylinder, Two nozzles of dia 10 mm &12mm, Vane of different shape (flat, inclined or curved)

Theory:- Momentum equation is based on Newton's second law of motion which states that the algebraic sum of external forces applied to control volume of fluid in any direction is equal to the rate of change of momentum in that direction. The external forces include the component of the weight of the fluid & of the forces exerted externally upon the boundary surface of the control volume. If a vertical water jet moving with velocity is made to strike a target, which is free to move in the vertical direction then a force will be exerted on the target by the impact of jet, according to momentum equation this force (which is also equal to the force required to bringback the target in its original position) must be equal to the rate of change of momentum of thejet flow in that direction.

Procedure:-

1. Note down the relevant dimension or area of collecting tank, dia of nozzle, and density ofwater.

2. Install any type of vane i.e. flat, inclined or curved.

3. Install any size of nozzle i.e. 10mm or 12mm dia.

4. Note down the position of upper disk, when jet is not running.

5 Note down the reading of height of water in the collecting tank.

6. As the jet strike the vane, position of upper disk is changed, note the reading in the scale to which vane is raised.

7. Put the weight of various values one by one to bring the vane to its initial position.

8. At this position finds out the discharge also.

9. The procedure is repeated for each value of flow rate by reducing the water supply.

10. This procedure can be repeated for different type of vanes and nozzle.

Precautions:-

1. Water flow should be steady and uniform.

2. The reading on the scale should be taken without any error.

3. The weight should be put slowly & one by one.

4. After changing the vane the flask should be closed tightly.

Viva Questions:-

1. Define the terms impact of jet and jet propulsion?

2. Find the expression for efficiency of a series of moving curved vane when a jet of water

strikes the vanes at one of its tips?

EXPERIMENT NO. 2

Aim:- To determine the coefficient of discharge of Orifice meter.

Apparatus Used:- Orifice meter, installed on different pipes, arrangement of varying flowrate, U- tube manometer, collecting tube tank, vernier calliper tube etc.

Theory:- Orifice meter are depending on Bernoulli’s equation. Orificemeter is a device usedfor measuring the rate of fluid flowing through a pipe. It is a cheaper device than Venturimeter.

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.

2. Now start the supply at water controlled by the stop valve.

3. One of the valves of any one of the pipe open and close all other of three.

4. Take the discharge reading for the particular flow.

5. Take the reading for the pressure head on from the u-tube manometer for corresponding

reading of discharge.

6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.

7. Now close the valve and open valve of other diameter pipe and take the three reading for this.

8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

Precautions:-

1. Keep the other valve closed whiletaking reading through one pipe.

2. The initial error in the manometer should be subtracted final reading.

3. The parallax error should be avoided.

4. Maintain a constant discharge for each reading.

5. The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Orifice meter are used for flow measuring. How?

2. Difference between Orifice meter and Venturi meter?

EXPERIMENT NO. 3

Aim: - To determine the coefficient of discharge of Notch (V, Rectangular and Trapezoidal types).

Apparatus Used:- Arrangement for finding the coefficient of discharge inclusive of supply tank, collecting tank, pointer, scale & different type of notches.

Theory:- Notches are overflow structure where length of crest along the flow of water isaccurately shaped to calculate discharge.

Procedure:-

1. The notch under test is positioned at the end of tank with vertical sharp edge on the upstream side.

2. Open the inlet valve and fill water until the crest of notch.

3. Note down the height of crest level by pointer gauge.

4. Change the inlet supply and note the height of this level in the tank.

5. Note the volume of water collected in collecting tank for a particular time and find out thedischarge.

6. Height and discharge readings for different flow rate are noted.

Precaution:-

1. Make the water level surface still, before takings the reading.

2. Reading noted should be free from parallax error.

3. The time of discharge is noted carefully.

4. Only the internal dimensions of collecting tank should be taken for consideration and

Viva Questions:-

1. Differentiate between :-

•Uniform and non uniform flow

•Steady and unsteady flow

2. Define notch?

3. What is coefficient of discharge?

EXPERIMENT NO. 4

Aim:- To determine the friction factor for the pipes.(Major Losses).

Apparatus Used:- A flow circuit of G. I. pipes of different diameter viz. 15 mm, 25mm, 32mm dia, U-tube differential manometer, collecting tank.

Theory:-

Friction factor in pipes or Major losses:- A pipe is a closed conduit through which fluid flowsunder the pressure. When in the pipe, fluid flows, some of potential energy is lost to overcomehydraulic resistance which is classified as:-

1. The viscous friction effect associated with fluid flow.

2. The local resistance which result from flow disturbances caused by Sudden expansion and contraction in pipe Obstruction in the form of valves, elbows and other pipe fittings.

Procedure:-

1. Note down the relevant dimensions as diameter and length of pipe between the pressure tapping, area of collecting tank etc.

2. Pressure tapping of a pipe is kept open while for other pipe is closed.

3. The flow rate was adjusted to its maximum value. By maintaining suitable amount of steadyflow in the pipe.

4. The discharge flowing in the circuit is recorded together with the water level in the left andright limbs of manometer tube.

5. The flow rate is reduced in stages by means of flow control valve and the discharge & readingof manometer are recorded.

6. This procedure is repeated by closing the pressure tapping of this pipe, together with otherpipes and for opening of another pipe.

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the meanposition carefully.

2. There in some water in collecting tank.

3. Carefully keep some level of fluid in inlet and outlet supply tank.

Result:-

Viva Questions:-

1. Define major loss in pipe?

2. Define equilent pipe?

3. Define friction factor in the pipe?

EXPERIMENT NO. 5

Aim:- To determine the coefficient of discharge of Venturimeter.

Apparatus Used:- Venturimeter, installed on different diameter pipes, arrangement ofvarying flow rate, U- tube manometer, collecting tube tank, vernier calliper tube etc.

Theory:-Venturimeter are depending on Bernoulli’s equation. Venturimeter is a device usedfor measuring the rate of fluid flowing through a pipe. The consist of three part in short

1. Converging area part

2. Throat

3. Diverging part

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.

2. Now start the supply at water controlled by the stop valve.

3. One of the valves of any one of the pipe open and close all other of three.

4. Take the discharge reading for the particular flow.

5. Take the reading for the pressure head on from the u-tube manometer for correspondingreading of discharge.

6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.

7. Now close the valve and open valve of other diameter pipe and take the three reading for this.

8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

Precautions:-

1.Keep the other valve closed while taking reading through one pipe.

2.The initial error in the manometer should be subtracted final reading.

3.The parallax error should be avoided.

4.Maintain a constant discharge for each reading.

5.The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Venturimeter are used for flow measuring. How?

2. Define co efficient of discharge?

3. Define parallax error?

4. Define converging area part?

5. Define throat?

6. Define diverging part?

EXPERIMENT NO. 6

Aim:- To determine the coefficient of discharge, contraction & velocity of an Orifice.

Apparatus Used:- Supply tank with overflow arrangement, Orifice plate of differentdiameter, hook gauge, collecting tank, piezometric tube.

Theory:- A mouthpiece is a short length of pipe which is two or three times its diameter inlength. If there pipe is filled externally to the orifices, the mouthpiece is called externalcylindrical mouthpiece and discharge through orifice increase is a small opening of any crosssectionon the side of bottom of the tank, through which the fluid is flowing orifice coefficient ofvelocity is defined as the ratio of two actualdischarge to orifice ratio of the actual velocity of the jet at vena- contracta to the coefficient oftheoretical velocity of the jet coefficient of contraction of defined as ratio of the actual velocityof jet at vena- contracta. Vena- Contracta:- The fluid out is in form of jet goes on contracting form orifice up todisputeofabout ½ the orifice dia.

Coefficient of velocity:- It is a ratio of actual velocity jet at vena-contracta to theoretical velocity.

Procedure:-

1. Set the mouthpiece of orifice of which the Cc, Cu, Cd are to be determined.

2. Note the initial height of water in the steady flow tank and the height of datum from the

bottom of orifice and mouthpiece. These remains constant for a particular mouthpiece or orifice.

3. By using the stop valve, set a particular flow in tank and tank height of water in tank.

4. Take the reading of discharge on this particular flow.

5. Using hook gauge, find the volume of Xo Y for mouthpiece.

6. Take three readings using hook gauge for one particular orifice.

7. Using the formula get value of Cd, Cu, and Cc for a particular orifice and mouthpiece.

Precautions:-

1. Take the reading of discharge accurately.

2. Take value of h without any parallax error.

3. Set the orifice and mouthpiece.

4. Height of water in the steady flow.

5. Take reading from hook gauge carefully.

Viva Questions:-

1. Define Orifice?

2. Define Mouth piece?

3. Define vena contracta?

4. Define co efficient of velocity?

EXPERIMENT NO. 7

Aim:- To verify the Bernoulli's theorem.

Apparatus Used:- A supply tank of water, a tapered inclined pipe fitted with no. ofpiezometer tubes point, measuring tank, scale, stop watch.

Theory:- Bernoulli's theorem states that when there is a continues connection between theparticle of flowing mass liquid, the total energy of any sector of flow will remain same providedthere is no reduction or addition at any point.

Procedure:-

1. Open the inlet valve slowly and allow the water to flow from the supply tank.

2. Now adjust the flow to get a constant head in the supply tank to make flow in and out flowequal.

3. Under this condition the pressure head will become constant in the piezometer tubes.

4. Note down the quantity of water collected in the measuring tank for a given interval of time.

5. Compute the area of cross-section under the piezometer tube.

6. Compute the area of cross-section under the tube.

7. Change the inlet and outlet supply and note the reading.

8. Take at least three readings as described in the above steps.

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the meanposition carefully.

2. Carefully keep some level of fluid in inlet and outlet supply tank.

Result:-

Viva Questions:-

1. Briefly explain the various terms involved in Bernoulli's equation?

2. Assumption made to get Bernoulli's equation from Euler's equation by made?

3. What is piezometer tube?

EXPERIMENT NO. 8

Aim:- To find critical Reynolds number for a pipe flow.

Apparatus Used:- Flow condition inlet supply, elliptical belt type arrangement for colouredfluid with regulating valve, collecting tank.

Formula Used:- Reynolds No = Inertia force/Viscous force

Procedure:-

1. Fill the supply tank some times before the experiment.

2. The calculated fluid is filled as container.

3. Now set the discharge by using the valve of that particular flow can be obtained.

4. The type of flow of rate is glass tube is made to be known by opening the valve of dyecontainer.

5. Take the reading of discharge for particular flow.

6. Using the formula set the Reynolds no. for that particular flow, aspect the above procedure forall remaining flow.

Precaution:-

1. Take reading of discharge accurately.

2. Set the discharge value accurately for each flow.

Viva Questions:-

1. Reynolds number importance?

2. Describe the Reynolds number experiments to demonstrate the two type of flow?

3. Define laminar flow, transition flow and turbulent flow?

EXPERIMENT NO. 9

Aim:- To determine the Meta-centric height of a floating body.

Apparatus Used:- Take tank 2/3 full of water, floating vessel or pontoon fitted with apointed pointer moving on a graduated scale, with weights adjusted on a horizontal beam.

Theory: -

Consider a floating body which is partially immersed in the liquid, when such a body is tilted,the center of buoyancy shifts from its original position 'B' to 'B' (The point of application ofbuoyanant force or upward force is known as center of G which may be below or above thecenter of buoyancy remain same and couple acts on the body. Due tothis couple the body remains stable. At rest both the points G and B also Fb x Wc act throughthe same vertical line but in opposite direction. Forsmall change (θ) B shifted to B.The point of intersection M of original vertical line through B and G with the new vertical, linepassing through 'B' is known as metacentre. The distance between G and M is known asmetacentre height which is measure of static stability.

Procedure: -

1. Note down the dimensions of the collecting tank, mass density of water.

2. Note down the water level when pontoon is outside the tank.

3. Note down the water level when pontoon is inside the tank and their difference.

4. Fix the strips at equal distance from the center.

5. Put the weight on one of the hanger which gives the unbalanced mass.

6. Take the reading of the distance from center and angle made by pointer on arc.

7. The procedure can be repeated for other positioned and values of unbalanced mass.

Precautions: -

1. The reading taking carefully without parallax error.

2. Put the weight on the hanger one by one.

3. Wait for pontoon to be stable before taking readings.

4. Strips should be placed at equal distance from the centre.

Viva Questions:-

1. Define Buoyancy?

2. Define Meta-centre?

3. Define Meta- centric height?

4. With respect to the position of metacentre, state the condition of equilibrium for a floatingbody?

EXPERIMENT NO. 10

Aim:- To determine the minor losses due to sudden enlargement, sudden contraction and bend.

Apparatus Used:- A flow circuit of G. I. pipes of different pipe fittings viz. Large bend,Small bend, Elbow, Sudden enlargement from 25 mm dia to 50 mm dia, Sudden contractionfrom 50 mm dia to 25 mm dia, U-tube differential manometer, collecting tank.

Theory:- Minor Losses:-

The local or minor head losses are caused by certain local features or disturbances. Thedisturbances may be caused in the size or shape of the pipe. This deformation affects the velocitydistribution and may result in eddy formation.

Sudden Enlargement:- Two pipe of cross-sectional area A1 and A2 flanged together with aconstant velocity fluid flowing from smaller diameter pipe. This flow breaks away from edges ofnarrow edges section, eddies from and resulting turbulence cause dissipation of energy. Theinitiations and onset of disturbances in turbulence is due to fluid momentum and its area.It is given by:- h exit =V2/2gEddy loss:- Because the expansion loss is expended exclusively on eddy formation andcontinues substance of rotational motion of fluid masses.Sudden Contraction:- It represents a pipe line in which abrupt contraction occurs.Inspection of the flow pattern reveals that it exists in two phases.

Losses at bends, elbows and other fittings:-

The flow pattern regarding separation and eddying in region of separations in bends, valves. Theresulting head loss due to energy dissipation can be prescribed by the relation h = KV2/2g.Where V is the average flow velocity and the resistance coefficient K dependson parameterdefining the geometry of the section and flow. Resistances of large sizes elbows can be reducedappreciably by splitting the flow into a number of streams by a jet of guide vanes calledcascades.

Procedure:-

1. Note down the relevant dimensions as diameter and length of pipe between the pressuretapping, area of collecting tank etc.

2. Pressure tapping of a pipe a is kept open while for other pipe is closed.

3. The flow rate was adjusted to its maximum value. By maintaining suitable amount of steadyflow in the pipe.

4. The discharge flowing in the circuit is recorded together with the water level in the left andright limbs of manometer tube.

5. The flow rate is reduced in stages by means of flow control valve and the discharge & readingof manometer are recorded.

6. This procedure is repeated by closing the pressure tapping of this pipe, together with otherpipes and for opening of another pipe.

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the meanposition carefully.

2. There in some water in collecting tank.

3. Carefully keep some level of fluid in inlet and outlet supply tank.

Result:-

Viva Questions:-

1. Define hydraulic gradient and total energy lines?

2. Define eddy loss?

3. Define sudden contraction?

4. Define sudden enlargement?

EXPERIMENT NO. 11

Aim:- To study Viscosity, Velocity & Pressure measuring device.

Theory:- Viscosity measuring device:-

1. Capillary tube

2. Viscometer.

Capillary tube:-Poiseiulle showed that the volume (v) of a liquid or gas flowing per secondthrough a horizontal capillary tube of a given radius length (L) under a constant difference ofpressure (ΔP) between two ends is inversely proportional to the viscosity of fluid. The volume offluid through the f tube in t is given byThe lesser the volume of flowing fluid through the tube per unit time, the larger the viscosity.

Viscometer:- It is an instrument to measure the viscosity. It measures some quantity which is afunction of viscosity. The quantity measured is usually time taken to pass certain volume of theliquid through an orifice fluid at the bottom of the viscometer. The temperature of liquid, while itis being passed through the orifice should be maintained constant. Some viscometer is used aresay bolt universally, redwood, Engler viscometer which has a vertical tube. The times in secondto pass 60cc of fluid liquid for the determination of viscosity is “say bolt second”.

The following empirical relations are used to determine kinematics viscosity in stokes:-

A) Say bolt universal viscometer

B) Red wood viscometer

C) Engler viscometer

Velocity measuring device:-Rota Meter.

Construction:- A Rota meter is a device to find the velocity of a flow in a pipe with the aid ofrotating free float. It is essentially an orifice meter with fixed pressure drop and variable orificearea. Fluid is allowed to flow vertically upward through a tapered transparent tube placedvertically with a large end at the top. The float is freely suspended upside the tube. Themaximum diameter of float is slightly less then the minimum bore. There are two L-bend lies onthe inlet and outlet of the tube. Guide wire for float is calibrated at the centre of the tapered tube.The outlet portion for fluid generally less then the inlet portion. The tapered tube is generallyhaving the glass covering on the part of taking the reading of the float

Working:- When there is no flow, float rests at bottom, but fluid when some velocity float hasrises upward to make way for fluid motion. The float rises to such a position that the pressureloss across the amuler orifice just balances to the weight of the float mechanism which isattached to it. The float therefore attains a state of equilibrium and the distance from the stop tofloat is a measure of the discharge in liter/second. The float is provided with slantwise slots toenable it to occupy a stable position at the center of tube.

Pressure measuring device:-

A) Dead weight piston gauge

B) Mechanical gauge

A) Dead weight piston gauge:- This is the direct method for precise determination to of a pistonsteady pressure measurement. The instrument consists of a piston & a cylinder of known areaconnected to a fluid pressure on the piston equal to the pressure times the piston area. This forcecan be balanced by weight fitted on the top of the vertical piston. This is the most accuratedevice and used for precision and for calibrating other pressure gauge. The pressure of liquid isbalanced by known weight. Pressure in Kgf/cm2 or KN/m2

B) Mechanical gauge:- By the help of spring or dead weight balanced the liquid column whosepressure is to be measured. In gauge are the liquid exert the force on a movable diaphragm or piston, which is the resisted by a spring of known valve. The intensityof pressure then would be equal to the force F divided by the areaa of the diaphragm or piston P =F/aThey are suited for the measurement of high pressure when it is more then to atmospheres. Themost accurate and reliable region on the scale of mechanical gauge in between 40% & 70% ofthe maximum may give direct pressure reading, portability and wider operating gauge. They canfairly accurate reading if properly calibrated.

1 Bourdon tube pressure gauge

2 Diaphragm pressure gauge

3 Dead weight pressure gauge

Viva Questions:-

1 Define and explain the Newton’s law of viscosity?

2 Define construction of bourdon tube pressure gauge?

3 Define construction of Rotameter?

4 What is meant by calibration?

5 Which type of fluid is used in bourdon tube pressure gauge?

Title of Course: Surveying Practice-II Lab
Course Code: CE 492
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. To learn and understand the concepts and perform the surveying of construction with the help of different methods of surveying like chain surveying, compass surveying, plane table surveying and levelling.
2. To understand and differentiate between compass surveying, plane table surveying, levelling and contouring.
3. To operate the various instruments of surveying like surveyors compass, to measure the distance between any two inaccessible points, to efficiently operate the dumpy levels and understand the level difference between inaccessible points.
4. To set out simple curves using state of the art modern equipment like Total Station and Theodolite.

Learning Outcomes: The students will have a clear understanding of the basic concepts of surveying. They will develop a clear understanding of the various steps of surveying with different instruments. Surveying is the first step before any construction activity and the students will be able to develop the concepts of chain surveying, compass surveying, plane table surveying, levelling and contouring. The students will be able to efficiently perform surveying with the help of modern equipments like Total Station and transit theodolite. The students will be able to set out simple curves as per the theoretical calculations.

Course Contents:
Practicals that must be done in this course are listed below:

1. Traversing by Using Theodolite: Preparation of Gales Table from field data.
2. Traversing by using Total Station.
3. Use of Total Station for levelling and Contouring.
4. Setting out of Simple Curves.

Text Book:
1.Surveying Volume II B.C.Punmia By Laxmi Publications.

PRACTICAL NO: 1

Objective: To measure horizontal angle by method of reiteration

Apparatus: Theodolite, ranging rods and arrows.

Theory: Reiteration is a method of measuring horizontal angles with high precision. It is less

tedious and is generally preferred when there are several angles to be measured at a station. Several angles are measured successively and finally the horizon is closed. Closing the horizon is the process of measuring the angles around a point to obtain a check on their sum which should be equal to 3600.

Procedure:

1. Select a station point O.

2. Set the theodolite at O and do the temporary adjustments. The telescope is adjusted for right face right swing.

3. Set the vernier A to zero using upper clamp. Loosen the lower clamp, direct the telescope to the station point A and bisect A exactly by using the lower clamp and lower tangent screw.

4. Note the vernier readings (A and B).

5. Loosen the upper clamp and turn the telescope clockwise until the point B is exactly bisected.

6. Note the vernier readings (A and B).

7. The mean of the two vernier readings gives the value of <AOB.

8. Bisect all the points successively and note the readings of both verniers at each bisection.

9. Finally close the horizon by sighting the station point A. The A vernier The A vernier should be 3600. If not, note the closing error.

10. Adjust the telescope for left face left swing.

11. Repeat the whole process by turning the telescope in anticlockwise direction.

12. Distribute the closing error proportionately the several observed angles.

13. Take the average of face left and face right observations to give the corresponding horizontal angles.

PRACTICAL NO 2:

Objective: To measure the horizontal angle AOB by repetition method.

Apparatus: Theodolite, ranging rods and arrows.

Theory: The method of repetition is used to measure a horizontal angle to a finer degree of accuracy. By this method, an angle is measured two or more times by allowing the vernier to remain clamped each time at the end of each measurement instead of setting it back at zero when sighting at the previous station. Thus an angle reading is mechanically added several times depending upon the number of repetitions. The average horizontal angle is then obtained by dividing the final reading by the number of repetitions. For very accurate work the method of repetition is used.

Procedure :

1. Select a station point O.

2. Set the theodolite at O and do the temporary adjustments. The telescope is adjusted for right face right swing.

3. Set the vernier A to zero using upper clamp. Loosen the lower clamp, direct the telescope to the station point A and bisect A exactly by using the lower clamp and lower tangent screw.

4. Note the vernier readings (A and B).

5. Loosen the upper clamp and turn the telescope clockwise until the point B is exactly bisected.

6. Note the vernier readings (A and B).

7. The mean of the two vernier readings gives gives the value of <AOB.

8. Loosen the lower clamp and turn the telescope to station point A and bisected A by using the lower clamp and lower tangent screw.

9. Loosen the upper clamp and turn the telescope clockwise until the point B is exactly bisected. Now the vernier reading is twice the value of the angle.

10. Repeat the process for the required number of times (usually 3).

11. The correct value of the angle AOB is obtained by dividing the final reading by the number of repetition.

12. Adjust the telescope for left face left swing.

PRACTICAL NO 3:

Objective - To measure direct angle, deflection angle and magnetic bearing of line by using theodolite

Apparatus: Transit theodolite, ranging rod, peg etc

Procedure:-Set up the theodolite at O and level it accurately set vernier A to 0°0′0″.Loose the lower plate and take back sight on A.

1. Loose upper plate rotate telescope clockwise and bisect B exactly read both vernier.

2. Plunge the telescope turns the instrument about its outer axis and take back sight on A the reading on vernier A will be same as in Step 1.

3. Loose the upper plate, turn the telescope clockwise and again bisect B exactly.

4. Read both vernier. The reading will be twice the previous, <AOB will be obtain by dividing the final reading by 2.

PRACTICAL NO: 4

Objective: - To measure vertical angle between two points using theodolite.

Apparatus: Transit theodolite Tripod, ranging rod, pegs etc.

Procedure: To measure the vertical angle of an object P

1. Set up the instrument over station O and level it carefully with respect to altitude bubble.

2. By means of vertical circle clamp and tangent screw, set 0 of the vertical circle exactly to 0 of the circle.

3. Bring the bubble of the altitude level to the centre of its run by means of foot &clip screw.

4. The line of sight is thus made horizontal.

5. Loose the vertical circle clamp and direct the telescope in vertical plane towards the object P, and bisect exactly using vertical tangent screw.

6. Read both the vernier C and D, the mean of two readings gives angle for that face.

7. Change the face and repeat the above process, and get the face reading.

8. The average of two face values gives exact value of required vertical angle.

PRACTICAL NO 5:

Objective: Setting out of simple circular curve by Rankine method of tangential angle.

Apparatus: Theodolite, ranging rods, pegs, arrows etc.

Theory: A deflection angle to any point on the curve is the angle at P.C between the back tangent and the chord from the P C to that point.

Theory:

T1V= rear tangent

T1 = Point to curve

= the tangential angles or the angles with each of the successive chords

T1A, AB, BC etc. Makes with the respective tangents to the curve at T1, A, B etc

= Total tangential angles of the deflection angles to the points A , B, C etc.

C1, C2, C3 = lengths f the chords T1A, AB, BC etc...

A1A = tangent to the curve at A

= 1719 C /R minutes

For the first chord

= tangential angle for the chord AB

Hence, the deflection angle for any chord is equal to the deflection angle for the previous chord plus the tangential angle for that chord.

Procedure:

1. Set the theodolite at the point of curve T1.

2. With both the plates clamped to zero, direct the theodolite to bisect the point of intersection V. The line of sight is thus in the direction of the rear tangent.

3. Release the vernier plate and set angle 1 on the vernier .The line of sight is thus directed along chord T1A.

4. With zero end of tape pointed at T1 and arrow held at a distance T1A = c along it, swing the tape around T1 till the arrow is bisected by the cross hairs.

5. Thus the first point A is fixed.

6. Set the second deflection angle 2 on the vernier so that the line of sight is directed along T1B.

7. with the zero end of the tape pinned at A, and an arrow held at distance AB = C along it, swing the tape around A till the arrow is bisected by the cross hairs, thus fixing the point B.

8. Repeat steps 4 and 5 till last point is reached.

Result: The simple curve was set by Rankine’s method of tangential angle.

Title of Course: Soil Mechanics-I Lab
Course Code: CE 493
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. The students will be able to differentiate between different types of soils and characteristics of each type of soil.
2. The students will be involved in the collection of the field samples and identification of the types of soils without natural testing.
3. The students will be able to determine the natural moisture content of the soil.

Learning Outcomes: The students will develop a clear understanding of the different types of soils and will be able to identify the types of soils as per the Indian Standards. The students will be able to determine the moisture contents and specific gravity of cohesive soils and cohesion less soils. The students will also develop a clear understanding of the compaction characteristics of the soil.

Course Contents:
Practicals that must be done in this course are listed below:

1. Field identification of different types of soil as per Indian standards [collection of field samples and identifications without laboratory testing, determination of natural moisture content.
2. Determination of specific gravity of i) Cohesionless ii) cohesive soil
3. Determination of Insitu density by core cutter method & sand replacement method.
4. Grain size distribution of cohesionless soil by sieving & finegrained soil by hydrometer analysis.
5. Determination of Atterberg's limits (liquid limit, plastic limit & shrinkage limit).
6. Determination of co- efficient of permeability by constant head permeameter (coarse grained soil) & variable head parameter (fine grained soil).
7. Determination of compaction characteristics of soil.

Text Book:
1.Soil Testing by T.W. Lamb (John willey).
2. 2. SP-36 (Part I- & Part – II).
3. Soil Mechanics Laboratory Manual by Braja Mohan Das, OXFORD UNIVERSITY PRESS.
4. Measurement of Engineering properties of soil by E Saibaba Reddy & K. Rama Sastri. (New age International publication.

EXPERIMENT NO 1: DETERMINATION OF MOISTURE CONTENT.

OBJECTIVE Determine the natural content of the given soil sample.

NEED AND SCOPE OF THE EXPERIMENT

In almost all soil tests natural moisture content of the soil is to be determined. The knowledge of the natural moisture content is essential in all studies of soil mechanics. To sight a few, natural moisture content is used in determining the bearing capacity and settlement. The natural moisture content will give an idea of the state of soil in the field.

DEFINITION

The natural water content also called the natural moisture content is the ratio of the weight of water to the weight of the solids in a given mass of soil. This ratio is usually expressed as percentage.

APPARATUS REQUIRED

1. Non-corrodible air-tight container.

2. Electric oven, maintain the temperature between 1050 C to 1100 C.

3. Desiccator

4. Balance of sufficient sensitivity.

PROCEDURE

1. Clean the container with lid, dry it and weigh it (W1). 2. Take a specimen of the sample in the container and weigh with lid (W2). 3. Keep the container in the oven with lid removed. Dry the specimen to constant weight maintaining the temperature between 1050 C to 1100 C for a period varying with the type of soil but usually 16 to 24 hours. 4. Record the final constant weight (W3) of the container with dried soil sample. Peat and other organic soils are to be dried at lower temperature (say 600) possibly for a longer period.

Certain soils contain gypsum which on heating loses its water if crystallization. If itb is suspected that gypsum is present in the soil sample used for moisture content determination it shall be dried at not more than 800 C and possibly for a longer time.

OBSERVATIONS AND RECORDING

Data and observation sheet for water content determination

EXPERIMENT NO 2: DETERMINATION OF SPECIFIC GRAVITY

OBJECTIVE Determine the specific gravity of soil fraction passing 4.75 mm I.S sieve by density bottle.

NEED AND SCOPE The knowledge of specific gravity is needed in calculation of soil properties like void ratio, degree of saturation etc.

DEFINITION

Specific gravity G is defined as the ratio of the weight of an equal volume of distilled water at that temperature both weights taken in air.

APPARATUS REQUIRED

1. Density bottle of 50 ml with stopper having capillary hole. 2. Balance to weigh the materials (accuracy 10gm). 3. Wash bottle with distilled water. 4. Alcohol and ether.

PROCEDURE

1. Clean and dry the density bottle

a. wash the bottle with water and allow it to drain.

b. Wash it with alcohol and drain it to remove water.

c. Wash it with ether, to remove alcohol and drain ether.

2. Weigh the empty bottle with stopper (W1)

3. Take about 10 to 20 gm of oven soil sample which is cooled in a desiccator. Transfer it to the bottle. Find the weight of the bottle and soil (W2).

4. Put 10ml of distilled water in the bottle to allow the soil to soak completely. Leave it for about 2 hours.

5. Again fill the bottle completely with distilled water put the stopper and keep the bottle

under constant temperature water baths (Tx0).

6. Take the bottle outside and wipe it clean and dry note. Now determine the weight of the bottle and the contents (W3).

7. Now empty the bottle and thoroughly clean it. Fill the bottle with only disttiled water and weigh it. Let it be W4 at temperature (Tx0 C).

8. Repeat the same process for 2 to 3 times, to take the average reading of it.

EXPERIMENT NO 3: FIELD DENSITY TEST

SAND REPLACEMENT METHOD

OBJECTIVE Determine the in situ density of natural or compacted soils using sand pouring cylinders.

NEED AND SCOPE The in situ density of natural soil is needed for the determination of bearing capacity of soils, for the purpose of stability analysis of slopes, for the determination of pressures on underlying strata for the calculation of settlement and the design of underground structures.

It is very quality control test, where compaction is required, in the cases like embankment and pavement construction.

APPARATUS REQUIRED 1. Sand pouring cylinder of 3 litre/16.5 litre capacity, mounted above a pouring come and separated by a shutter cover plate. 2. Tools for excavating holes; suitable tools such as scraper tool to make a level surface. 3. Cylindrical calibrating container with an internal diameter of 100 mm/200 mm and an internal depth of 150 mm/250 mm fitted with a flange 50 mm/75 mm wide and about 5 mm surrounding the open end. 4. Balance to weigh unto an accuracy of 1g. 5. Metal containers to collect excavated soil. 6. Metal tray with 300 mm/450 mm square and 40 mm/50 mm deep with a 100 mm/200 mm diameter hole in the centre. 7. Glass plate about 450 mm/600 mm square and 10mm thick. 8. Clean, uniformly graded natural sand passing through 1.00 mm I.S.sieve and retained on the 600micron I.S.sieve. It shall be free from organic matter and shall have been oven dried and exposed to atmospheric humidity. 9. Suitable non-corrodible airtight containers. 10. Thermostatically controlled oven with interior on non-corroding material to maintain the temperature between 1050C to 1100C. 11. A dessicator with any desiccating agent other than sulphuric acid.

THEORY

By conducting this test it is possible to determine the field density of the soil. The moisture content is likely to vary from time and hence the field density also. So it is required to report the test result in terms of dry density. The relationship that can be established between the dry density with known moisture content is as follows:

PROCEDURE

Calibration of the Cylinder

1. Fill the sand pouring cylinder with clean sand so that the level of the sand in the cylinder is within about 10 mm from the top. Find out the initial weight of the cylinder plus sand (W1) and this weight should be maintained constant throughout the test for which the calibration is used.

2. Allow the sand of volume equal to that of the calibrating container to run out of the cylinder by opening the shutter, close the shutter and place the cylinder on the glass sand takes place in the cylinder close the shutter and remove the cylinder carefully. Weigh the sand collected on the glass plate. Its weight(W2) gives the weight of sand filling the cone portion of the sand pouring cylinder. Repeat this step at least three times and take the mean weight (W2) Put the sand back into the sand pouring cylinder to have the same initial constant weight (W1) Determination of Bulk Density of Soil

3. Determine the volume (V) of the container be filling it with water to the brim. Check this volume by calculating from the measured internal dimensions of the container.

4. Place the sand poring cylinder centrally on yhe of the calibrating container making sure that constant weight (W1) is maintained. Open the shutter and permit the sand to run into the container. When no further movement of sand is seen close the shutter, remove the pouring cylinder and find its weight (W3).

Determination of Dry Density of Soil In Place

5. Approximately 60 sqcm of area of soil to be tested should be trimmed down to a level surface,approximately of the size of the container. Keep the metal tray on the level surface and excavate a circular hole of volume equal to that of the calibrating container. Collect all the excavated soil in the tray and find out the weight of the excavated soil (Ww). Remove the tray, and place the sand pouring cylinder filled to constant weight so that the base of the cylinder covers the hole concentrically. Open the shutter and permit the sand to run into the hole. Close the shutter when no further movement of the sand is seen. Remove the cylinder and determine its weight (W3).

6. Keep a representative sample of the excavated sample of the soil for water content determination.

EXPERIMENT NO 4: DIRECT SHEAR TEST

Objective

To determine the shearing strength of the soil using the direct shear apparatus.

NEED AND SCOPE

In many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are required for the design. Direct shear test is used to predict these parameters quickly. The laboratory report cover the laboratory procedures for determining these values for cohesionless soils.

PLANNING AND ORGANIZATION

Apparatus

1. Direct shear box apparatus

2. Loading frame (motor attached).

3. Dial gauge.

4. Proving ring.

5. Tamper.

6. Straight edge.

7. Balance to weigh upto 200 mg.

8. Aluminum container.

9. Spatula.

KNOWLEDGE OF EQUIPMENT:

Strain controlled direct shear machine consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation and volume changes. A two piece square shear box is one type of soil container used.

A proving ring is used to indicate the shear load taken by the soil initiated in the shearing plane.

PROCEDURE

1. Check the inner dimension of the soil container.

2. Put the parts of the soil container together.

3. Calculate the volume of the container. Weigh the container.

4. Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil.

5. Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of the soil.

6. Make the surface of the soil plane.

7. Put the upper grating on stone and loading block on top of soil.

8. Measure the thickness of soil specimen.

9. Apply the desired normal load.

10.Remove the shear pin.

11. Attach the dial gauge which measures the change of volume.

12. Record the initial reading of the dial gauge and calibration values.

13. Before proceeding to test check all adjustments to see that there is no connection between two parts except sand/soil.

14. Start the motor. Take the reading of the shear force and record the reading.

15.Take volume change readings till failure.

16. Add 5 kg normal stress 0.5 kg/cm2 and continue the experiment till failure

17. Record carefully all the readings. Set the dial gauges zero, before starting the experiment

GENERAL REMARKS

1. In the shear box test, the specimen is not failing along its weakest plane but along a predetermined or induced failure plane i.e. horizontal plane separating the two halves of the shear box. This is the main draw back of this test. Moreover, during loading, the state of stress cannot be evaluated. It can be evaluated only at failure condition i.e Mohr s circle can be drawn at the failure condition only. Also failure is progressive.

2. Direct shear test is simple and faster to operate. As thinner specimens are used in shear box, they facilitate drainage of pore water from a saturated sample in less time. This test is also useful to study friction between two materials one material in lower half of box and another material in the upper half of box.

3. The angle of shearing resistance of sands depends on state of compaction, coarseness of grains, particle shape and roughness of grain surface and grading. It varies between 28o(uniformly graded sands with round grains in very loose state) to 46o(well graded sand with angular grains in dense state).

4. The volume change in sandy soil is a complex phenomenon depending on gradation, particle shape, state and type of packing, orientation of principal planes, principal stress ratio, stress history, magnitude of minor principal stress, type of apparatus, test procedure, method

of preparing specimen etc. In general loose sands expand and dense sands contract in volume on shearing. There is a void ratio at which either expansion contraction in volume takes place. This void ratio is called critical void ratio. Expansion or contraction can be inferred from the movement of vertical dial gauge during shearing.

5. The friction between sand particle is due to sliding and rolling friction and interlocking action.

The ultimate values of shear parameter for both loose sand and dense sand approximately attain the same value so, if angle of friction value is calculated at ultimate stage, slight disturbance in density during sampling and preparation of test specimens will not have much effect.

EXPERIMENT NO 5: CONSOLIDATION TEST

OBJECTIVE

To determine the settlements due to primary consolidation of soil by conducting one dimensional test.

NEED AND SCOPE

The test is conducted to determine the settlement due to primary consolidation. To determine :

i. Rate of consolidation under normal load.

ii. Degree of consolidation at any time.

iii. Pressure-void ratio relationship.

iv. Coefficient of consolidation at various pressures.

v. Compression index.

From the above information it will be possible for us to predict the time rate and extent of settlement of structures founded on fine-grained soils. It is also helpful in analyzing the stress history of soil. Since the settlement analysis of the foundation depends mainly on the values determined by the test, this test is very important for foundation design.

PLANNING AND ORGANIZATION

1. Consolidometer consisting essentially

a) A ring of diameter = 60mm and height = 20mm

b) Two porous plates or stones of silicon carbide, aluminum oxide or porous metal.

c) Guide ring.

d) Outer ring.

e) Water jacket with base.

f) Pressure pad.

g) Rubber basket.

2. Loading device consisting of frame, lever system, loading yoke dial gauge fixing device and weights.

3. Dial gauge to read to an accuracy of 0.002mm.

4. Thermostatically controlled oven.

5. Stopwatch to read seconds.

6. Sample extractor.

7. Miscellaneous items like balance, soil trimming tools, spatula, filter papers, sample containers.

PRINCIPAL INVOLVED

When a compressive load is applied to soil mass, a decrease in its volume takes place, the decease in volume of soil mass under stress is known as compression and the property of soil mass pertaining to its tendency to decrease in volume under pressure is known as compressibility. In a saturated soil mass having its void filled with incompressible water, decrease in volume or compression can take place when water is expelled out of the voids. Such a compression resulting from a long time static load and the consequent escape of pore water is termed as consolidation.

Then the load is applied on the saturated soil mass, the entire load is carried by pore water in the beginning. As the water starts escaping from the voids, the hydrostatic pressure in water gets gradually dissipated and the load is shifted to the soil solids which increases effective on them, as a result the soil mass decrease in volume. The rate of escape of water depends on the permeability of the soil.

1) From the sample tube, eject the sample into the consolidation ring. The sample should project about one cm from outer ring. Trim the sample smooth and flush with top and bottom of the ring by using a knife. Clean the ring from outside and keep it ready from weighing.

2) Remoulded sample :

a) Choose the density and water content at which samples has to be compacted from the moisture density relationship.

b) Calculate the quantity of soil and water required to mix and compact.

c) Compact the specimen in compaction mould in three layers using the standard rammers.

d) Eject the specimen from the mould using the sample extractor.

PROCEDURE

1. Saturate two porous stones either by boiling in distilled water about 15 minute or by keeping them submerged in the distilled water for 4 to 8 hrs. Wipe away excess water. Fittings of the consolidometer which is to be enclosed shall be moistened.

2. Assemble the consolidometer, with the soil specimen and porous stones at top and bottom of specimen, providing a filter paper between the soil specimen and porous stone. Position the pressure pad centrally on the top porous stone.

3. Mount the mould assembly on the loading frame, and center it such that the load applied is axial.

4. Position the dial gauge to measure the vertical compression of the specimen. The dial gauge holder should be set so that the dial gauge is in the begging of its releases run, allowing sufficient margin for the swelling of the soil, if any.

5. Connect the mould assembly to the water reservoir and the sample is allowed to saturate. The level of the water in the reservoir should be at about the same level as the soil specimen.

6. Apply an initial load to the assembly. The magnitude of this load should be chosen by trial, such that there is no swelling. It should be not less than 50 g/cm3 for ordinary soils & 25 g/cm2 for very soft soils. The load should be allowed to stand until there is no change in dial gauge readings for two consecutive hours or for a maximum of 24 hours.

7. Note the final dial reading under the initial load. Apply first load of intensity 0.1 kg/cm2 start the stop watch simultaneously. Record the dial gauge readings at various time intervals. The dial gauge readings are taken until 90% consolidation is reached. Primary consolidation is gradually reached within 24 hrs.

8. At the end of the period, specified above take the dial reading and time reading. Double the load intensity and take the dial readings at various time intervals. Repeat this procedure fir successive load increments. The usual loading intensity are as follows :

a. 0.1, 0.2, 0.5, 1, 2, 4 and 8 kg/cm2.

9. After the last loading is completed, reduce the load to 60 % of the value of the last load and allow it to stand for 24 hrs. Reduce the load further in steps of the previous intensity till an intensity of 0.1 kg/cm2 is reached. Take the final reading of the dial gauge.

10. Reduce the load to the initial load, keep it for 24 hrs and note the final readings of the dial gauge.

11. Quickly dismantle the specimen assembly and remove the excess water on the soil specimen in oven, note the dry weight of it.

In the log fitting method, a plot is made between dial reading and logarithmic of time, the time corresponding to 50% consolidation is determined.

In the square root fitting method, a plot is made between dial readings and square root of time and the time corresponding to 90% consolidation is determined. The values of Cv are recorded in table

EXPERIMENT NO 6: UNCONFINED COMPRESSION TEST

OBJECTIVE determine shear parameters of cohesive soil

NEED AND SCOPE OF THE EXPERIMENT

It is not always possible to conduct the bearing capacity test in the field. Some times it is cheaper to take the undisturbed soil sample and test its strength in the laboratory. Also to choose the best material for the embankment, one has to conduct strength tests on the samples selected. Under these conditions it is easy to perform the unconfined compression test on undisturbed and remoulded soil sample. Now we will investigate experimentally the strength of a given soil sample.

PLANNING AND ORGANIZATION

We have to find out the diameter and length of the specimen.

EQUIPMENT

1. Loading frame of capacity of 2 t, with constant rate of movement. What is the least count of the dial gauge attached to the proving ring!

2. Proving ring of 0.01 kg sensitivity for soft soils; 0.05 kg for stiff soils.

3. Soil trimmer.

4. Frictionless end plates of 75 mm diameter (Perspex plate with silicon grease coating).

5. Evaporating dish (Aluminum container).

6. Soil sample of 75 mm length.

7. Dial gauge (0.01 mm accuracy).

8. Balance of capacity 200 g and sensitivity to weigh 0.01 g.

9. Oven, thermostatically controlled with interior of non-corroding material to maintain the temperature at the desired level. What is the range of the temperature used for drying the soil

10. Sample extractor and split sampler.

11. Dial gauge (sensitivity 0.01mm).

12. Verniercalipers

EXPERIMENTAL PROCEDURE (SPECIMEN)

1. In this test, a cylinder of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen as called Unconfined compressive strength of the soil.

Preparation of specimen for testing

A. Undisturbed specimen

1. Note down the sample number, bore hole number and the depth at which the sample was taken.

2. Remove the protective cover (paraffin wax) from the sampling tube.

3. Place the sampling tube extractor and push the plunger till a small length of sample moves out.

4. Trim the projected sample using a wire saw.

5. Again push the plunger of the extractor till a 75 mm long sample comes out.

6. Cutout this sample carefully and hold it on the split sampler so that it does not fall.

7. Take about 10 to 15 g of soil from the tube for water content determination.

8. Note the container number and take the net weight of the sample and the container.

9. Measure the diameter at the top, middle, and the bottom of the sample and find the average and record the same.

10. Measure the length of the sample and record.

11. Find the weight of the sample and record.

B. Moulded sample

1. For the desired water content and the dry density, calculate the weight of the dry soil Ws required for preparing a specimen of 3.8 cm diameter and 7.5 cm long.

2. Add required quantity of water Ww to this soil.

Ww = WS *W/100 gm

3. Mix the soil thoroughly with water.

4. Place the wet soil in a tight thick polythene bag in a humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.

5. After 24 hours take the soil from the humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.

6. Place the lubricated moulded with plungers in position in the load frame.

7. Apply the compressive load till the specimen is compacted to a height of 7.5 cm.

8. Eject the specimen from the constant volume mould.

9. Record the correct height, weight and diameter of the specimen.

Test procedure

1. Take two frictionless bearing plates of 75 mm diameter.

2. Place the specimen on the base plate of the load frame (sandwiched between the end plates).

3. Place a hardened steel ball on the bearing plate.

4. Adjust the center line of the specimen such that the proving ring and the steel ball are in the same line.

5. Fix a dial gauge to measure the vertical compression of the specimen.

6. Adjust the gear position on the load frame to give suitable vertical displacement.

7. Start applying the load and record the readings of the proving ring dial and compression dial for every 5 mm compression.

8. Continue loading till failure is complete.

9. Draw the sketch of the failure pattern in the specimen.