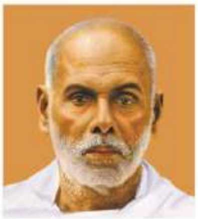
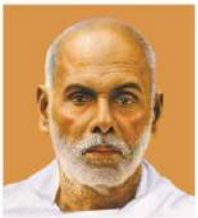


SAMPLES OF LAB MANUALS

Est. 2003

Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307



DEPARTMENT OF CIVIL ENGINEERING

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY, KERALA

DEPARTMENT OF CIVIL ENGINEERING

SEVENTH SEMESTER
[2022]

LAB RECORD

CEL 411: ENVIRONMENTAL ENGINEERING LAB

HOD

Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY, PAYYANUR
KANNUR

LAB RECORD

CEL411
ENVIRONMENTAL ENGINEERING LAB

Name: ....

PRN..Semester:..

Registration No..

Certified that this is the bonafide record of the work done in "CEL411 Environmental Engineering Lab" of Department of Civil Engineering at Sree Narayana Guru College of Engineering and Technology, Payyanur, Kannur by

Mr./Ms..

......

for the award of the Degree of Bachelor of Technology in Civil Engineering of A P J Abdul Kalam Technological University, Kerala.

Place:

Date:

Staff in-charge

Internal Examiner **Head of the Department** **External Examiner**

Dr. LEENA A. V.
PRINCIPAL
SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY, PAYYANUR
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DEPARTMENT OF CIVIL ENGINEERING

VISION OF THE DEPARTMENT

- To pursue excellence in Civil Engineering and technology towards sustainable development and to bring out professionals with futuristic vision.

MISSION OF THE DEPARTMENT

- To mould students into outstanding Civil Engineers by inculcating technological competency through conducive environment for education and committed faculty.
- To contribute to nation building and development of society through innovation and design of sustainable infrastructure.
- To enhance employability, imbibe professional ethics, encourage entrepreneurship and equip for higher education.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1:-To prepare students to excel and succeed in Civil Engineering profession through quality education.

PEO2:-To provide students with a robust foundation in mathematics, basic sciences and engineering required to solve real life problems as well as also to pursue higher studies and research.

PEO3:-To enable students to comprehend, design, analyze and create sustainable infrastructure through state of the art tools and technologies.

PEO4:-To inculcate professionalism, ethics, communication skills, teamwork, multi-disciplinary approach and ability to relate civil engineering with socio economic dynamics for overall development of students.

PEO5:-To empower the students through intellectually inspiring academic environment to become successful engineers, scientists, technocrats, administrators or entrepreneurs.

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PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering Fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriateonsideration for the public health and safety, and the cultural, societal, and environmentalconsiderations.

4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1:-Demonstrate in-depth knowledge in the analysis, design, experimental research and construction aspects of civil engineering structures.

PSO2:-Apply the concept of sustainability in various fields of civil engineering like construction technology, transportation engineering, soil conservation, water resource engineering and waste management.

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ASSESSMENT PATTERN

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 15 marks

Continuous Assessment: 30 marks

Internal Test (Immediately before the second series test): 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work: 15 Marks

(b) Implementing the work/Conducting the experiment: 10 Marks

(c) Performance, result and inference (usage of equipment and troubleshooting): 25 Marks

(d) Viva voce: 20 marks

(e) Record: 5 Marks

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SYLLABUS

CEL 411	ENVIRONMENTAL ENGINEERING LAB	CATEGORY	L	T	P	CREDIT	Year of Introduction
		PCC	0	0	3	2	2019

Preamble: This lab provides the knowledge on tests used to analyse the physio-chemical and bacteriological properties of water and explains the various method followed in the test along with its suitability as a drinking water.

Prerequisite: CET 304 Environmental Engineering

Course Outcomes: After the completion of the course, the student will be able to:

Course outcome	Course Outcome Description
CO1	Analyse various physico-chemical and biological parameters of water
CO2	Compare the quality of water with drinking water standards and recommend its suitability for drinking purposes

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	-	3	3	-	-	-	-	3
CO2	3	3	3	1	-	3	3	-	-	-	-	3

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List of Exercises

1. Determination of pH, Electrical Conductivity and Turbidity*
2. Determination of TS, TDS and TSS, TVS *
3. Determination of Alkalinity and Acidity *
4. Determination of Hardness *
5. Determination of Chlorides
6. Determination of Total Iron
7. Determination of Biochemical Oxygen Demand*
8. Determination of Chemical Oxygen Demand*
9. Optimum Coagulant dosage*
10. Break point Chlorination *
11. Determination of Available Chlorine in a sample of bleaching powder
12. Determination of Sulphates
13. Determination of Fluoride
14. Determination of Dissolved Oxygen*
15. Determination of nitrates
16. Determination of phosphates
17. Determination of any two Heavy Metal concentration
18. Total coliforms *

Note: * mandatory

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References

1. Standard Methods for the Examination of Water and Wastewater, 23rd edition, American Public Health Association, American Water Works Association, Water Environment Federation, 2017.

2. Water Supply Engineering, 33rd edition, Santhosh Kumar Garg, Khanna publishers.

3. Sewage Disposal and Air Pollution Engineering, 39th edition, Santhosh Kumar Garg, Khanna publishers.

4. IS: 10500:2012 Drinking Water - Specification, Second revision, Bureau of Indian Standards, 2012.

SAFETY RULES AND UNSAFE PRACTICES

GENERAL SAFETY RULES

Remember, that "accidents do not occur, they are caused". With this in mind, strictly follow the general safety rules given below and safe practices indicated in brief under each section.

1. Safety First, Work Next
2. Know your job and follow instructions.
3. Avoid wearing clothing that might catch, moving or rotating parts. Long sleeves of shirts, long hair, neck tie and jewelers are definite hazards in the shop.
4. Wear safety shoes. Do not wear canvas shoes; they give no resistance to hard objects dropped on the feet.
5. Keep the area around the machine or work clean.
6. Keep away from revolving work.
7. Be sure that all guards are in place.
8. One person only should operate the machine control
9. Use tools correctly and do not use them if they are not in proper working condition.
10. Wear safety goggle when working in areas, where sparks or chips of metal are flying.
11. Never
    (a) operate a machine unless you are authorized to do so.
    (b) Start a machine unless you know how to stop it.
    (c) Walk away leave a machine running.
12. Place all belongings out of the work area.
13. Do not obstruct doorways.
14. Do not play in the lab

INSTRUCTIONS:

- Any 12 of the 18 experiments included in the list of experiments need to be performed mandatorily.

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- Virtual Lab facility cannot be used to substitute the conduct of these mandatory experiments.
- Periodic maintenance and calibration of various testing instruments needs to be made.
- Practical examination to be conducted covering entire syllabus given below.
- Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

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INDEX					
Sl No.	**Exercise**	**Date**	**Page**	**Mark**	**Remarks**
1	Determination of pH, Electrical Conductivity and Turbidity				
2	Determination of TS, TDS and TSS, TVS				
3	Determination of Alkalinity and Acidity				
4	Determination of Hardness				
5	Determination of Chlorides				
6	Determination of Biochemical Oxygen Demand				
7	Determination of Chemical Oxygen Demand				
8	Optimum Coagulant dosage				
9	Break point Chlorination				
10	Determination of Available Chlorine in a sample of bleaching powder				
11	Determination of Dissolved Oxygen				
12	Total coliforms				

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Exercise:1

Date:

DETERMINATION OF pH, Electrical Conductivity and Turbidity

(i) pH

It is the positive Hydrogen ion concentration. The pH scale is used to express the concentration of hydrogen ions in a liquid. The pH scale ranges from 1 to 14 i.e. most acid to most alkaline. The hydrogen ion concentration is an important parameter in determining the quality of water and wastewater. The pH of the water/wastewater sample is measured by pH meter. A pH meter consists of a measuring probe connected to electronic meter that measures and displays the pH reading.

ENVIRONMENTAL SIGNIFICANCE

Determination of pH is one of the important objectives in biological treatment of the wastewater. In anaerobic treatment, if the pH goes below 5 due to excess accumulation of acids, the process is severely affected. Shifting of pH beyond 5 to 10 upsets the aerobic treatment of the wastewater. In these circumstances, the pH is generally adjusted by addition of suitable acid or alkali to optimize the treatment of the wastewater. pH value or range is of immense importance for any chemical reaction. Chemical coagulation, disinfection, water softening and corrosion control are governed by pH adjustment.

Lower value of pH below 4 will produce sour taste and higher value above 8.5 a bitter taste. Higher values of pH hasten the scale formation

AIM

To determine the pH of the given water sample.

HOD

APPARATUS

pH meter, Beaker.

PRINCIPLE

The pH electrode used in the pH measurement is a combined glass electrode. It consists of sensing half-cell and reference half-cell, together form an electrode system. The sensing half-cell is a thin pH sensitive semi permeable membrane, separating two solutions, viz., the outer solution, the sample to be analyzed and the internal solution enclosed inside the glass membrane and has a known pH value. An electrical potential is developed inside and another electrical potential is developed outside, the difference in the potential is measured and is given as the pH of the sample.

OBSERVATIONS AND CALCULATIONS

Sample No.	pH	
	pH meter	pH paper

PROCEDURE

1. Rinse the probe with distilled water. Calibrate the pH meter using reference solution.

2. Rinse the probe with sample and dip the pH measuring probe in sample and read the value of pH on the screen of the pH meter.

3. Rinse the probe with distilled/deionized water between samples.

4. Thoroughly rinse the probe in distilled water after measurement, keep it in distilled water when not in use.

(II) ELECTRICAL CONDUCTIVITY

The electrical conductivity (EC) is a measure of the capacity of a substance or solution to carry an electrical current. The conductivity is represented by reciprocal value of electrical resistance in ohms relative to cubic centimeter of water at 25oC. The measured EC value is used as an alternate method to estimate the total dissolved solids (TDS) concentration of the sample. EC is represented by the symbol 'k' and its units are millisiemens per meter (mS/m) or micromhos per centimeter [μmho/cm].

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ENVIRONMENTAL SIGNIFICANCE

Measuring conductivity is a quick and easy way to estimate the amount of total dissolved solids (TDS) in natural waters, since most of these solids dissolve to form ions. Whereas total dissolved solids can include organic as well as inorganic molecules, conductivity depends only upon dissolved ions. Conductivity measurements can also be a useful tool for monitoring the inflow of saline water in estuaries and identifying sources of pollution, such as mining or industrial wa ste or agricultural runoff.

Municipal water supplies are monitored for conductivity, as increased dissolved solids in the water supply can create hard water, add scale build-up to plumbing, and change the taste of the water.

AIM

To determine the turbidity of the given water sample.

PRINCIPLE

Conductivity is determined using the distance between the electrodes and their surface area. According to Ohm's law, the current through a conductor between two points is directly proportional to the potential difference across the two points.

APPARATUS

Conductivity meter, small beakers

REAGENT

Distilled water or de-ionized water: The water should have an electrical conductivity of less than 0.01 mS/m (< 0.1 μmho/cm). Boil the water shortly before use to minimize CO2 content (equal to atmospheric equilibrium).

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0.01M Standard potassium chloride solution (KCl): Dissolve 745.6 mg anhydrous KCl (dried 1 hour at 180 °C) in conductivity water and dilute to 1000 ml. This solution has an electrical conductivity of 141.2 mS/m at 25o C.

PROCEDURE

1. Rinse conductivity cell with 0.01M KCl solution. Calibrate the conductivity meter using the KCl reference solution to obtain cell constant.

2. Measure the electrical conductivity of the 0.01M KCl solution at room temperature.

3. Rinse cell with sample and measure the electrical conductivity of the sample.

4. Rinse the cell with deionized water between samples.

5. Thoroughly rinse the cell in distilled water after measurement, keep it in distilled water when not in use.

CALCULATIONS

The conductance (G in μmho) of standard potassium chloride (KCl) solution is measured and from the corresponding conductivity, a cell constant 'C' is calculated by the expression: $C=kG$

For 0.01 N KCl solution the 'k' value is 1412.

$EC= Gs*$ (μmho/cm)

where Gs= measured conductance of the given sample.

The TDS of an unknown sample is calculated using the following relationship:

$TDS\ (mg/l) = \quad C\ x\ EC$ (μmho/cm)

where C is empirical constant (it varies between 0.55 to 0.9, depending upon the soluble solids present in water).

(III) TURBIDITY

Turbidity is a measure of suspended matter that affects the light scattering/light absorption properties of water. Jackson (light absorption principle) and Nephelometric (intensity light scattering principle) meters are mostly used to measure turbidity of

1. Switch on turbidity meter and wait for few minutes till the instrument warms up.

2. Shake the standard solution present in the cell/bottle before keeping it in sample ch amber/holder and measure the turbidity of the reference standard solutions.

3. Any deviation in reading of the reference solution, calibrate the instrument using calibration switch.

4. Shake the sample before keeping it in sample chamber/holder and note down the turbidity of the sample.

RESULT

Turbidity= NTU

Electrical conductivity = μS

pH =

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SCORING SHEET

No	Performance criteria	Excellent-5/10	Good-4/8	Satisfactory -3/6	Poor	Marks
1	**General understanding of the exercise (5)**	Clear understanding of the experiment and ability to apply the concept in practical situations independently. (5)	Clear understanding of the experiment and ability to apply the concept in practical situations with guidance (4)	Ambiguity in understanding of the experiment and ability to apply the concept in practical situations with guidance. (3)	Lack Clarity in the concept and not able to apply the concept in practical situation. (2)	
2	**Conduct of exercise (10)**	Carries out systematically in a professional manner (10)	Carries out systematically with guidance (8)	Carries out in a fairly systematical way with guidance (6)	Carries out in a poorly systematic way (4)	
3	**Output (10)**	Accurate results in first attempt independently (10)	Accurate results with guidance (8)	Fairly accurate result (6)	Poorly accurate result (4)	
4	**Viva(5)**	Accurate and clear answers (5)	Fairly accurate answers (3)	Vague answers (2)	Wrong answers (0)	
					TOTALMARKS (30)	

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CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:2

Date:

DETERMINATION OF TS,TDS AND TSS,TVS

Solids refers to the residue remaining after a water/waste water sample has been evaporated and dried at a specified temperature (103-105°C). High concentration of total solids will make drinking water unpalatable and might have an adverse effect on human beings. The main source of solids in water includes industrial discharge, sewage treatment plant, fertilizers, road runoff, soil erosion etc.

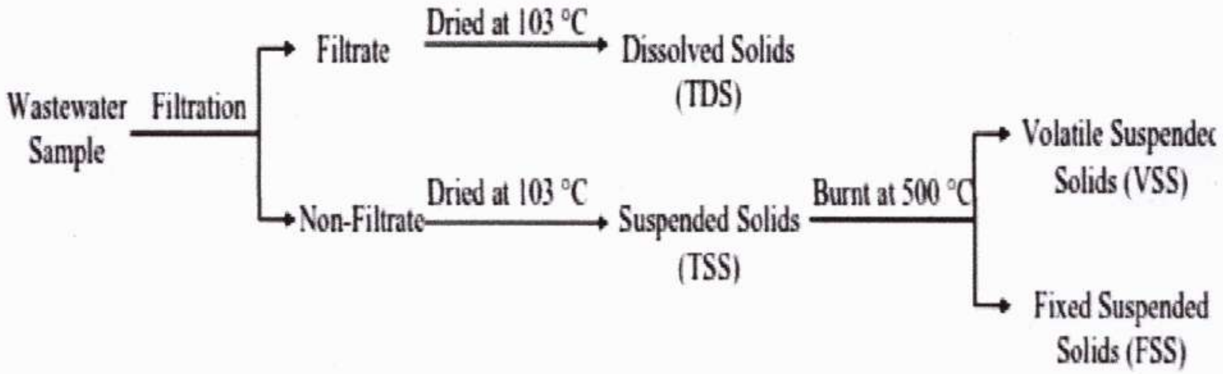
Total solids (TS) consist of total suspended solids and dissolved solids. Total dissolved solids (TDS) are mainly due to the organic matter present in solution in water. The main constituents are calcium, magnesium, sodium and potassium. Hardness, scaly deposits, sediments are some the effects caused by TDS. Total suspended solids (TSS) are the materials that are retained in the filter paper when the TDS is filtered.

The term **fixed solids** (FS) are applied to the residue remaining after evaporation, drying at 103°c followed by ignition at 600°c. The loss of weight in oxidation and volatilization on ignition is called **volatile solids** (VS). Determination of fixed and volatile solids does not distinguish precisely between inorganic and organic matter because loss on ignition is not confined to organic matter. It includes losses on volatilization of some mineral salts. The ratio of the VS to FS is often used to characterize the waste water with respect to amount of organic matter present.

The term **settleable solid** refers to the materials in suspension settled due to gravitational force under quiescent condition. Settleable solids in surface and saline waters as well as domestic and industrial wastes may be determined and expressed in ml/l. It can be either determined by volumetric and gravimetric method. It is usually conducted in Imhoff cone which is graduated glass cone of 1L capacity with a narrow apex.

ENVIRONMENTAL SIGNIFICANCE

Total solids measurements can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activities, sewage treatment plant discharges, and other sources. Total solids also affect water clarity. Higher solids decrease the passage of light through water, thereby slowing more rapidly and hold more heat; this, in turn, might adversely affect photosynthesis by aquatic plants.



Although the waste water or sewage normally contains 99.9 percent of water and only 0.1 percent of solids, but it is the solids that have the nuisance value. The amount of solids in wastewater is frequently used to describe the strength of the water. The more solids present in a particular wastewater, the stronger that wastewater will be. The environmental impacts of solids in all forms have detrimental effects on quality since they cause putrefaction problems.

Dissolved minerals, gases and organic constituents may produce aesthetically displeasing color, taste and odor. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens. In industries, the use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of the product.

AIM

To find the total, suspended, dissolved, volatile, fixed, settleable solids present in the given sample.

PRINCIPLE

The measurement of solids is by means of the gravimetric procedure. The various forms of solids are determined by weighing after the appropriate handling procedures. The total solids concentration of a sample can be found directly by weighing the sample before and after drying at 103°C. However, the remaining forms, TDS and TSS require filtration of the sample. For liquid samples, all these solids levels are reported in mg/L.

APPARATUS

Evaporating dishes/porcelain dish or crucible, drying oven, desiccator, weighing balance, Wattman filter paper, muffle furnace, filtration apparatus, Imhoff cone.

OBSERVATIONS AND CALCULATIONS

Total solids, mg/L = $(A-B)*1000$

where

A= weight of dish + residue, mg after evaporation and drying of sample at 103°C

B = weight of dish, mg

V = volume of sample (mL)

Total dissolved solids, mg/L =$(A-B)V*1000$

where

A= Final weight of the dish, mg

B = weight of dish, mg

V = volume of sample (mL)

Total suspended solids, mg/L = $(C-D)*1000$

where

C= final weight of the filter paper containing the residue (mg)

D= initial weight of the filter paper (mg)

V= volume of sample (mL)

Total volatile solids, mg/L = $(A-B)*1000$

where

A= weight of dish + residue, mg after evaporation and drying of sample at 103oC

B = Final weight of the dish, mg after evaporation of sample at 600°c

V = volume of sample (mL)

Total solids, mg/L = $(A-B)*1000$ =

=

Total dissolved solids, mg/L =$(A-B)V*1000$ =

=

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Total suspended solids, mg/L = $(C-D)*1000$=

=

Total volatile solids, mg/L = $(A-B)*1000$=

=

PROCEDURE

(i) Total solids:

1. Dry evaporating dish at 104 ±1°C for 1 hour, cool and store in a desiccator.

2. Weigh the dish immediately before use. Note down the weight as B.

3. Stir sample with a magnetic stirrer. While stirring, pipette a measured volume into the pre-weighed evaporating dish using a wide bore pipette.

4. Evaporate the sample to dryness in an oven at 104 ±1°C.If necessary, add successive portions to the same dish after evaporation.

5. To prevent splattering, the oven temperature may be lowered initially by 2°C below boiling point and raised to 104°C after evaporation for 1 h. Cool in a desiccator and note down the weight as A.

(ii) Total dissolved solids:

1. Measure the empty weight of porcelain dish and note down the reading as B.

2. Take known quantity of sample and pass it through the filter paper and collect the filtrate.

3. Dry the filtrate sample in oven at 103ºC and cooled in a dessicator and note down the final weight as A.

(iii) Total suspended solids:

1. Measure the empty weight of filter paper and note down reading as D.

2. Dry the filter paper with filtered sample in oven at 103ºC. Then cool it in a dessicator and note down the final weight as C.

(iv)Total Volatile solids

1. Keep the sample which is oven dried (sample used total solids, whose weight=A) in muffle furnace at a temperature of 600ºC for 1 hour.

2. Cool the sample and note down the final weight as B. This will give the amount of volatile solids.

	Concentration (mg/L)
TS	
TDS	
TSS	
TVS	

RESULT

1). Total solids (TS) present in the given sample =…………..

2). Total dissolved solids (TDS) present in the given sample =…….

3). Total suspended solids (TSS) present in the given sample =……..

4). Total volatile solids (TVS) present in the given sample =…………..

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SCORING SHEET

No	Performance criteria	Excellent-5/10	Good-4/8	Satisfactory - 3/6	Poor	Marks
1	**General understanding of the exercise (5)**	Clear understanding of the experiment and ability to apply the concept in practical situations independently. (5)	Clear understanding of the experiment and ability to apply the concept in practical situations with guidance (4)	Ambiguity in understanding of the experiment and ability to apply the concept in practical situations with guidance. (3)	Lack Clarity in the concept and not able to apply the concept in practical situation. (2)	
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					TOTALMARKS (30)	

HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

Exercise: 3

Date:

DETERMINATION OF ALKALINITY AND ACIDITY

(I) ALKALINITY

The alkalinity of water is a measure of its capacity to neutralize acids i.e.to absorbs hydrogen ions, without significant pH change. The alkalinity in water is primarily due to the presence of salts of weak acids and strong bases. It is caused by presence of hydroxides (OH-), carbonates (CO--) and bicarbonates (HCO_3).

ENVIRONMENTAL SIGNIFICANCE

Wastewaters containing excess caustic (hydroxide) alkalinity are not to be discharged into natural water bodies or sewers. Alkalinity as carbonate and bicarbonate of saline water is very important in tertiary recovery processes for recovering petroleum. Alkaline water offers better wetting to the formation rock and improve oil release. As an additional benefit, ions that provide alkalinity absorb on rock surfaces occupying adsorption sites and decrease the loss of recovery chemical by adsorption. The alkalinity value is necessary in the calculation of carbonate scaling tendencies of saline waters.

The alkalinity acts as a pH buffer in coagulation and lime-soda softening of water. In wastewater treatment, alkalinity is an important parameter in determining the amenability of wastes to the treatment process and control of processes such as anaerobic digestion, where bicarbonate alkalinity, total alkalinity, and any fraction contributed by volatile acid salts become considerations.

AIM

To determine the alkalinity in the given water samples.

PRINCIPLE

Alkalinity can be obtained by neutralizing OH-, CO_3^{2}-and $HCO^{3-}$with standardH_2SO4. Titration to pH 8.3 or decolourisation of phenolphthalein indicator will show complete neutralization of OH^- and ½ CO_3^{2-} while to pH 4.4 or sharp change from yellow to pink of methyl orange indicator will indicate total alkalinity.

$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$

OBSERVATIONS AND CALCULATIONS

Titration 1 (For Phenolphthalein alkalinity)

Burette solution: H_2SO_4

Pipette solution: Sample

Indicator: phenolphthalein

End Point: Disappearance of pink colour

Sample No.	Volume of Sample (ml)	Burette reading		Volume of H_2SO_4 (ml)
		Initial reading (ml)	Final reading (ml)	

Titration 2 (For total alkalinity)

Burette solution: H_2SO_4

Pipette solution: Sample

Indicator: mixed indicator (methyl orange)

End Point: Appearance of pink colour (yellow to pink)

Sample No.	Volume of Sample (ml)	Burette reading		Volume of H_2SO_4 (ml)
		Initial reading (ml)	Final reading (ml)	

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$2CaCO_3 + H_2SO_4 \rightarrow Ca(HCO3)_2 + CaSO_4$

$Ca(HCO3)_2 + H_2SO_4 \rightarrow CaSO_4 + CO_2$

APPARATUS

Burettes, Volumetric flasks, Conical flasks, Measuring cylinder and Beakers.

REAGENTS

0.05N Standard sodium carbonate solution: Dry 3 to 5g of sodium carbonate, Na_2CO_3,at 250°C for 4 hour and cool in a dessicator. Accurately weigh 2.5±0.2g to the nearest mg, dissolve in distilled water and make to 1L.

0.1N Standard H_2SO_4 solution: Dilute 2.8 mL conc. sulphuric acid to 1L. Standardise against 40.00 mL 0.05*N* Na_2CO_3 with about 60 mL distilled water, in a beaker by titrating potentiometrically to pH 5. Lift out electrodes, rinse into the same beaker and boil gently for 3 to 5 min under a watch glass cover. Cool to room temperature, rinse cover glass into beaker and finish titration to pH 4.3. Calculate normality of sulphuric acid:

Normality, $N = (A \times B)(53.00 \times C)$

where:

A = g Na_2CO_3 weighed into the 1L-flask for the Na_2CO_3 standard

B = mL Na_2CO_3 solution taken for standardisation titration

C = mL acid used in standardisation titration

0.02N Standard sulphuric acid solution: Dilute the approximate 0.1N solution to 1L. Calculate volume to be diluted as:

Volume (ml) = N/20

where: N = exact normality of the approximate 0.1N solution

Phenolphthalein indicator solution (alcoholic, pH 8.3) - Dissolve 5 g phenolphthalein in 500 mL of 95% ethyl alcohol. Add 500 mL distilled water

Mixed indicator (Methyl Orange Indicator) - Dissolve 20g of methyl red, 100mg of bromocrysol green in 100ml 95%ethyl or isopropyl alcohol.

PROCEDURE

Phenolphthalein alkalinity:

1. Take 25 to 50 mL sample in a conical flask.

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2. Add 2 to 3 drops of phenolphthalein indicator. If it turns pink ($pH > 8.3$), titrate with 0.02 *N* H_2SO_4 till the pink colour disappear. Record volume (mL) of titrant used.

Phenolphthalein alkalinity (P) (as $CaCO_3$) = ~~(V1*N of H_2SO_4* 50,000)~~

Vol. of sample

Total alkalinity (T) (as $CaCO_3$) = (V2*N of H_2SO_4* 50,000)

Vol. of sample

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Total alkalinity:

1. Add a drop of mixed indicator to the solution in which the phenolphthalein alkalinity is determined.

2. Titrate it against 0.02N sulphuric acid. Appearance of pink colour indicates the end point.

(II) ACIDITY

Acidity is the measure of the amount of base required to neutralize a given sample to the specific pH. Strong mineral acids, weak acids such as carbonic, acetic and hydrolyzing salt such as ferric and aluminium sulphates may contribute acidity. It is important because acid contributes to corrosiveness and influences certain chemical and biological processes. Dissolved CO_2 is usually the major acidity component of unpolluted surface water. In the sample, containing only carbon dioxide-bicarbonate carbonate, titration to pH 8.3 at 25°C corresponds to stoichiometric neutralisation of carbonic acid to carbonate. Since the colour change of phenolphthalein indicator is close to pH 8.3, this value is accepted as a standard end point for the titration of total acidity. For more complex mixture or buffered solution fixed end point of pH 3.7 and pH 8.3 are used. Thus, for standard determination of acidity of wastewater and natural water, methyl orange acidity (pH 3.7) and phenolphthalein acidity (pH 8.3) are used.

ENVIRONMENTAL SIGNIFICANCE

Acid waters are of concern because of their corrosive characteristics and the expense involved in removing or controlling the corrosion-producing substances. The corrosive factor in most waters is carbon dioxide, but in many industrial wastes it is mineral acidity. Carbon dioxide must be reckoned with in water-softening problems where the lime or lime-soda ash method is employed. When biological processes of treatment are used, the pH must ordinarily be maintained within the range of 6 to 9.5. This criterion often requires adjustment of pH to favorable levels, and calculation of the amount of chemicals needed is based upon acidity values in most cases.

AIM

To determine the acidity in the given water and waste water samples.

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OBSERVATIONS AND CALCULATIONS

Titration 1 (For Methyl orange acidity)

1. Burette solution: NaOH
2. Pipette solution: Sample
3. Indicator: Methyl orange
4. End Point: Yellow

Sample No.	Volume of Sample (ml)	Burette reading		Volume of NaOH (ml)
		Initial reading (ml)	Final reading (ml)	

Titration 2 (For total acidity)

1. Burette solution: NaOH
2. Pipette solution: Sample
3. Indicator: Phenolphthalein
4. End Point: Pink

Sample No.	Volume of Sample (ml)	Burette reading		Volume of NaOH (ml)
		Initial reading (ml)	Final reading (ml)	

Methyl orange acidity due to mineral acids (as $CaCO_3$) $= \dfrac{V1 * N \text{ of NaOH} * 50,000}{\text{Vol. of Sample}}$

PRINCIPLE

Hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes are neutralised by titration with standard alkali. The acidity thus depends upon the end point pH or indicator used.

APPARATUS

Burette, Pipette, Conical flasks, Measuring cylinder, Volumetric flasks and Beakers.

REAGENTS

0.02N NaOH Solution: Dissolve 0.8g of NaOH in distilled water and dilute to 1000ml

Methyl orange indicator: Dissolve 50g of methyl orange powder in distilled water and dilute to 100ml

Phenolphthalein indicator: Dissolve 1g of phenolphthalein in 100ml of 95% ethyl alcohol or isopropyl alcohol, and add 100ml of distilled to it and 0.02N NaOH solution drop wise until faint pink colour appears

PROCEDURE

1 Pipette out 25 mL of sample into conical flask. Add 2 drops of methyl orange indicator to the sample solution.

2 Titrate the sample solution against 0.02N sodium hydroxide solution. The end point is noted when the colour changes from orange red to yellow.

3 Add two drops of phenolphthalein indicator and continue the titration till a pink colour formation. Note down the volume of the titrant used.

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Phenolphthalein acidity =Total acidity (as $CaCO_3$) = $\frac{(V2*N \text{ of } NaOH *50,000)}{\text{Vol. of Sample}}$

RESULT

(i) pH of the sample =

(ii) Methyl orange acidity =

Phenolphthalein acidity =

Total acidity =

(iii) Total alkalinity present in the water sample =

Phenolphthalein alkalinity present in the sample =

Methyl orange alkalinity present in the sample =

INFERENCE

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SCORING SHEET

No	Performance criteria	Excellent-5/10	Good-4/8	Satisfactory -3/6	Poor	Marks
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3	**Output (10)**	Accurate results in first attempt independently (10)	Accurate results with guidance (8)	Fairly accurate result (6)	Poorly accurate result (4)	
4	**Viva(5)**	Accurate and clear answers (5)	Fairly accurate answers (3)	Vague answers (2)	Wrong answers (0)	
					TOTALMARKS (30)	

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise: 4

Date:

DETERMINATION OF HARDNESS

GENERAL

Hard waters are generally considered to be those waters that require considerable amounts of soap to produce foam or lather and that also produce scale in hot water pipes, heaters, boilers and other units in which the temperature of water is increased materially. Hardness is caused by divalent metallic ions. Principal cations and anions causing hardness in water are presented in the table given below

Cations causing hardness	Ca+	Mg++	S++	Fe++
Associated anions	HCO_3	SO_4	Cl-	NO_3

As Ca and Mg are present in significant quantities in water hardness is generally attributed due to their presence .When the hardness is numerically greater than the sum of carbonate and bicarbonate alkalinity ,the amount of hardness that is equivalent to total alkalinity is called the carbonate hardness and the balance is non carbonate hardness. When the total hardness is less than the sum of carbonate and bicarbonate alkalinity, hardness is due to carbonate only. Sodium is very large quantities may behave like a hardness producing ion due to common ion effect. Hardness due to such causes is called pseudo hardness

When alkalinity <total hardness, Carbonate hardness =alkalinity When alkalinity >= total hardness, Carbonate hardness =total hardness

Carbonate hardness is called temporary hardness as it can be removed by prolonged boiling while non carbonate hardness is permanent hardness.

AIM

To determine the hardness of given water sample

PRINCIPLE

Ethylene diamine tetra acetic acid (EDTA) method of determination of hardness, involves the use of solutions of EDTA or its sodium salt as the titrating agent. The complexes usually represented as EDTA are chelating agents and form extensively stable complex ions with Ca 2+ and Mg ++ and other divalent ions causing hardness as shown in the equation.

M++ + EDTA M.EDTA complex

The dye called Erichrome black T (EBT) serves as excellent indicator to show when all the hardness producing ions have been complexed. When EBT is added to the aqueous solution containing small calcium and magnesium ions at a pH of 10+/-0.1 ,the solution becomes wine red. Higher the Ph sharper the endpoint .However, above pH 10 ,there is a danger of precipitation of calcium carbonate and magnesium hydroxide .When a small amount of EBT ,having blue colour is added to hard water with a pH of about 10.0 it combines with a few of the Ca ++ and Mg ++ ions to form a weak complex ion which is wine red in colour as shown in equation

M++ + EBT M.EBT Complex

During the titration with EDTA all free hardness ions are complexed. Finally the EDTA disrupts the red EBT because it is capable of forming a more stable complex with the hardness ions. This action frees EBT indicator and the wine red colour changes to a distinct blue colour indicating the end of the titration. An accurate method of determining hardness is calculation based upon concentration of divalent ion.

APPARATUS

1. Burette
2. Pipette
3. Erlenmeyer flask

REAGENTS

1) 0.01MEDTA
2) Ammonium buffer solution
3) Eriochrome black T(EBT)
4) Litmus paper

PROCEDURE

1. A sample volume V which requires less than 15 ml EDTA titrant is chosen

2. One or two ml of buffer solution is added so as to bring the pH to10 +- 0.1

3. One or two drops of the indicator solution are added. If there is Ca or Mg hardness, solution turns to wine red

4. EDTA titrant is added from the burette with vigorous shaking till the wine red colour just turns to blue

5. The volume of the titrant added is noted down (V1)

6. Procedure is repeated for concordant values.

OBSERVATIONS AND CALCULATIONS

Sample no	Volume of sample (v ml)	Burette reading		Volume of EDTA (V1) in ml	Hardness in (mg/l) as $CaCO_3$
		Initial	Final		

Hardness in mg/l as calcium carbonate $= \frac{V1 \times S \times 1000}{V}$

Where V1 = ml of titrant used V = volume of sample

S = mg of $CacCO_3$ equivalent to 1ml of EDTA

=1 mg $CaCO_3$

RESULT

Hardness of given water sample=

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SCORING SHEET

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					TOTALMARKS (30)	

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise: 5
Date:

DETERMINATION OF CHLORIDES

CHLORIDES

Chlorides are present in water and wastewater in varying concentration. Various sources such as mineral contents, sea water droplets, human excreta discharging to natural water bodies contribute chloride concentration to water.

ENVIRONMENTAL SIGNIFICANCE

Chlorides in reasonable concentrations are not harmful to human. At concentrations above 250 mg/L they give a salty taste to water, which is objectionable to many people. For this reason, chlorides are generally limited to 250 mg/L in supplies intended for public use. In many areas of the world where water supplies are scarce, water source containing as much as 2,000 mg/L are used for domestic purposes without the development of adverse effects, once the human system becomes adapted to the water.

AIM

To determine the chloride concentration present in given water sample.

PRINCIPLE

Chloride ion concentration in the water can be determined by titration with silver nitrate. As the silver nitrate solution is slowly added, a precipitate of silver chloride forms.

$Ag^{+} (aq) + Cl^{-} (aq) \rightarrow AgCl (s)$

The end point of the titration occurs when all the chloride ions are precipitated. Then additional silver ions react with the chromate ions of the indicator, potassium chromate, to form a red-brown precipitate of silver chromate.

$2Ag^{+} (aq) + CrO_4^{2-} (aq) \rightarrow Ag_2CrO_4 (s)$

Titration should be carried out under conditions of pH 6.5 – 9. At higher pH silver ions may be removed by precipitation with hydroxide ions, and at low pH chromate ions may be removed by an acid-base reaction to form hydrogen chromate ions or dichromate ions, affecting the accuracy of the end point.

APPARATUS

Burette, pipettes, conical flasks, beakers, measuring cylinders, weighing balance, stirrer etc.

REAGENTS

Indicator 5% K_2CrO_4: 1.0 g of K2CrO4dissolved in 20 mL of distilled water.

$AgNO_3$ solution: 9.0 g of AgNO3was weighed out, transferred to a 500 mL volumetric flask and made up to volume with distilled water. The resulting solution was approximately 0.1 M.

PROCEDURE

1. Take 25 ml of sample in the conical flask. Adjust the sample pH between to be 7 to 8 by adding sulphuric acid or sodium hydroxide solution.
2. Add 1 ml of potassium chromate to get light yellow color.
3. Titrate with standard silver nitrate ($AgNO_3$) solution till the color changes from yellow to brick red. Note down the volume of $AgNO_3$ solution added (V1).
4. Repeat the above procedure for the blank sample (distilled water) and note down the volume of $AgNO_3$ solution added (V2).

OBSERVATIONS AND CALCULATIONS

Trial	Volume of AgNO3 (mL)		
	Initial Reading(IR)	Final Reading(FR)	FR-IR
BLANK			

$$\text{Chloride in mg/l} = \frac{\{(V1-V2) * N \text{ of } AgNO_3 *35.45* 1{,}000\}}{\text{Vol. of sample}}$$

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RESULT

Chloride concentration in the given sample =

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SCORING SHEET

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					TOTALMARKS (30)	

HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:6
Date:

DETERMINATION OF BIOCHEMICAL OXYGEN DEMAND (BOD)

BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under controlled aerobic conditions. The BOD test relies on measurable depletion of dissolved oxygen (DO) over a specified period of time, generally 5 days at 20°C incubation. The BOD is considered complete after 20 days. 20 Days is too long to wait and 5 days is a reasonable period as most of the BOD to be exerted is about 70 to 80 % of total BOD.

ENVIRONMENTAL SIGNIFICANCE

BOD is the principle test to give an idea of the biodegradability of any sample and strength of the waste. Hence the amount of pollution can be easily measured by it. Efficiency of any treatment plant can be judged by considering influent BOD and the effluent BOD and so also the organic loading on the unit.

Application of the test to organic waste discharges allows calculation of the effect of the discharges on the oxygen resources of the receiving water. Ordinary domestic sewage may have a BOD of 200 mg/L. Any effluent to be discharged into natural bodies of water should have BOD less than 30 mg/L. This is important parameter to assess the pollution of surface waters and ground waters where contamination occurred due to disposal of domestic and industrial effluents. Drinking water usually has a BOD of less than 1 mg/L. But, when BOD value reaches 5 mg/L, the water is doubtful in purity. The determination of BOD is used in studies to measure the self-purification capacity of streams and serves regulatory authorities as a means of checking on the quality of effluents discharged to stream waters.

AIM

To determine the BOD of the given sample

PRINCIPLE

The BOD is measured by determining the oxygen consumed (by the bacteria) from a sample placed in an air-tight container and kept in a controlled environment for a preselected period of time.

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APPARATUS

BOD bottles, burette, pipette, conical flask, BOD Incubator

REAGENTS

Phosphate buffer solution: Dissolve 8.5 g KH_2PO_4, 21.75 g K_2HPO_4, 33.4 g $Na_2HPO_47H_2O$, and 1.7 g NH_4Cl in about 500 mL distilled water and dilute to 1 L. The pH should be 7.2 without further adjustment. Alternatively, dissolve 42.5 g KH_2 PO_4 or 54.3 g K_2HPO_4 in about 700 mL distilled water. Adjust pH to 7.2 with 30% NaOH and dilute to 1 L.

Magnesium sulfate solution: Dissolve 22.5 g $MgSO_47H_2O$ in distilled water and dilute to 1 L.

Calcium chloride solution: Dissolve 27.5 g $CaCl_2$in distilled water and dilute to 1 L

Ferric chloride solution: Dissolve 0.25 g $FeCl_36H_2O$ in distilled water and dilute to 1 L.

Dilution water:Place desired volume of distilled water in a suitable bottle and add 1 mL each of phosphate buffer, MgSO4, CaCl2, and FeCl3 solutions/L of water. Seed dilution water, if desired. pH of the dilution water should be between 6.5- 8.5 (it is customary to buffer the solution by means of a phosphate system at about pH 7). Calcium and magnesium salts are added to give buffering capacity and proper osmotic conditions. Ferric chloride and magnesium sulphate supply the requirements for iron sulphur and nitrogen. The phosphate buffer furnishes any phosphorous that may be needed. The nitrogen should be eliminated in cases where nitrogenous oxygen demand is being measured.

PROCEDURE

1. Dilute the settled sewage provided to 30-40 times using aerated tap water.

2. Fill the BOD bottle with diluted sewage by taking care that no air bubble entraps.

3. Determine the DO of the BOD sample and blank.

4. Incubate both the sample and blank BOD bottles at 200 C.

5. After 5 days take the bottles having sewage and blank from the incubator.

6. Measure DO and calculate BOD5.

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Ultimate BOD, = $(1 - e^{-kt})$

Lt= BOD at any time t

L0= ultimate BOD

T= time in days

K= BOD rate constant (0.23/day)

OBSERVATIONS AND CALCULATIONS

0th day reading

Sample	Burette reading mL of ($Na_2S_2O_3\ 5H_2O$)			DO in mg/L
	Final reading (FR)	Initial reading (IR)	FR-IR	
Blank				
BOD sample				

5 day reading

Sample	Burette reading mL of ($Na_2S_2O_3\ 5H_2O$)			DO in mg/L
	Final reading (FR)	Initial reading (IR)	FR-IR	
Blank				
BOD sample				

5 day BOD = BOD_5 (mg/l)

= $(D1-D2)-(B1-B2)P$

D1 = DO of the sample immediately after preparation, mg/L,

D2 = DO of the sample after 5 day incubation at 20°C, mg/L,

B1 = DO of blank immediately after preparation, mg/L,

B2 = DO of blank after 5 day incubation at 20°C, mg/L,

P= dilution factor

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RESULT

BOD of the given sample =

Ultimate BOD of the sample =

INFERENCE

HOD

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SCORING SHEET

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					TOTAL MARKS (30)	

HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:7

Date:

DETERMINATION OF CHEMICAL OXYGEN DEMAND (COD)

Test is used to measure the quantity of oxygen required to oxidize the organic material in wastewater using dichromate in an acid solution. COD test is widely used as a means of measuring the organic strength of domestic and industrial wastes. It allows measurement of a waste in terms of the total quantity of oxygen required for oxidation to CO2 and H2O. The major advantage of COD test is the short time required for evaluation. Many organic matters which are difficult to oxidize biologically such as lignin can be oxidized chemically.

ENVIRONMENTAL SIGNIFICANCE

COD is often measured as a rapid indicator of organic pollutant in water; it is normally measured in both municipal and industrial wastewater treatment plants and gives an indication of the efficiency of the treatment process. COD has further applications in power plant operations, chemical manufacturing, commercial laundries, pulp & paper mills, environmental studies and general education.

AIM

To determine the Chemical oxygen demand (COD) of the given sample.

PRINCIPLE

It is based on the principle that organic matter present in the sample gets oxidized completely by potassium dichromate ($K_2Cr_2O_7$) in the presence of sulphuric acid (H_2SO_4) and catalyst silver sulphate (Ag_2SO_4) to produce CO_2 and H_2O. The excess of potassium dichromate remaining after the reaction is treated with ferrous ammonium sulphate. The dichromate consumed gives O_2 required for oxidation of organic matter.

APPARATUS

COD digestion vessel, COD digester, burette, pipette and beaker.

REAGENTS

Standard potassium dichromate solution: 0.0417M (0.25N): Dissolve 12.259g $K_2Cr_2O_7$, primary standard grade, previously dried at 103°C for 2 hours, in distilled water and dilute to 1L.

Sulphuric acid reagent: Add 5.5g Ag_2SO_4 technical or reagent grade, per kg of conc.H_2SO_4, keep for a day or two to dissolve.

Ferroin indicator solution: Dissolve 1.485g 1, 10-phenanthroline monohydrate and 695mg $FeSO_4.7H_2O$ in distilled water and dilute to 100 mL. Commercially prepared may also be available.

Standard ferrous ammonium sulphate (FAS) (0.25M): Dissolve 98g $Fe(NH_4)_2(SO_4)_2.6H_2O$ in distilled water, add 20 mL conc. H_2SO_4, cool and dilute to 1L.

PROCEDURE

1. Take 2.5ml of the sample in digestion vessel and add 1.5ml of 0.25N $K_2Cr_2O_7$ solution and 3.5ml of Ag_2SO_4 +H_2SO_4 solution.
2. Reflux the mixture on a hot plate/digester for 2 hrs at 150°C and cool the mixture to room temperature.
3. Titrate mixture against ferrous ammonium sulphate (FAS) solution using ferroin indicator till blue green color turns to reddish brown color. Note down the volume of FAS used as 'A'mL.
4. Repeat the experiment for blank sample (distilled water) and note down the volume of FAS used as 'B'mL.

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OBSERVATIONS AND CALCULATIONS

Sl.no.	Sample	Burette reading		Dilution factor (if any)	Volume of FAS consumed (ml)
		Initial	Final		
1	Hot blank				
	Diluted sample				
2	Hot blank				
	Diluted sample				

$COD\ (mg/L)=\{(B-A)*M*8000\}*dilution\ factor\ (if\ any)Volume\ of\ sample$

where:

A = FAS used for sample, mL

B = FAS used for blank, mL

M = Normality of FAS

HOD

RESULTS

The COD of the given water sample =

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SCORING SHEET

No	Performance criteria	Excellent-5/10	Good-4/8	Satisfactory - 3/6	Poor	Marks
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4	**Viva(5)**	Accurate and clear answers (5)	Fairly accurate answers (3)	Vague answers (2)	Wrong answers (0)	
					TOTAL MARKS (30)	

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

HOD

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Exercise: 8

Date:

DETERMINATION OF OPTIMUM COAGULATION DOSAGE

Coagulation is the process of destabilizing colloidal particles so that particle growth can occur as a result of particle collisions. In wastewater treatment, settleable solids are effectively removed by sedimentation process. But it is difficult to remove the small size colloidal particles by gravitational settling due to its Brownian motion. However, if the colloidal particles are destabilized through agglomeration of particles into group/large particles which increases the settling velocities, and thus can be effectively removed in sedimentation tank. The exact mechanism of coagulation is not known, however, four mechanisms are thought to be occurring during coagulation process. These include ionic layer compression, adsorption, charge neutralization and inter-particle bridging. Typical coagulants used in wastewater treatment are synthetic organic polymers, metal salts such as alum or ferric sulphate, prehydrolized metal salts (polyaluminum chloride and polyiron chloride).

ENVIRONMENTAL SIGNIFICANCE

Coagulation of raw water using the optimum coagulant dose removes colloidal impurities from the water. These colloidal impurities are normally associated with organic matter containing pathogenic bacteria which are responsible for water borne diseases. The chemical coagulation also makes the process of disinfection more effective. Coagulation also removes objectionable colour, taste and odour from water. Usually the dose of Alum varies between 5mg/l for relatively clear water to about 85 mg/l for very turbid waters. The average dose is about 20mg/l.

AIM

To find the optimum amount of coagulant required to treat given water sample.

PRINCIPLE

Metal salts hydrolyses in presence of the natural alkalinity to form metal hydroxides. The divalent cations can reduce the zeta-potential, while the metal hydroxides are good absorbents and hence remove the suspended particles by enmeshing them.

Alum [$Al_2S(SO_4)_3$. $18H_2O$] is the most widely used coagulant in water treatment. When alum solution is added to water, the molecules dissociate to yield SO_4^{2-} and Al^{3+} .The +ve species combine with negatively charged colloidal to neutralize part of the charge on the colloidal particle. Thus, agglomeration takes place. Coagulation is a quite complex phenomenon and the coagulant should be distributed uniformly throughout the solution. A flash mix accomplishes this.

APPARATUS

Jar test apparatus, turbid meter, beakers, pipette and pH meter.

REAGENTS

Alum, Ferric chloride

PROCEDURE

1. Measure the initial turbidity of the given sample.

2. Find the pH of the sample and adjust it to 6 to 8.5.

3. Take six jars of 1 L capacity and take 0.5 l of sample in each jar and add varying doses of alum (1, 2, 4, 6, 8, 10 mg/l) of alum to each one of them.

3. Keep the sample in jar test apparatus and put it for rapid mixing at 100 rpm for 1 min and then to slow mixing at 20 rpm for 20 min.

4. Stop the motor and allow the sample to settle for 30 min. Collect the supernatant from each jar and find out the turbidity.

5. Plot a graph with alum dosage along x-axis and turbidity along y-axis.

6. The dosage of alum, which represents least turbidity, gives Optimum Coagulant Dosage (O.C.D.).

7. Repeat steps 3–6 with higher dose of alum, if necessary.

OBSERVATIONS AND CALCULATIONS

Concentration (ppm)	Turbidity (NTU)

RESULT

Optimum coagulant dosage = mg/L

INFERENCE

HOD

SCORING SHEET

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HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:9

Date:

BREAKPOINT CHLORINATION

AIM

Determination of the breakpoint with a graph by reacting chlorine and ammonia at different molar ratios.

THEORY

Disinfection of pathogenic microorganisms is called disinfection. In order to prevent waterborne diseases, disinfection is applied to drinking water. While disinfectants should not adversely affect human beings and natural habitat, but should be toxic to pathogenic microorganisms at the same time. It is also desirable that the disinfectant is cheap and easily obtainable. Many factors can reduce the efficiency of disinfection. The most important of these are turbidity and resistant organisms. Viruses are more resistant to disinfection than bacteria. In this case, higher disinfectant concentrations and longer disinfection times are required. For these reasons, many factors must be considered for the selection of disinfectants. Disinfectant should be selected according to the characteristics of wastewater. Factors affecting the efficiency of removal of microorganism in disinfection can be listed as follows:

The type and density of the microorganisms, the type and dosage of the disinfectant used, the time of contact, the pH, the temperature and the characteristics of the water.

The rate of mortality of microorganisms can be expressed by first-order reaction kinetics and can be formulated as follows by Chick's Law:

$dN/dt = -Kn$; When this expression is integrated

$N_t = N_o.e^{-kt}$;which is,

N_o: Number of live cells initially,

N_t: The number of live cells at time t,

K: The experimentally calculated death constant.

MATERIALS USED

1) A chemical containing free chlorine

2) Ammonia

3) Residual chlorine measurement reagents (iodometric method will be used)

PROCEDURE

1. Both chlorine and ammonia are added to a water sample to observe the breakpoint; so that the molar ratio of the samples will be 1 to 11.
2. 1 hour reaction time is waited. Then the residual chlorine is measured.
3. Add concentrated acetic acid (usually 1 - 2 mL) to each sample to bring the pH to 3-4.
4. 1 g of potassium iodide (KI) is added.
5. The resulting color is titrated with sodium thiosulphate ($Na_2S_2O_3$) until the yellow color, consumption is recorded.
6. Add 1 mL of starch solution.
7. The resulting bluish color is titrated with sodium thiosulphate ($Na_2S_2O_3$) until it is colorless, consumption is recorded.
8. All these procedures applied to blank sample.
9. Residual chlorine is calculated

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OBSERVATION AND CALCULATIONS

Sl.no	Volume of sample(ml)	Burette reading		Volume of thiosulphate (ml)	Average (ml)
		Initial	Final		

Residual Chlorine $(mg/L) = \frac{(A-B)xNx35450}{\text{mL of sample}}$

A = the amount of $Na_2S_2O_3$ used for the sample

B = the amount of $Na_2S_2O_3$ used for the blank

N = Normality of $Na_2S_2O_3$

RESULTS

HOD

INFERENCES

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SCORING SHEET

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HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:10

Date:

DETERMINATION OF AVAILABLE CHLORINE IN A SAMPLE OF BLEACHING POWDER

Chlorination of public water supplies and polluted waters serves primarily to destroy or de-activate disease-producing microorganisms. Disinfection with chlorine is widely practiced. Chlorination may produce some adverse effects including taste and odor problem.In recent years, chlorination has been found to produce trihalomethanes (THMs) and other organics of health concern (THMs are suspected human carcinogens). Thus, use of alternative disinfectants, such as chlorine dioxide and ozone that do not cause this particular problem, is increasing.

ENVIRONMENTAL SIGNIFICANCE

Bleaching powder is commonly used as a disinfectant. The chlorine present in the bleaching powder gets reduced with time. So, to find the exact quantity of bleaching powder required, the amount of available chlorine in the sample must be found out. Chlorine will liberate free iodine from potassium iodide solution when its pH is 8 or less. The iodine liberated, which is equivalent to the amount of active chlorine, is titrated with standard sodium thiosulphate solution using starch as indicator.

AIM

To determine the available chorine in the bleaching powder.

PRINCIPLE

Disinfectant capabilities of chlorine depend on its chemical form in water, which in turn is dependent on pH, temperature, organic content of water, and other water quality factors. Chlorine is used in the form of free chlorine [e.g., chlorine gas] or as hypochlorites [e.g., NaOCl and $Ca(OCl)_2$]. Chlorine applied to water either as free chlorine or hypochlorite initially undergoes hydrolysis to form free chlorine consisting of aqueous molecular chlorine, hypochlorous acid and hypochlorite ion.

Chlorine gas rapidly hydrolyzes to hypochlorous acid according to:

$Cl_2 + H_2O \ HOCl + H^+ + Cl^-$

Aqueous solutions of sodium or calcium hypochlorite hydrolyze to:

$Ca(OCl)_2 + 2H_2O \ Ca^{2+} + 2HOCl + 2OH^-$

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$NaOCl + H2O Na+ + HOCl + OH–$

Hypochlorous acid is a weak acid and will disassociate according to:

$HOCl \Leftrightarrow H+ +OCl–$

The two chemical species formed by chlorine in water, hypochlorous acid (HOCl) and hypochlorite ion (OCl–), are commonly referred to as "free" or "available" chlorine.

APPARATUS

Beakers, conical flasks, burette

REAGENTS

Standard chlorine solution, acetic acid, potassium iodide, 0.025N standard sodium thiosulphate solution, iodine solution (0.025 N), starch indicator.

PROCEDURE

1. Dissolve 1g bleaching powder in 1 litre of distilled water in a volumetric flask, and stopper the container.
2. Place 5 mL acetic acid in an Erlenmeyer flask and add about 1g potassium iodide crystals. Pour 25 mL of bleaching powder solution prepared above and mix with a stirring rod.
3. Titrate with 0.025 N sodium thiosulphate solution until a pale yellow colour is obtained. (Deep yellow changes to pale yellow.)
4. Add 1mL of starch solution and titrate until the blue colour disappears.
5. Note down the volume of sodium thiosulphate solution added (V1).
6. Take a volume of distilled water corresponding to the sample used.
7. Add 5 mL acetic acid, 1g potassium iodide and 1 mL starch solution.
8. If blue colour occurs, titrate with 0.025 N sodium thiosulphate solution until the blue colour disappears.
9. Record the volume of sodium thiosulphate solution added (A1).
10. If no blue colour occurs, titrate with 0.025 N iodine solution until a blue colour appears. Note down the volume of iodine (A2).
11. Then, titrate with 0.025 N sodium thiosulphate solution till the blue colour disappears. Record the volume of sodium thiosulphate solution added (A3). Note down the difference between the volume of iodine solution and sodium thiosulphate as A4 (A4=A2- A3).

OBSERVATIONS AND CALCULATIONS

Bleaching powder solution x Standard sodium thiosulphate solution (0.025 N)

Sl. No.	Burette reading		Volume of the titrant (ml)
	Initial	Final	

Distilled water x Standard iodine solution (0.025N)

Sl. No.	Burette reading		Volume of the titrant (ml)
	Initial	Final	

Distilled water × Standard sodium thiosulphate solution (0.025N)

Sl. No.	Burette reading		Volume of the titrant (ml)
	Initial	Final	

$$\text{mg of } Cl_2/\text{mL (B)} = \frac{(V1 - A1) \text{ or } (V1 + A4) \times N \times 35.46}{\text{mL of bleaching powder solution taken}}$$

1000 mL of bleaching powder solution contains 1000 x B mg of Cl_2

i.e., 1000 mg bleaching powder contains 1000 B mg of Cl_2

therefore, 100 mg of bleaching powder contains = $\frac{1000 \times B}{10}$

% of chlorine available =

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RESULT

The available chlorine in the given bleaching powder =

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SCORING SHEET

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HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:11

Date:

DETERMINATION OF DISSOLVED OXYGEN

Dissolved oxygen is one of the most important constituents of natural water system. It indicates the pollution status of river. The dissolved oxygen in water depends upon its temperature and solubility. If DO is less, then it indicates the presence of organic matter. At least 4 mg/l of DO is required for fish and other species for survival.

ENVIRONMENTAL SIGNIFICANCE

Adequate dissolved oxygen is necessary for good water quality. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 4.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

AIM

To determine the amount of dissolved oxygen present in the given sample

PRINCIPLE

It is based on the principle that oxygen present in the sample oxidizes the divalent manganous to its higher valency under alkaline conditions and that manganese in higher state of valencies is capable of oxidizing I- to I2 under acidic conditions. Thus the amount of I2 released is equivalent to the dissolved oxygen present. The iodine is measured with standard sodium thiosulphate solution.

If no oxygen is present, a pure white precipitate of $Mn(OH)_2$ forms

$Mn^{2+} + 2OH^- \rightarrow Mn(OH)_2\,(s)$ (white ppt)

If oxygen is present

$Mn^{2+} + 2OH^- + O_2 \rightarrow MnO_2\,(s) + H_2O$ (red ppt)

Under low pH

$MnO_2 + 2I^- + 4\,H^+ \rightarrow Mn^{2+} + I_2 + 2H_2O$

I_2 is rather insoluble in water, but forms a complex with the excess iodide present.

$I_2 + I^- \leftrightarrow I^{3-}$

Thus more soluble tri-iodate prevents escape of I_2 from the solution.

APPARATUS

300 mL BOD bottles, burette, pipette, conical flask etc.,

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REAGENTS

***Manganous sulfate solution*:** Dissolve 480g $MnSO_44H_2O$,or 400g $MnSO_42H_2O$,or364g $MnSO_4$ H_2O in distilled water, filter and dilute to 1 litre. This solution should not produce a blue color with starch indicator when added to an acidified potassium iodide (KI) solution.

Alkaline-iodide-sodium azide solution: Dissolve 500g NaOH (or 700g KOH) and 135gNaI (or 150g KI) in distilled water and dilute to IL. Add 10 g NaN_3 dissolved in 40 mL distilled water.

***Starch indicator solution*:** Use either an aqueous solution or soluble starch powder mixture. Prepare an aqueous solution by dissolving 2 g of laboratory grade soluble starch powder and 0.2 g of salicylic acid (as a preservative) in 100 mL of hot distilled water.

Sodium thiosulfate standard solution, 0.0250 N: Dissolve 6.205 g $Na_2S_2O_35H_2O$ in distilled water. Add 1.5 mL 6 N NaOH or 0.4 g solid NaOH and dilute to 1 litre and standardize with bi-iodate solution.

PROCEDURE

1. Collect the sample to be tested in a 300 mL BOD bottle taking special care to avoid adding air to the liquid being collected. Fill bottle completely and add stopper.

2. Remove bottle stopper and add 2 mL of the manganous sulfate solution at the surface of the liquid. Add 2 mL of the alkaline-iodide-sodium azide solution at the surface of the liquid. Replace the stopper, avoid trapping air bubbles and shake well by inverting the bottle several times.

3. Repeat shaking after floc has settled halfway. Allow floc to settle a second time.

4. Add 2 mL of concentrated sulfuric acid and close the bottle with stopper. Rinse the top of the bottle to remove any acid and shake well until the precipitate is completely dissolved (uniform yellow color).

5. Take 203 mL of sample from the BOD bottle into a conical flask and titrate with 0.0250 N sodium thiosulfate until the solution is a pale yellow (straw) color.

6. Add a small quantity (approximately 1 mL) of starch indicator continue the titration with 0.0250 N sodium-thiosulfate until blue colour disappears (blue to colorless). Record the mL of sodium-thiosulfate used.

OBSERVATIONS AND CALCULATIONS

The concentration of DO in the sample is calculated using the following formula:

$$DO\ (mg/l) = \frac{ml\ of\ titrant * normality\ of\ titrant * 8000}{volume\ of\ the\ sample\ titrated}$$

Sl.No.	Burette reading of ($Na_2S_2O_3.5H_2O$) in ml		FR - IR
	Initial reading (IR)	Final reading (FR)	

RESULT

DO of the given sample =

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SCORING SHEET

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					TOTAL MARKS (30)	

HOD

CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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Exercise:12

Date:

DETERMINATION OF TOTAL COLIFORMS

MPN is a procedure to estimate the population density of viable microorganisms in a test sample. It's based upon the application of the theory of probability to the numbers of observed positive growth responses to a standard dilution series of sample inoculums placed into a set number of culture media tubes. Positive growth response after incubation may be indicated by such observations as gas production in fermentation tubes or visible turbidity in broth tubes, depending upon the type of media employed.

ENVIRONMENTAL SIGNIFICANCE

A variety of different microorganisms are found in untreated water. Certain organisms, referred to as pathogens, cause disease to humans which include species of bacteria, viruses and protozoa. Although it is possible to detect the presence of various pathogens in water, the isolation and identification of many of these is often extremely complicated, time-consuming and expensive proposition. Hence in most cases (except when presence of any particular microorganism is suspected) the microbiological quality of water is checked using some indicator organisms.

An indicator organism is one whose presence presumes that contamination has occurred and suggests the nature and extent of the contaminants. An indicator organism should be a microorganism whose presence is evidence of fecal contamination of warm blooded animals. Indicators may be accompanied by pathogens, but typically do not cause disease themselves. Most common indicator used in microbial examination of water is coliforms which satisfy most of the conditions required for indicator organism. The measurement of total coliforms is of particular relevance for treated and / or chlorinated water supplies; in this case the absence of total coliforms would normally indicate that the water has been sufficiently treated / disinfected to destroy various pathogens. Measurement of focal coliforms is a better indicator of general contamination by material of fecal origin.

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AIM

To determine total coliform of the given water sample.

PRINCIPLE

The MPN test procedure is based on the most probable number of coliform organism. The coliform group has the ability to ferment lactose or lauryl tryptose broth and produce gas. This offers a simple test of the presence of coliform. However some other organisms also ferment the broth under certain condition and therefore additional growth reaction must be carried out to confirm the presence of coliform group. After presumptive test the production of gas in the brilliant green lactose bile confirms the presence of coliform.

APPARATUS

1. Incubator.
2. Pre-sterilized test tubes
3. Test tube rack
4. Durham's tube
5. Petridishes
6. Inoculation loops and nichrome wire.

PROCEDURE

1. PRESUMPTIVE TEST

LACTOSE BROTH OR LAURYL TRYPTOSE BROTH TO BE USED IN THE PRESUMPTIVE TEST

1. Inoculate a series of fermentation tubes with appropriate graduated quantities (multiplies and submultiples of 10) of the water to be tested. The concentration of nutritive ingredients in the mixture of the medium should confirm to the specifications.
2. The portions of the water sample used for inoculating lactose or lauryl tryptose broth fermentation tubes will vary in size and number with the character of water under examination.
3. Usually decimal multiples and sub multiples of 1 ml of the sample is selected inoculate 10 ml portion of each water sample provided into different one or three large tubes containing

10 ml of lactose or lauryl tryptose broth which has been prepared with twice the normal

concentrations of constituents for allow for dilution. Inoculate 1 ml and 0.1 ml of water into small tubes (two sets of three each) of single strength lactose or lauryl tryptose broth.

4. Incubate the inoculated fermentation tubes at 35+/-.5 C. At the end of 24+/-2hr shake each tube gently and examine and if no gas has formed, repeat this test at the end of 48+/-3hr.

5. Record the presence or absence of gas formation at each examination of the tubes.

6. Formation within 48+/-3hr of gas in any amount in the inverted fermentation tubes constitutes a positive presumptive test. Active may be shown by the continued appearance of small bubbles of gas throughout the medium outside the inner vial in the fermentation tubes. A negative result indicates that water is fit for drinking.

7. Presumptive test without confirmation should not be used routinely except in the analysis of heavily polluted water.

2. CONFIRMED TEST

1. Lactose or lauryl tryptose broth may be used for primary fermentation in presumptive test to avoid false positive results.

2. Brilliant green lactose bile broth fermentations tubes are used in the confirmed test.

3. Submit all primary fermentation tubes showing any amount of gas at the end of 24 hour incubation to the confirmed test.

4. Gently shake primary fermentation tube showing gas formation and with a sterile metal loop, transfer one loop full of medium to a fermentation tube containing brilliant green lactose bile.

5. Incubate the inoculated brilliant green lactose bile broth tube for 48+/-3hr at 35+/-0.5 C

6. The formation of gas in any inverted vial of the brilliant green lactose bile broth fermentation tube at any time within 48+/-3hr constitute a positive confirmed test.

7. If no gas is formed, it is negative confirmed test and coliforms are absent.

3. COMPLETED TEST

Completed test is the next step following the confirmed test. It I applied to brilliant green lactose bile broth fermentation tubes showing gas in the confirmed test

1. Streak one or more endo or eosin methylene blue (EMB) agar plates from each tube of brilliant green lactose bile showing gas.

2. While streaking it is essential to ensure the presence of some discrete colonies separated by

at least 0.5 cm from one another.

3. Insert the end of the streaking needles into the liquid in the tube to a depth of 5 mm.

4. Streak the plate bringing only the curved section of the needle in contact with the agar surface so that the letter will not be scratched or torn.

5. Incubate the petri dishes (inverted) at 35+/-0C for24+/-2 hrs

6. The colonies developing on Endo or eosin methylene blue agar may be typical (opaque, un nucleated, mucoid after incubation for 24 hrs) or negative (all others)

7. From each of these plates fish out one or two colonies and transfer to lauryl tryptose broth fermentation tube and to nutrient agar slants.

8. Incubate the secondary broth tubes and near slants at 35+/-0C for 24+/-2 hrs or 48+/-3 hrs and if gas is not produced in 24 hrs. Gram stained preparation from these agar slant cultures are made.

9. The gas formation in the secondary lauryl tryptose broth tubes and the demonstration of gram-negative no-spore forming rod shaped bacteria in agar culture may be considered a satisfactory positive completed test.

10. If after 48+/-3hrs gas is produced in the secondary fermentation tubes and no spores of gram positive rods are found on the slant, the test may be considered a positive completed test and this demonstrates the presence of coliform organisms.

COMPUTATION OF MPN

The number of positive findings coliform, group organisms resulting from multiple portion decimal dilution plantings should be computed as the combinations of positives and recorded in terms of the Most probable Number (MPN). The MPN for a variety of planting series are presented in Table. The values are at the 95% confidence limits for each of the MPN determined. These values are prepared for 10, 1, 0.1 ml combination. if however the combination is 10,10 and 1 ml the MPN is 0.1 times the value in the table. If on the other hand, a combination corresponding properties at 1, 0.1 and 0.01 ml is planted; record 0 times the value shown in the table.The MPN for combination not appearing in the table or for other combinations of tubes and dilutions, may be estimated by Thomas's simple formula

$$\frac{\text{MPN}}{\text{100ml}} = \frac{\text{No of positive tubes x10}}{ml\ of\ sample\ in\ negative\ tubes\ \times ml\ of\ sample\ in\ all\ tubes}$$

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OBSERVATIONS

MPN Index for various combination of positive and negative results when three 10ml three 1ml portions are used.

No of tubes having reaction			MPN INDEX
3 of 10ml each	3 of 1ml each	3 of 0.1ml each	100ml

RESULT

INFERENCE

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SCORING SHEET

No	Performance criteria	Excellent-5/10	Good-4/8	Satisfactory - 3/6	Poor	Marks
1	**General understanding of the exercise (5)**	Clear understanding of the experiment and ability to apply the concept in practical situations independently. (5)	Clear understanding of the experiment and ability to apply the concept in practical situations with guidance (4)	Ambiguity in understanding of the experiment and ability to apply the concept in practical situations with guidance. (3)	Lack Clarity in the concept and not able to apply the concept in practical situation. (2)	
2	**Conduct of exercise (10)**	Carries out systematically in a professional manner (10)	Carries out systematically with guidance (8)	Carries out in a fairly systematical way with guidance (6)	Carries out in a poorly systematic way (4)	
3	**Output (10)**	Accurate results in first attempt independently (10)	Accurate results with guidance (8)	Fairly accurate result (6)	Poorly accurate result (4)	
4	**Viva(5)**	Accurate and clear answers (5)	Fairly accurate answers (3)	Vague answers (2)	Wrong answers (0)	
					TOTAL MARKS (30)	

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CRITERIA	MARKS
PERFORMANCE [50]	
VIVA[20]	
TOTAL[70]	

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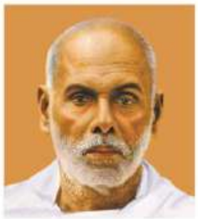
Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307

Est. 2003



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

THIRD SEMESTER

LAB MANUAL

CSL203 OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY, KERALA

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION OF THE DEPARTMENT

To be a centre of excellence in Computer Science and Engineering to produce competent professionals and entrepreneurs capable of exploring and assimilating latest technological advancements for the betterment of the society.

MISSION OF THE DEPARTMENT

- To facilitate transformative education in computer science and engineering.
- To build competent professionals and entrepreneurs by introducing new technologies.
- To accomplish higher education, induce ethical values and spirit of social commitment.

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PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering Fundamentals, and an engineering specialization to the solution of engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1:-To prepare students to excel in Computer Science and Engineering program through quality education enabling them to succeed in computing industry profession.

PEO2:-To provide students with core competencies by strengthening their mathematical, scientific and basic engineering fundamentals.

PEO3:-To design & develop novel products and innovative solutions for real life problems in Computer Science & Engineering field and related domains by broad based knowledge.

PEO4:-To inculcate professionalism among students by providing technical, entrepreneurial skills and soft skills with ethical standards.

PEO5:-To encourage students for higher studies by adapting to new technologies through interactive quality teaching and organizing symposiums, conferences, seminars, workshops and technical discussions.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1:-Computer Science Specific Skills: The ability to identify, analyze and design solutions for complex engineering problems in multidisciplinary areas by understanding the core principles and concepts of computer science.

PSO2:-Programming and Software Development Skills: The ability to acquire programming efficiency by designing algorithms and applying standard practices in software project development to deliver quality software products.

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SYLLABUS

CSL 203	OBJECT ORIENTED PROGRAMMING LAB (IN JAVA)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	0	0	3	2	2019

Preamble: The aim of the course is to provide hands-on experience to the learners on various object oriented concepts in Java Programming. This course helps the learners to enhance the capability to design and implement various Java applications for real world problems.

Prerequisite: Topics covered under the course Programming in C (EST 102)

Course Outcomes:

After the completion of the course the student will be able to

CO1	Implement the Object Oriented concepts - constructors, inheritance, method overloading & overriding and polymorphism in Java (Cognitive Knowledge Level: **Apply**)
CO2	Implement programs in Java which use data types, operators, control statements, built in packages & interfaces, Input/output streams and Files (Cognitive Knowledge Level: **Apply**)
CO3	Implement robust application programs in Java using exception handling (Cognitive Knowledge Level: **Apply**)
CO4	Implement application programs in Java using multithreading and database connectivity (Cognitive Knowledge Level: **Apply**)
CO5	Implement Graphical User Interface based application programs by utilizing event handling features and Swing in Java (Cognitive Knowledge Level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✔	✔	✔	✔	✔			✔		✔		✔
CO2				✔	✔							

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	✔	✔	✔					✔		✔		✔
CO3	✔	✔	✔	✔	✔			✔		✔		✔
CO4	✔	✔	✔	✔	✔			✔		✔		✔
CO5	✔	✔	✔	✔	✔			✔		✔		✔

Abstract Pos defined by National Board Of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and teamwork
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

Assessment Pattern:

Bloom's Category	Continuous Assessment Test(Internal Exam) Mark in Percentage	End Semester Examination Marks in percentage
Remember	20	20
Understand	20	20
Apply	60	60
Analyze		
Evaluate		
Create		

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Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3hours

Continuous Internal Evaluation Pattern:

Attendance : 15 Marks

Continuous Evaluation in Lab : 30 Marks

Continuous Assessment Test : 15 Marks Viva

Voce : 15

Internal Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks which will be converted out of 15 while calculating Internal Evaluation marks.

End Semester Examination Pattern: The marks will be distributed as Algorithm 30 marks, Program 20 marks, Output 20 marks and Viva 30 marks. Total 100 marks will be converted out of 75 for End Semester Examination.

Operating System to Use in Lab: Linux

Compiler/Software to Use in Lab: gcc, javac, jdk, jre, Eclipse, Net Beans, MySQL/ PostgreSQL.

Programming Language to use in La: Java

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LIST OF EXPERIMENT

CYCLE 1:

1. Write a Java Program to find the frequency of a given character in a string.

2. Write a Java program to multiply two given matrices.

CYCLE 2:

3. Write a Java program which creates a class named 'Employee'

4. Write a java program to create an abstract class.

5. Write a Java program that read from a file and write to file by handling all file related exceptions.

6. Write a Java program that reads a line of integers, and then displays each integer, and the sum of all the integers.

7. Write a Java program that shows the usage of try, catch, throws and finally.

8. Write a Java program that shows thread synchronization.

9. Write a Java program that works as a simple calculator.

10. Write a Java program that simulates a traffic light.

CYCLE 3:

11. Write a Java program for doubly linked list operations.

12. Write a Java program that implements Quick sort algorithm

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CYCLE 1

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1. Java Program to Find the Frequency of a Given Character in a String

AIM

Write a java_programs to find the frequency of a given character in a string using data types, operators, and control statements in Java.

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util. Scanner;
class Test
{
  public static void main(String args[])
  {
      Scanner sc = new Scanner(System.in);
      System.out.print("Enter the String:");
      String str = sc.nextLine();
      System.out.print("Enter the character:");
      char ch = sc.nextLine().charAt(0);
      int count = 0;
      for(int i=0;i<str.length();i++)
       {
             if(str.charAt(i) ==  ch)
             {
                    count++;
      }
      }
      System.out.println("Count of occurrence of "+ ch +"="+count);
  }
}
```

OUTPUT

Enter the String: java
Enter the character: a
Count of occurrence of a =2

RESULT

The output is obtained and successfully verified.

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2. Java Program to Multiply Two Given Matrices

AIM

Write a Java program to multiply two given matrices using data types, operators, and control statements in Java.

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util.Scanner;
class Test
{
    public static void main(String args[])
    {
        Scanner sc = new Scanner(System.in);
System.out.print("Enter the order - m1:");
        int m1 = sc.nextInt();
        System.out.print("Enter the order - n1:");
        int n1 = sc.nextInt();
        System.out.print("Enter the order - m2:");
        int m2 = sc.nextInt();
        System.out.print("Enter the order - n2:");
        int n2 = sc.nextInt();
        if(n1 != m2)
        {
                System.out.println("Matrix Multiplication not Possible");
return;
        }
      int A[][] = new int[m1][n1];
      int B[][] = new int[m2][n2];
      int C[][] = new int[m1][n2];
      System.out.println("Read Matrix A");
for(int i=0;i<m1;i++)
        {
                for(int j=0;j<n1;j++)
                {
                        System.out.print("A["+i+"]["+j+"]=");
        A[i][j] = sc.nextInt();
                }
        }
      System.out.println("Read Matrix B");
for(int i=0;i<m2;i++)
        {
                for(int j=0;j<n1;j++)
```

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```
                {
                        System.out.print("B["+i+"]["+j+"]=");
    B[i][j] = sc.nextInt();
                }
    }
  for(int i=0;i<m1;i++)
    {
            for(int j=0;j<n2;j++)
              {
                    C[i][j]=0;
                    for(int k=0;k<n1;k++)
                    {
                            C[i][j] += A[i][k] * B[k][j];
                    }
              }
    }
  System.out.println("Matrix A"); for(int
  i=0;i<m1;i++)
    {
            for(int j=0;j<n1;j++)
              {
                    System.out.print(A[i][j]+"\t");
              }
                    System.out.println();
     }
  System.out.println("Matrix B");
  for(int i=0;i<m2;i++)
    {
            for(int j=0;j<n2;j++)
               {
                    System.out.print(B[i][j]+"\t");
               }
            System.out.println();
     }
  System.out.println("Matrix C");
  for(int i=0;i<m1;i++)
    {
            for(int j=0;j<n2;j++)
              {
                    System.out.print(C[i][j]+"\t");
              }
             System.out.println();
    }
 }
}
```

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OUTPUT

Enter the order - m1 2

Enter the order - n1 2

Enter the order - m2 2

Enter the order - n2 2

Read Matrix A: 2
2
2
2

Matrix A 2 2
2 2

Read Matrix B: 2
2
2
2

Matrix B 2 2
2 2

Matrix C 8
8

RESULT

The output is obtained and successfully verified.

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CYCLE 2

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3. Java Program Which Creates a Class Named 'Employee'

AIM

Write a Java program which creates a class named 'Employee' having the following members: Name, Age, Phone number, Address, Salary. It also has a method named 'print Salary ( )' which prints the salary of the Employee. Two classes 'Officer' and 'Manager' inherit the 'Employee' class. The 'Officer' and 'Manager' classes have data members 'specialization' and 'department' respectively. Now, assign name, age, phone number, address and salary to an officer and a manager by making an object of both of these classes and print the same. (Exercise to understand inheritance).

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util.Scanner;
class Employee
{
  private String name;
  private int age;
  private long phoneNumber;
  private String address;
   private double salary;
  public void setName(String name)
       {
              this.name = name;
       }
  public void setAge(int age)
       {
              this.age=age;
       }
  public void setPhoneNumber(long phoneNumber)
       {
              this.phoneNumber = phoneNumber;
       }
  public void setAddress(String address)
       {
              this.address = address;
       }
  public void setSalary(double salary)
       {
              this.salary = salary;
       }
  public double printSalary()
       {
```

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```
            return salary;
        }
    public String getName()
        {
            return name;
        }
    public int getAge()
        {
            return age;
        }
    public String getAddress()
        {
            return address;
        }
    public long getPhoneNumber()
        {
            return phoneNumber;
        }
}

class Officer extends Employee
 {
      private String specialization;
       private String department;
      public void setSpecialization(String specialization)
        {
            this.specialization = specialization;
        }
      public void setDepartment(String department)
        {
            this.department = department;
        }
      public String getDepartment()
        {
             return department;
        }
      public String getSpecialization()
        {
            return specialization;
        }

}
class Manager extends Employee
```

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```
{
        private String specialization;
        private String department;
        public void setSpecialization(String specialization)
            {
                this.specialization = specialization;
            }
        public void setDepartment(String department)
            {
                this.department = department;
            }
        public String getDepartment()
            {
                return department;
            }
        public String getSpecialization()
            {
                return specialization;
            }
}
class Test
 {
    public static void main(String args[])
        {
            Scanner sc = new Scanner(System.in);
             Officer o = new Officer();
            System.out.println("Enter the officer's Detail");
            System.out.print("Name:");
             o.setName(sc.nextLine());
            System.out.print("Address:");
             o.setAddress(sc.nextLine());
    System.out.print("Specialization:");
            o.setSpecialization(sc.nextLine());
            System.out.print("Department:");
            o.setDepartment(sc.nextLine());
             System.out.print("Age:");
            o.setAge(sc.nextInt()); System.out.print("Number:");
            o.setPhoneNumber(sc.nextLong());
            System.out.print("Salary:");
            o.setSalary(sc.nextDouble());
            sc.nextLine();
            System.out.println("The officer Detail");
```

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```
            System.out.println("Name:"+o.getName());
            System.out.println("Age:"+o.getAge());
            System.out.println("Number:"+o.getPhoneNumber());
            System.out.println("Address:"+o.getPhoneNumber());
            System.out.println("Salary:"+o.printSalary());
            System.out.println("Specialization:"+o.getSpecialization());
            System.out.println("Department:"+o.getDepartment());
            Manager m = new Manager(); System.out.println("Enter the
            manager's Detail"); System.out.print("Name:");
            m.setName(sc.nextLine()); System.out.print("Address:");
            m.setAddress(sc.nextLine());
            System.out.print("Specialization:");
            m.setSpecialization(sc.nextLine());
            System.out.print("Department:");
            m.setDepartment(sc.nextLine()); System.out.print("Age:");
            m.setAge(sc.nextInt());
            System.out.print("Number:");
            m.setPhoneNumber(sc.nextLong());
            System.out.print("Salary:");
            m.setSalary(sc.nextDouble());
            sc.nextLine();
            System.out.println("The manager's Detail"); System.out.println("Name:"+m.getName());
            System.out.println("Age:"+m.getAge());
            System.out.println("Number:"+m.getPhoneNumber());
            System.out.println("Address:"+m.getPhoneNumber());
            System.out.println("Salary:"+m.printSalary());
            System.out.println("Specialization:"+m.getSpecialization());
            System.out.println("Department:"+m.getDepartment());
    }
}
```

OUTPUT

```
Enter the officer's Detail
Name:Sangeeth
Address:Trivandrum
 Specialization:Computer Science
Department:CSE
Age:32
Number:9633566474
Salary:10000
```

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The officer Detail
Name:Sangeeth
Age:32
Number:9633566474
Address:9633566474
Salary:10000.0 Specialization:Computer
Science Department:CSE

Enter the manager's Detail
Name:Manu
Address:Kochi
Specialization:CSE
Department:Computer Science
Age:30
Number:9895881182
Salary:67000

The manager's Detail
Name:Manu
Age:30
Number:989588112
Address:9895881182 Salary:67000.0
Specialization:CSE
Department:Computer Science

RESULT

The output is obtained and successfully verified.

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4. Java Program to Create an Abstract Class

AIM

Write a java program to create an abstract class named Shape that contains an empty method named numberOfSides ( ). Provide three classes named Rectangle, Triangle and Hexagon such that each one of the classes extends the class Shape. Each one of the classes contains only the method numberOfSides ( ) that shows the number of sides in the given geometrical structures. (Exercise to understand polymorphism).

ALGORITHM / PROCEDURE

PROGRAM

```
abstract class Shape
{
   public abstract void numberOfSides();
}
class Rectangle extends Shape
{
   public void numberOfSides()
   {
     System.out.println("Number of Sides = 4");
   }
}
class Triangle extends Shape
{
   public void numberOfSides()
   {
       System.out.println("Number of Sides = 3");
   }
}
class Hexagon extends Shape
{
   public void numberOfSides()
   {
      System.out.println("Number of Sides = 6");
   }
}
class Test
{
   public static void main(String args[])
   {
      Rectangle r = new Rectangle();
      Triangle t = new Triangle();
      Hexagon h = new Hexagon();
```

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```
        r.numberOfSides();
        t.numberOfSides();
        h.numberOfSides();
    }
}
```

OUTPUT

Number of Sides of Rectangle = 4

Number of Sides of Triangle = 3

Number of Sides of Hexagon = 6

RESULT

The output is obtained and successfully verified.

HOD/USE

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5. Java Program That Read From A File And Write To File By Handling All File Related Exceptions

AIM

Write a Java program that read from a file and write to file by handling all file related exceptions.

ALGORITHM / PROCEDURE

PROGRAM

```
import java.io.FileWriter;
 import java.io.FileReader;
import java.io.IOException;
class ReadWriteFile
{
        public static void main(String[] args) throws IOException
        {
                // variable declaration
                 int ch;
                // check if File exists or not
                FileReader fr=new FileReader("sample.txt");
                FileWriter fw=new FileWriter("new sample.txt");
                // read from FileReader till the end of file, print the content and write to another file
        while ((ch=fr.read())!=-1)
                 {
                        System.out.print((char)ch);
                         fw.write((char)ch);
                 }
                // close the file
                fr.close();
                fw.close();
        }
}
```

OUTPUT

First create a file sample.txt with content "Hello world "
After execution of program a new file is generated with name new sample.txt with contents readed rom sample.txt.
"Hello world"

RESULT

The output is obtained and successfully verified.

HOD/CSE

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6. Java Program That Reads a Line of Integers, and Then Displays Each Integer, And the Sum of All the Integers

AIM

Write a Java program that reads a line of integers, and then displays each integer, and the sum of all the integers (Use String Tokenizer class of java.util).

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util.*;
class StringTokenizerDemo
{
        public static void main(String args[])
        {
                int n;
                int sum = 0;
                Scanner sc = new Scanner(System.in);
        System.out.println("Enter integers with one space gap:");
                String s = sc.nextLine();
                StringTokenizer st = new StringTokenizer(s, " ");
                while (st.hasMoreTokens())
                {
                        String temp = st.nextToken();
                        n = Integer.parseInt(temp);
                        System.out.println(n);
                        sum = sum + n;
                }
                System.out.println("sum of the integers is: " + sum);
                sc.close();
        }
}
```

OUTPUT

```
Enter integers with one space gap: 10 20
30 40 50
10
20
30
40
50
sum of the integers is: 150
```

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RESULT

The output is obtained and successfully verified.

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7. Java Program That Shows the Usage of Try, Catch, Throws and Finally

AIM

Write a Java program that shows the usage of try, catch, throws and finally.

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util.Scanner;
class Test
{
        public static void main(String args[])
        {
                Scanner sc = new Scanner(System.in);
                try
                {
                        System.out.println("Program to perform Division");
                        System.out.print("Enter Number-1:");
                        int a = sc.nextInt(); System.out.print("Enter Number-2:");    int
                b = sc.nextInt();
                        int c = a/b;
                        System.out.println("Result="+c);
                }
                catch(ArithmeticException e)
                {
                        System.out.print(e.getMessage( ));
                }
                finally
                {
                        System.out.println("End of Operation");

                }
        }
}
```

OUTPUT:

Program to perform Division

Enter Number-120

Enter Number-20

/ by zero

End of Operation

RESULT

The output is obtained and successfully verified.

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8. Java Program That Shows Thread Synchronization

AIM

Write a Java program that shows thread synchronization.

ALGORITHM / PROCEDURE

PROGRAM

```
class Display
{
    public synchronized void print(String msg)
    {
        System.out.print("["+msg);
        try
        {
            Thread.sleep(1000);
        }
        catch(Exception e)
        {
            System.out.println(e.getMessage());
        }
        System.out.println("]");
    }
}
class SyncThread extends Thread
{
    private   Display   d;
    private String msg;
    public SyncThread(Display d,String msg)
    {
        this.d=d;
        this.msg = msg;
    }
    public void run()
    {
        d.print(msg);
    }
}
class Test
{
    public static void main(String args[])
    {
        Display d = new Display();
```

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```
        SyncThread  t1  =  new  SyncThread(d,"Hello");
        SyncThread  t2  =  new  SyncThread(d,"World");
        t1.start();
                t2.start();
        }
}
```

OUTPUT

[Hello]
[World]

RESULT

The output is obtained and successfully verified.

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9. Java Program That Works as a Simple Calculator

AIM

Write a Java program that works as a simple calculator. Arrange Buttons for digits and the + - * % operations properly. Add a text field to display the result. Handle any possible exceptions like divide by zero. Use Java Swing.

ALGORITHM / PROCEDURE

PROGRAM

```
import javax.swing.*;
import java.awt.event.*;
class Calculator extends JFrame implements ActionListener
{
    private JTextField t1;
    private JButton b1;
    private JButton b2;
    private JButton b3;
    private JButton b4;
    private  JButton b5;
    private JButton b6;
    private JButton b7;
    private JButton b8;
    private JButton b9;
    private JButton b10;
    private JButton b11;
    private JButton b12;
    private JButton b13;
    private JButton b14;
    private JButton b15;
    private JButton b16;
    private JButton b17;
    private Integer res;
    private String operation;
    public Calculator( )
    {
        setLayout(null);
        setSize(680,480);
        t1 = new JTextField();
        t1.setBounds(100,100,200,30);
```

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```
b1 = new JButton("1");
b1.setBounds(100,140,50,30);
 b2 = new JButton("2");
b2.setBounds(150,140,50,30);
 b3 = new JButton("3");
b3.setBounds(200,140,50,30);
b4 = new JButton("+");
b4.setBounds(250,140,50,30);
// Third Row
b5 = new JButton("4");
b5.setBounds(100,170,50,30);
b6 = new JButton("5");
b6.setBounds(150,170,50,30);
b7 = new JButton("6");
b7.setBounds(200,170,50,30);
b8 = new JButton("-");
b8.setBounds(250,170,50,30);
// Fourth Row
b9 = new JButton("7");
b9.setBounds(100,200,50,30);
b10 = new JButton("8");
b10.setBounds(150,200,50,30);
b11 = new JButton("9");
b11.setBounds(200,200,50,30);
b12 = new JButton("*");
b12.setBounds(250,200,50,30);
b13 = new JButton("/");
b13.setBounds(100,230,50,30);
b14 = new JButton("%");
b14.setBounds(150,230,50,30);
b15=new JButton("=");
b15.setBounds(200,230,50,30);
b16=new JButton("C");
b16.setBounds(250,230,50,30);
b17=new JButton("0");
b17.setBounds(100,260,200,30);
add(t1);
add(b1);
add(b2);
add(b3);
add(b4);
add(b5);
```

Leena

```
        add(b6);
        add(b7);
        add(b8);
        add(b9);
        add(b10);
        add(b11);
        add(b12);
        add(b13);
        add(b14);
        add(b15);
        add(b16);
        add(b17);
        b1.addActionListener(this);b2.addActionListener(this);
        b3.addActionListener(this);b4.addActionListener(this);
        b5.addActionListener(this);b6.addActionListener(this);
        b7.addActionListener(this);b8.addActionListener(this);
        b9.addActionListener(this);b10.addActionListener(this);
        b11.addActionListener(this);b12.addActionListener(this);
        b13.addActionListener(this);b14.addActionListener(this);
        b15.addActionListener(this);b16.addActionListener(this);
        b17.addActionListener(this);
}
public void doAction(String op)
  {
        if(operation == null)
         {
                operation = op;
                res = Integer.parseInt(t1.getText());
         t1.setText("");
         }

        else
         {
                switch(operation)
                 {
                        case "+": res = res + Integer.parseInt(t1.getText());
                                break;
                        case "-": res = res - Integer.parseInt(t1.getText());
                                break;
                        case "/":       try
                                {
                                        if(t1.getText().equals("0")
```

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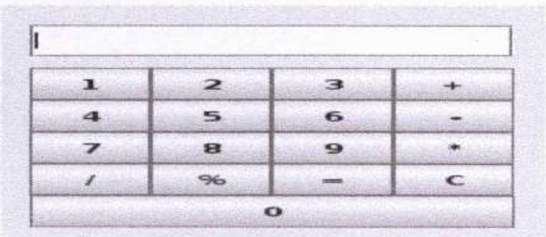
```
                        {
                                throw new ArithmeticException("Divide by Zero");
                        }
                        res = res / Integer.parseInt(t1.getText());
                catch(ArithmeticException e)
                {
                        t1.setText(e.getMessage());
                        operation = null;
                        res = 0;
                }
                break;
            case "*": res = res * Integer.parseInt(t1.getText());
                break;
            case "%": res = res % Integer.parseInt(t1.getText());
                break;
        }
        if(op.equals("="))
        {
            t1.setText(res.toString());
            res = 0;
            operation = null;
        }
        else
        {
            operation = op;
            t1.setText("");
        }
    }
}
public void actionPerformed(ActionEvent e)
{
        if(e.getSource()== b1)
                t1.setText(t1.getText()+"1");
            else if(e.getSource()== b2)
                t1.setText(t1.getText()+"2");
            else if(e.getSource()== b3)
                t1.setText(t1.getText()+"3");
            else if(e.getSource()== b5)
                t1.setText(t1.getText()+"4");
            else if(e.getSource()== b6)
                t1.setText(t1.getText()+"5");
            else if(e.getSource()== b7)
```

```
                        t1.setText(t1.getText()+"6");
                else if(e.getSource()== b9)
                        t1.setText(t1.getText()+"7");
                else if(e.getSource()== b10)
                        t1.setText(t1.getText()+"8");
                else if(e.getSource()== b11)
                        t1.setText(t1.getText()+"9");
                else if(e.getSource()== b16)
                        {
                                t1.setText("");
                                res =0;
                                operation = null;
                        }
                else if(e.getSource()== b4)
                        {
                                doAction("+");
                        }
                else if(e.getSource()== b8)
                        doAction("-");
                else if(e.getSource()== b12)
                        doAction("*");
                else if(e.getSource()== b13)
                        doAction("/");
                else if(e.getSource()== b14)
                        doAction("%");
                else if(e.getSource()== b15)
                        doAction("=");
        }
        public static void main(String args[])
                {
                        new Calculator().setVisible(true);
                }
}
```

OUTPUT



RESULT

The output is obtained and successfully verified.

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10.Java Program That Simulates a Traffic Light

AIM

Write a Java program that simulates a traffic light. The program lets the user select one of three lights: red, yellow, or green. When a radio button is selected, the light is turned on, and only one light can be on at a time. No light is on when the program starts.

ALGORITHM / PROCEDURE

PROGRAM

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;
class TrafficLight extends JPanel implements ActionListener
{
    private JRadioButton r1;
    private JRadioButton r2;
    private JRadioButton r3;
    private Color red_c;
    private Color green_c;
    private Color orange_c;
    public TrafficLight(){
    setBounds(0,0,600,480);
    r1 = new JRadioButton("Red");
    r2 = new JRadioButton("Green");
    r3 = new JRadioButton("Orange");
    ButtonGroup group = new ButtonGroup();
    r1.setSelected(true);
    group.add(r1);
    group.add(r2);
    group.add(r3);
    add(r1);
    add(r2);
    add(r3);
    red_c = Color.red;
    green_c = getBackground ();
    orange_c = getBackground();
    r1.addActionListener(this);
    r2.addActionListener(this);
    r3.addActionListener(this);
 }
public void actionPerformed(ActionEvent e)
```

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```
{
    if(r1.isSelected() == true)
    {
        red_c = Color.red;
        green_c = getBackground ();
        orange_c = getBackground();
    }
    else if(r2.isSelected() == true)
    {
        red_c = getBackground ();
        green_c = Color.green;
        orange_c = getBackground();
    }
    else if(r3.isSelected() == true)
    {
        red_c = getBackground ();
        green_c = getBackground();
        orange_c = Color.orange;
    }
    repaint();
}
public void paintComponent(Graphics g)
{
    super.paintComponent(g);
    g.drawOval(50,50,50,50);
    g.drawOval(50,110,50,50);
    g.drawOval(50,170,50,50);
    g.setColor(red_c);
    g.fillOval(50,50,50,50);
    g.setColor(orange_c);
    g.fillOval(50,110,50,50);
    g.setColor(green_c);
    g.fillOval(50,170,50,50);
}
}
class Test
{
  public static void main(String args[])
  {
        JFrame f1 = new JFrame();
        f1.setVisible(true);
        f1.setSize(600,480);
        f1.setLayout(null);
        TrafficLight t = new TrafficLight();
        f1.add(t);
```

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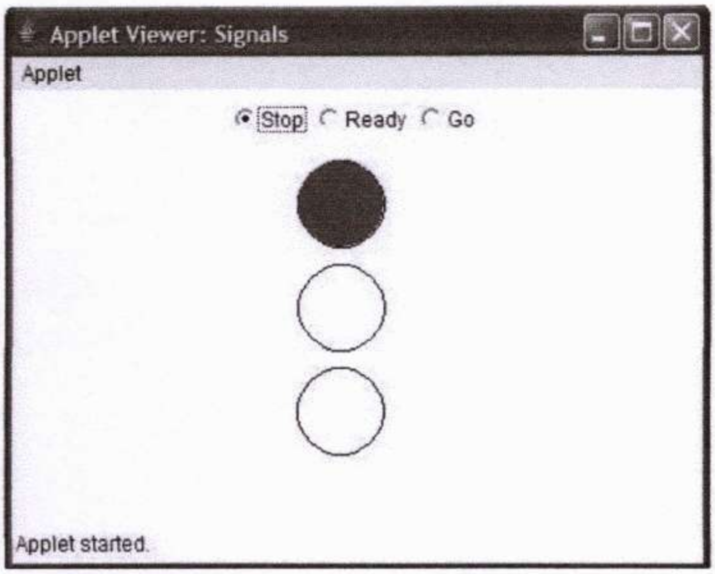
```
    }
}
```

OUTPUT



RESULT

The output is obtained and successfully verified

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CYCLE 3

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11.Java Program for Doubly Linked List Operations

AIM

Write a Java program for the following:

1. Create a doubly linked list of elements.
2. Delete a given element from the above list.
3. Display the contents of the list after deletion

.

ALGORITHM / PROCEDURE

PROGRAM

```
import java.util.Scanner;
class LinkedList
{
  private Node head;
  class Node
   {
          private int data;
          private Node left;
          private Node right;
          public Node(int data)
              {
                  this.data = data;
                  this.left = null;
                  this.right = null;
              }
    }
  public void insert(int data)
    {
          Node temp = new Node(data);
          if(head == null)
           {
                  head = temp;
           }
          else
          {
              Node ptr = head;
              while(ptr.right != null)
               {
                  ptr = ptr.right;
               }
```

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```
                ptr.right = temp;
                temp.left = ptr;
            }
        }
    public void delete()
    {
        int x = head.data;
        head = head.right;
        head.left = null;
        System.out.println("Element "+x +" got deleted");
    }
    public void display()
    {
        if(head == null)
        System.out.println("List is Empty");
        else
          {
                Node ptr = head;
                while(ptr != null)
                {
                        System.out.print(ptr.data +"\t");
                        ptr = ptr.right;
                }
        System.out.println();
    }
  }
}
class Test
{
    public static void main(String [] args)
      {
        LinkedList list = new LinkedList();
        Scanner sc = new Scanner(System.in);
        String choice = "";
        while(!choice.equals("4"))
            {
                System.out.print("1. Insert at End \n2. Delete From Front \n3. Display \n4.Exit\n");
                System.out.println("Enter the choice:");
                choice = sc.nextLine();
                switch(choice)
                {
                        case "1": System.out.print("Enter the number to insert:");
```

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```
                        int data = sc.nextInt();
                        sc.nextLine();
                        list.insert(data);
                        System.out.println("Data inserted Successfully");
                        break;
                case "2": list.delete();
                        break;
                case "3": list.display();
                        break;
                case "4": break;
                default: System.out.println("Invalid Choice");
            }
        }
    }
}
```

OUTPUT

```
1. Insert at End
2. Delete From Front
3. Display
4.Exit

Enter the choice: 1
Enter the number to insert :10
10
Data inserted successfully
```

RESULT

The output is obtained and successfully verified.

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12.Java Program That Implements Quick Sort Algorithm

AIM

Write a Java program that implements Quick sort algorithm for sorting a list of names in ascending order.

ALGORITHM / PROCEDURE

PROGRAM

```
public class QuickSortOnStrings
 {
      String names[];
      int length;
      public static void main(String[] args)
      {
         QuickSortOnStrings obj = new QuickSortOnStrings();
        String stringsList[] = {"Raja", "Gouthu", "Rani", "Gouthami", "Honey", "Heyaansh", "Hello"};
        obj.sort(stringsList);
        for (String i : stringsList) { System.out.print(i); System.out.print(" ");
      }
}
void sort(String array[])
{
      if (array == null || array.length == 0)
      {
         return;
      }
         this.names = array;
         this.length = array.length;
         quickSort(0, length - 1);
}
void quickSort(int lowerIndex, int higherIndex)
{
      int i = lowerIndex;
      int j = higherIndex;
      String pivot = this.names[lowerIndex + (higherIndex - lowerIndex) / 2];
      while (i <= j)
      {
         while (this.names[i].compareToIgnoreCase(pivot) < 0)
         {
               i++;
         }
```

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```
            while (this.names[j].compareToIgnoreCase(pivot) > 0)
             {
                  j--;
            if (i <= j)
              {
                exchangeNames(i, j);
                    i++;
             }
           }
       if (lowerIndex < j)
          {
               quickSort(lowerIndex, j);
          }
       if (i < higherIndex)
          {
            quickSort(i, higherIndex);
          }
     }
void exchangeNames(int i, int j)
 {
   String temp = this.names[i];
    this.names[i] = this.names[j];
   this.names[j] = temp;
 }
}
```

OUTPUT

```
Gouthami
Gouthu
Hello
Heyaansh
Honey Raja
Rani
```

RESULT

The output is obtained and successfully verified.

HOD/CSE

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Approved by:

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11/11/2021.

Dated signature of Module Coordinator

Dated signature of HOD

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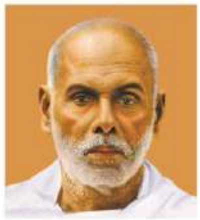

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS ENGINEERING

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

(Affiliated to KTU & Kannur University and Approved by AICTE New Delhi)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ECL202: ANALOG CIRCUITS ANDSIMULATION LAB MANUAL

For Third Year B.Tech Degree Courses

(As per APJ Abdul Kalam Technological University Syllabus)

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HOD

ANALOG CIRCUITS AND SIMULATION LABORATORY

MANUAL

6/6/23

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CODE OF CONDUCT FOR THE LABORATORIES

1. **Safety is first, work is next.**

2. Each lab group will be assigned an area to store lab materials. Please store your components and other equipment only in your assigned area.

3. Make sure TEST instruments are set for proper FUNCTION AND RANGE prior to taking a measurement.

5. Do not remove any parts or equipment from the lab without prior permission from the course coordinator or laboratory staff.

6. Report all equipment problems to laboratory staff.

7. Do not write on equipments and work table.

8. Do not put suspected defective parts back in the bins. Give them to laboratory staff for testing or disposal.

9. Return components and connecting wires, when you are finished with them.

10. Each group is responsible for the Lab bench. After the Lab exercise is over, all equipment should be powered down and disconnected from the socket, all probes, cords, etc. returned to their proper position. Do not cut and drop wires on the Lab bench. Your Lab grade will be affected if your bench is not tidy when you leave the Lab.

11. Lab clean up (to be accomplished at the end of each lab session):

i. Turn off test equipment.

ii. Put hand tools back on the pegboard rack.

iii. Place the chairs properly.

iv. Clean bench top.

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EXPT.No-1

RC INTEGRATOR AND DIFFERENTIATOR

AIM

1. To design and set up a RC integrator circuit,RC differentiator circuit and study the response to square wave.
2. To observe the response of the designed circuits for the given square waveform for RC<<T,RC=T,RC>>T.

COMPONENTS & EQUIPMENTS REQUIRED

Resistor 5.6KΩ	-	1No:
Capacitor 2.2μF ,0.1μF, 0.22μF,1μF	-	1 No:
Function Generator	-	1 No:
CRO	-	1 No:
Bread board	-	1 No:
Connecting Wires		

THEORY

An RC integrator is constituted by a resistance in series and a capacitor parallel with the output. This circuit produces an output voltage that is proportional to the integral of the input. Here the time constant is very large in comparison with the time required for the input signal to change. Under this condition the voltage drop across C will be very small in comparison with the drop across R. The current is V_{in}/R since almost all current appears across R. Output voltage across C is

$$\text{For } RC>>\tau, V_O = V_C = \frac{1}{RC}\int_0^{\tau} V_{in}\, dt$$

Voltage drop across C increases as time increases.A square waveform has positive and negative excursions with respect to its reference zero. If the input is square wave, capacitor charges and discharges from negative voltage to the positive voltage and back.For the circuit to work as a good integrator $\theta=90^0$ .As $\tan\theta=\omega RC$; tan90=infinity, which is practically impossible. Therefore a reasonable criterion for good integration is $\theta=89.4^0$ if $\theta=89.4^0$, $\omega RC=95.48^0$. So RC>16T will give the integrating practically.

An RC differentiator circuit is constituted with a capacitor connected in series and a resistor connected in parallel to the output. The time constant RC of the circuit is very small in comparison with the time period of the input signal. The voltage drop across R will be very small in comparison with the drop across C. The current through the capacitor is $C\frac{dV_{in}}{dt}$.Hence the output is proportional to the derivative of the input. Output voltage across R is

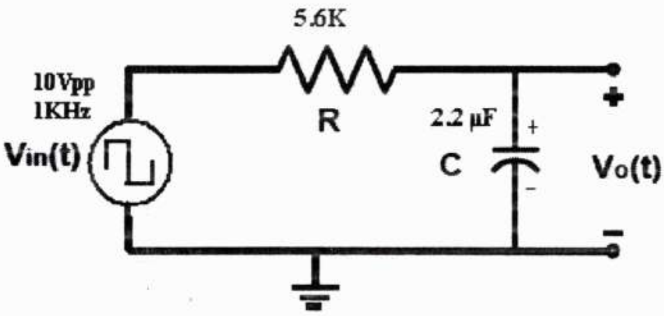
$$\text{For } RC<<\tau, V_O = V_R \cong RC\frac{dV_{in}}{dt}$$

Differentiated output is proportional to the rate of change of input. When the input rises to maximum value, differentiated output follows it because the sudden change of voltage is transferred to the output by the capacitor. Since the rate of change of voltage is positive ,differentiated output is also positive. When input remains maximum for a period of time, the rate of change of voltage is zero. So output falls to zero. During this time, input acts like a dc voltage and capacitor offers high impedance to it. So the charges in capacitor drains to earth through the resistance. When input falls to zero, rate of change of input voltage is negative. Then the output also goes to negative.

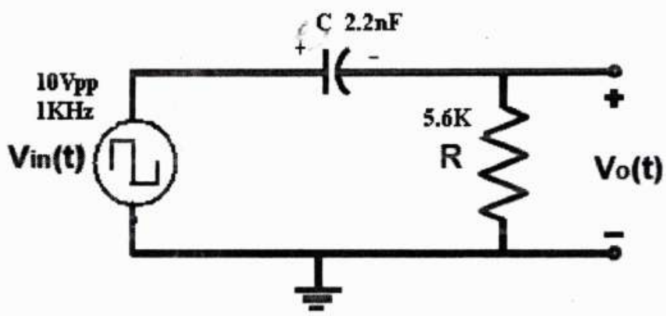
For the circuit to work as a good differentiator $\theta=90^0$ .As $\tan\theta=1/\omega RC$; tan90=infinity. This result can be obtained only if R=0 or C=0, which is practically impossible. Therefore a reasonable criterion for good differentiation is $\theta=89.4^0$ if $\frac{1}{wRC}=100$.So RC=0.0016T will give the differentiating practically. Assume RC=0.01T for getting good spike waveforms. The peak of the output of the differentiator gets doubled when the square wave is fed to the input.

CIRCUIT DIAGRAM

RC Integrator



RC Differentiator



DESIGN

RC Integrator

Case 1: RC>>T

To avoid loading, select R=10 times the output impedance of signal generation. If output impedance=600Ω, select R=6000ΩUse R=5.6KΩ

RC=10T

where R=5.6KΩ and T=1ms

then C=10T/R=1.78µF (2.2µF standard)

Case2:RC=T

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$RC=T$

where $R=5.6K\Omega$ and $T=1ms$

then $C=T/R=0.22\mu F$ ($0.22\mu F$ standard)

Case3: $RC<<T$

$RC=0.1T$

where $R=5.6K\Omega$ and $T=1ms$

then $C=0.1T/R=0.0178\mu F$ ($0.01\mu F$ standard)

RC Differentiator

Case 1: $RC<<T$

To avoid loading, select R=10 times the output impedance of signal generation.If output impedance=600Ω, select $R=6000\Omega$.,Use $R=5.6K\Omega$.

$RC=0.01T$

where $R=5.6K\Omega$ and $T=1ms$

then $C=0.01T/R=1.78nF$ (2.2nF standard)

Case2: $RC=T$

$RC=T$

where $R=5.6K\Omega$ and $T=1ms$

then $C=T/R=0.22\mu F$ ($0.22\mu F$ standard)

Case3: $RC>>T$

$RC=5T$

where $R=5.6K\Omega$ and $T=1ms$

then $C=5T/R=0.89\mu F$ ($1\mu F$ standard)

PROCEDURE

1. Set up the circuit as per the diagram of integrator.
2. Switch on the function generator and set a square wave of 2Vpp,1KHz.
3. Observe the input and output on the X and Y channels of CRO respectively.
4. Note down the output waveforms for the following conditions:
    - RC<<T
    - RC=T
    - RC>>T (Integrator)
5. Repeat the same steps for differentiator.

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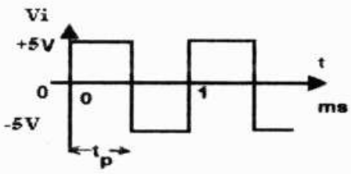
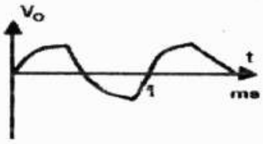
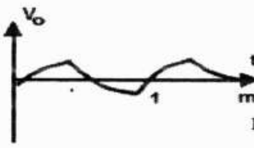
OUTPUT WAVEFORMS

Integrator

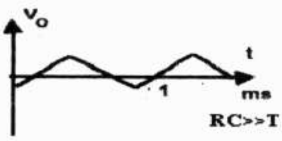




RC<<T

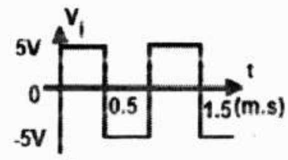


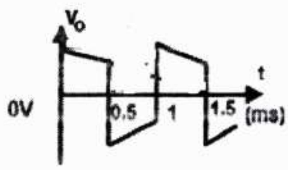
RC=T



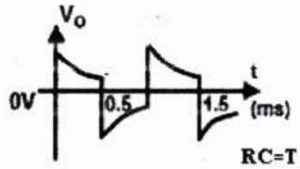
RC>>T

Differentiator

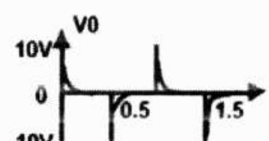




RC>>T



RC=T



RC<<T

RESULT

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RC Integrator and differentiator circuits are designed and observed the waveforms for different time constants.

VIVA QUESTIONS

1. Mention one application of the RC integrator.
2. What is the requirement of a low pass filter to act as integrator?
3. What is time constant of an RC circuit?
4. Mention one application of the RC differentiator.
5. What is the requirement of a high pass filter to act as differentiator?

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EXPT.No-2

CLIPPING AND CLAMPING CIRCUITS

AIM

Design and setup various clipping circuits and clamping circuits using diodes and plot the output waveform and transfer characteristics.

COMPONENTS & EQUIPMENTS REQUIRED

PN Diode 1N4007	-	1No:
Zener diode SZ5.6	-	1 No:
Resistors 3.3KΩ	-	1 No:
Function Generator	-	1 No:
CRO	-	1 No:
Regulated Power Supply 0-30 V	-	1 No:
Bread board		
Capacitor 1μF	-	1 No:
Connecting Wires		

THEORY

<u>CLIPPING CIRCUITS</u>

The property of a diode as a switching device is utilized in clipping circuits. Clipping circuits are linear wave shaping circuits. They are useful to clip off the positive or negative portions of an input waveform. It can also be used to slice off an input waveform between two voltage levels. Using a positive clipper, a moderate quality square waveform can be generated from a sine wave. The diode clippers can be classified as series and shunt clippers. If a diode is connected in series with input in a clipper, such a clipper is called a series clipper. If the diodes are connected in parallel with the input, that clipper is called a shunt clipper. A resistance is used to limit the current through the diode. The value of the series resistance used in the clipping circuits is given by the expression :

$$R = \sqrt{R_f * R_r}$$

where R_f = forward resistance of the diode and R_r = reverse resistance of the diode.

Positive clipper with clipping level at 0.6V :

This circuit passes only negative going half cycles of the input to the output. The entire positive half cycle is bypassed through the diode since the diode gets forward biased when the input becomes positive. Due to the voltage drop across the diode the clipping occurs exactly at +0.6V.

1. **Negative clipper with clipping level at 0.6V :**

This circuit passes only positive going half cycles of the input to the output. The entire negative half cycle is bypassed through the diode since the diode gets forward biased when the input becomes negative. Due to the voltage drop across the diode the clipping occurs exactly at -0.6V.

2. **Positive clipper with clipping level at +2.6V :**

For the diode to be forward biased anode voltage must be greater than cathode voltage. Till the input becomes greater than +2V, diode is reverse biased and the input will appear at the output. When the input exceeds +2V, diode becomes forward biased and the cell voltage appears at the output. Since the diode is in series with the cell, actual clipping level is +2.6V.

3. **Negative clipper with clipping level at -2.6V :**

Till the input becomes less than -2V, diode is reverse biased and the input will appear at the output. When the input is less than -2V, diode becomes forward biased and the cell voltage appears at the output. Since the diode is in series with the cell, actual clipping level is -2.6V.

4. **Positive clipper with clipping level at -1.4V :**

The diode is forward biased till the input becomes less than -1.4V .Here the cell voltage appears at the output. During the negative cycle when the input is less than -1.4V, diode is reverse biased and input appears at the output.

5. **Negative clipper with clipping level at +1.4V :**

During the positive cycle when the input is greater than +1.4V, diode is reverse biased and input appears at the output. Till the input becomes greater than +1.4V diode is forward biased and the cell voltage appears at the output.

6. **Double clipper with clipping level at +3.6V & -2.6V :**

This circuit is the merging positive and negative clippers. During the positive half cycle of the input, one branch will be effective and the other remains open and vice versa during negative half cycle. Actual clipping levels ate +3.6V and -2.6V.

7. **Positive slicer with slicing level at +1.4V & +3.6V :**

This circuit allows the signal to pass to the output only between +3V and +2V. During the negative half cycle of the input, diode D_1 conducts and diode D_2 gets reverse biased. Thus the output remains at +2V. During the positive half cycle of the input, when input exceeds +2V, D_1 is reverse biased and the input appears at the output. If the output exceeds +3V, diode D_2 conducts and the output remains at +3V. Actual clipping levels ate +1.4V and +3.6V.

8. **Clipper using Zener diode :**

During positive cycle till +5.6V zener diode is reverse biased and all of input will appear at output. The output remains at +5.6V. During negative cycle diode is forward biased and the diode drop of -0.6V will appear at the output.

CLAMPING CIRCUITS

Clamping circuits are necessary to add or subtract a dc voltage to a given waveform without changing the shape of the waveform. A capacitor which is charged to a voltage and subsequently prevented from discharging can serve as a suitable replacement for a dc source. This principle is used in clamping circuits. The clamping level can be made at any voltage level by biasing the diode. Such a clamping circuit is called a biased clipper.

Suppose the input voltage is represented by the expression V_m sinωt

1. **Positive clamper with clamping level at 0V :**

During one negative half cycle of the input sine wave, the diode conducts and capacitor charges to V_m with positive polarity at right side of the capacitor. During positive half cycle of the input sine wave, the capacitor cannot discharge since the diode does not conduct. Thus capacitor acts a dc source of V_m connected in series with the input signal source. The output voltage then can be expressed as $V_o = V_m + V_m \sin\omega t$.

2. **Negative clamper with clamping level at 0V :**

During one positive half cycle of the input sine wave, the diode conducts and capacitor charges to V_m with negative polarity at right side of the capacitor. During negative half cycle of the input sine wave, the capacitor cannot discharge since the diode does not conduct. Thus capacitor acts a dc source of V_m connected in series with the input signal source. The output voltage then can be expressed as $V_o = -V_m + V_m \sin\omega t$.

3. **Positive clamper with clamping level at +3V :**

During one negative half cycle of the input sine wave, capacitor charges through the dc source and diode till (V_m+3) volts with positive polarity of the capacitor at the right side. The charging of the capacitor is limited to (V_m+3) volts due to the the presence of the dc source. The output is then $V_o = (V_m+3) + V_m \sin\omega t$.

4. **Negative clamper with clamping level at -3V :**

During one positive half cycle of the input sine wave, capacitor charges through the dc source and diode till (V_m+3) volts with negative polarity of the capacitor at the right side. The charging of the capacitor is limited to (V_m+3) volts due to the the presence of the dc source. The output is then $V_o = -(V_m+3) + V_m \sin\omega t$.

5. **Positive clamper with clamping level at -3V :**

During one negative half cycle of the input sine wave, capacitor charges through the dc source and diode till (V_m-3) volts with positive polarity of the capacitor at the right side. The charging of the capacitor is limited to (V_m-3) volts due to the the presence of the dc source. The output is then $V_o = (V_m-3) + V_m \sin\omega t$.

6. **Negative clamper with clamping level at +3V :**

During one positive half cycle of the input sine wave, capacitor charges through the dc source and diode till (V_m-3) volts with negative polarity of the capacitor at the right side. The charging of the capacitor is limited to (V_m-3) volts due to the the presence of the dc source. The output is then $V_o = -(V_m-3) + V_m \sin\omega t$.

DESIGN

Select 1N4007

The series resistance used for current limiting

$$R = \sqrt{R_f * R_r}$$

Typical values of forward resistance Rf = 30 Ω and of Rr= 300 kΩ.

$R = \sqrt{(30 \times 300k)} = 3k$ .Use 3.3 kΩ standard .

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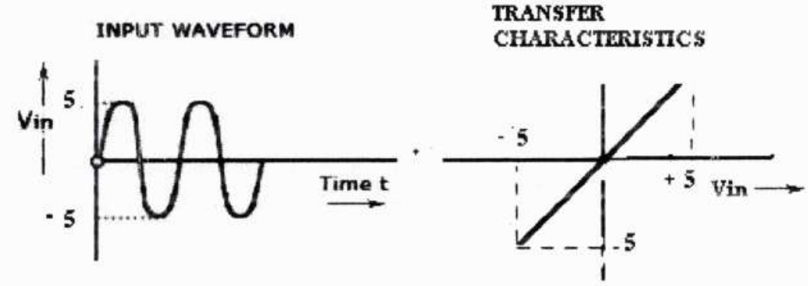
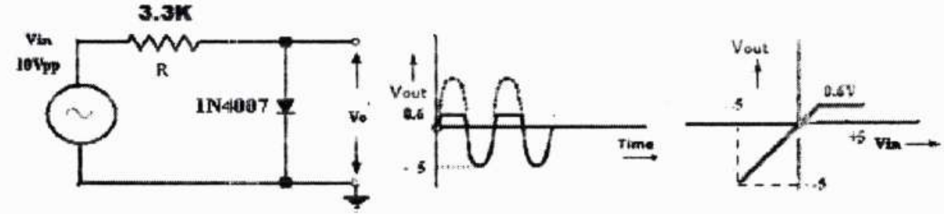
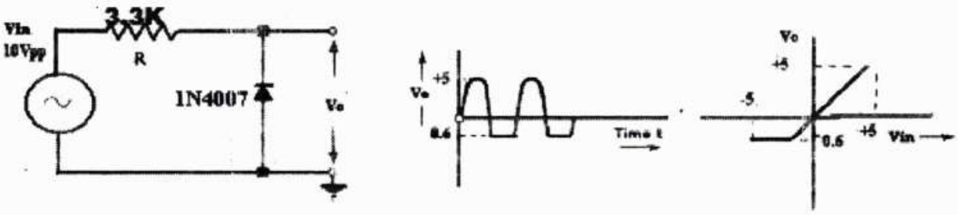
CIRCUIT DIAGRAM, WAVEFORMS & TRANSFER CHARACTERISTICS



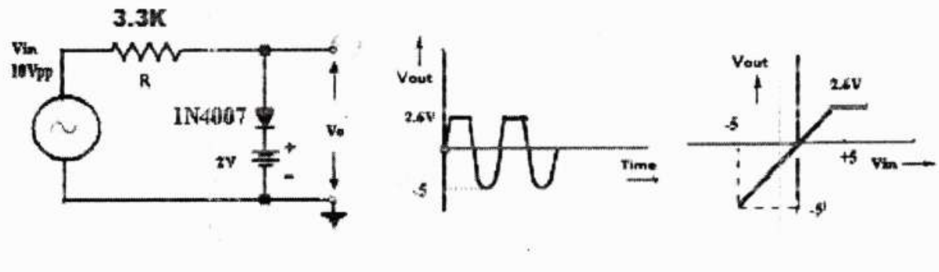
1. **Positive clipper with clipping level at 0.6V**



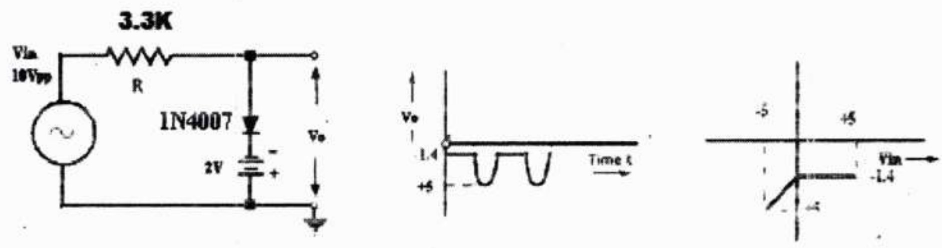
2. Negative clipper with clipping level at 0.6V :



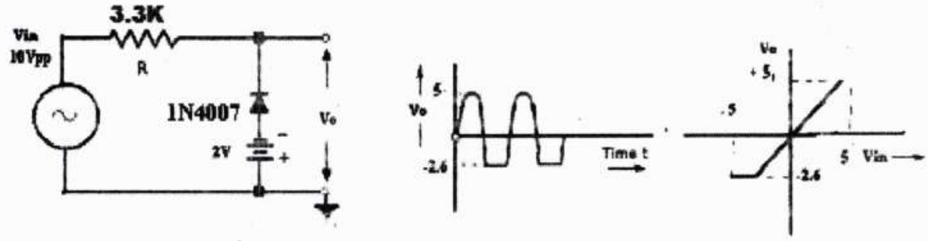
3. Positive clipper with clipping level at +2.6V



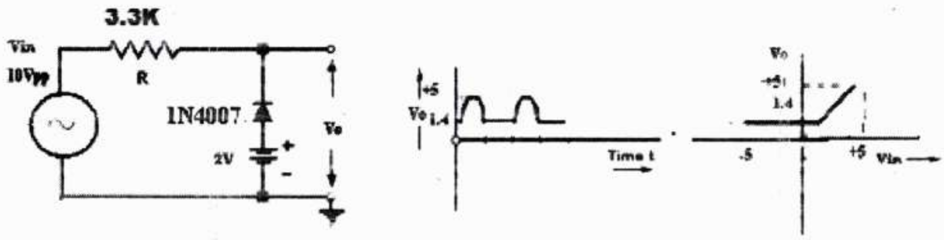
4. Positive clipper with clipping level at -1.4V



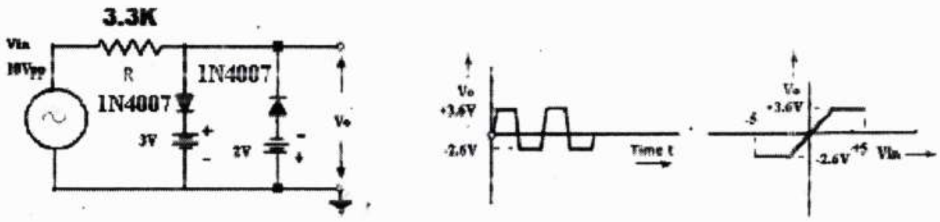
5. Negative clipper with clipping level at -2.6V



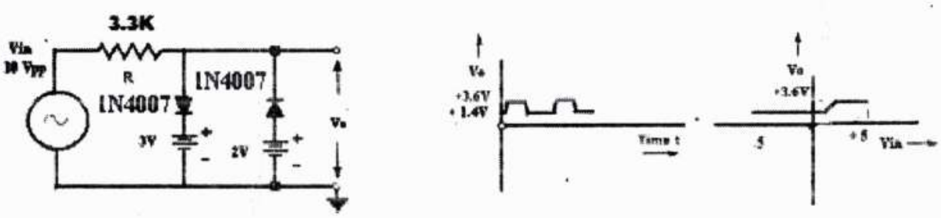
6. Negative clipper with clipping level at +1.4V



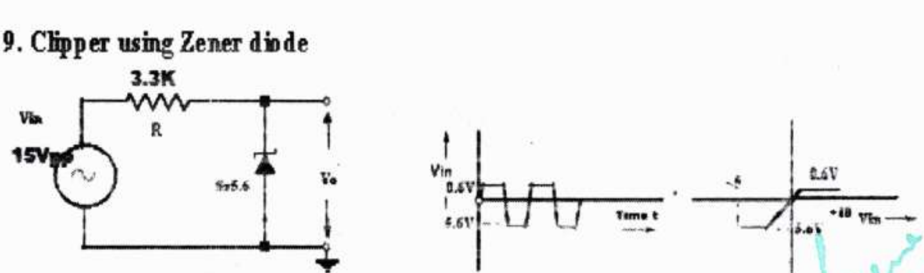
7. Double clipper with clipping level at +3.6V & -2.6V



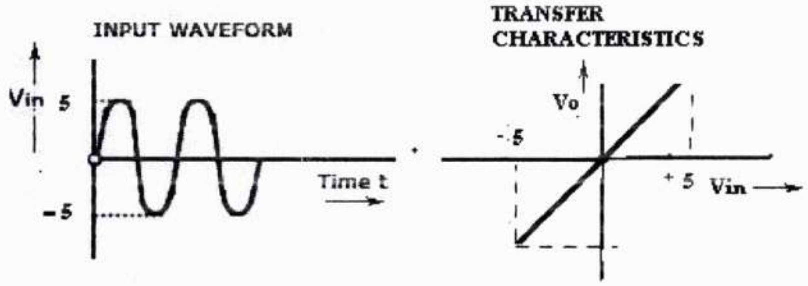
8. Positive slicer with slicing level at +1.4V & +3.6V



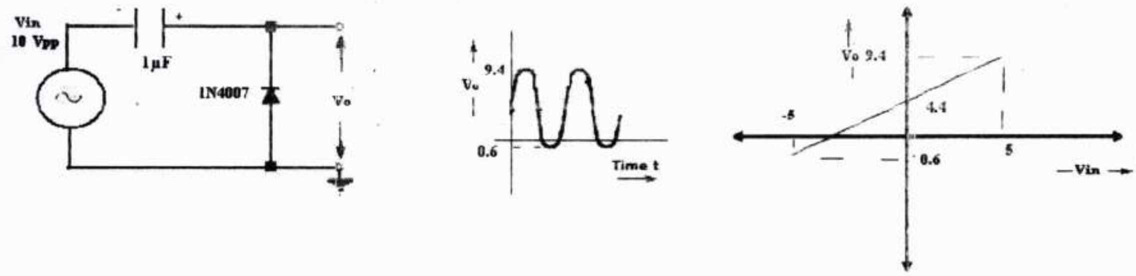
9. Clipper using Zener diode



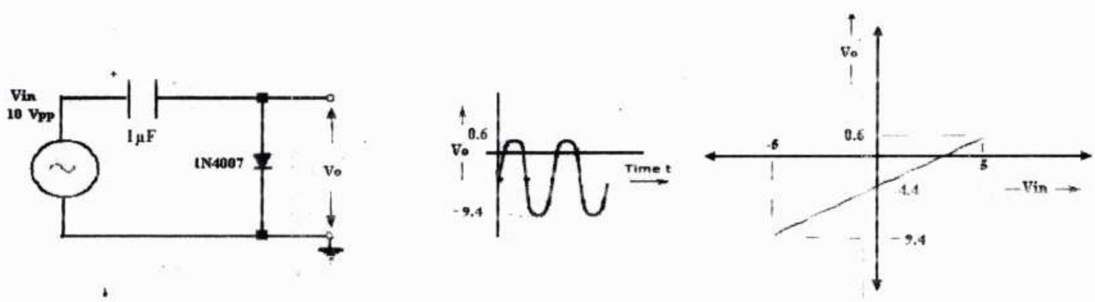
CIRCUIT DIAGRAM, WAVEFORMS & TRANSFER CHARACTERISTICS



1. Positive clamper with clamping level at 0V



2. Negative clamper with clamping level at 0V



3. Positive clamper with clamping level at +3V

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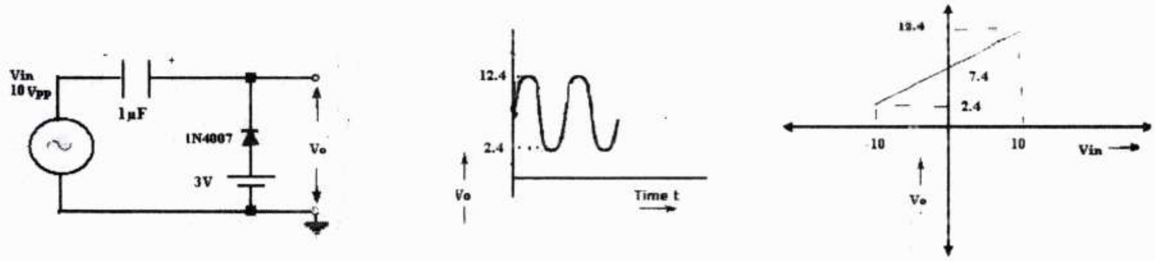
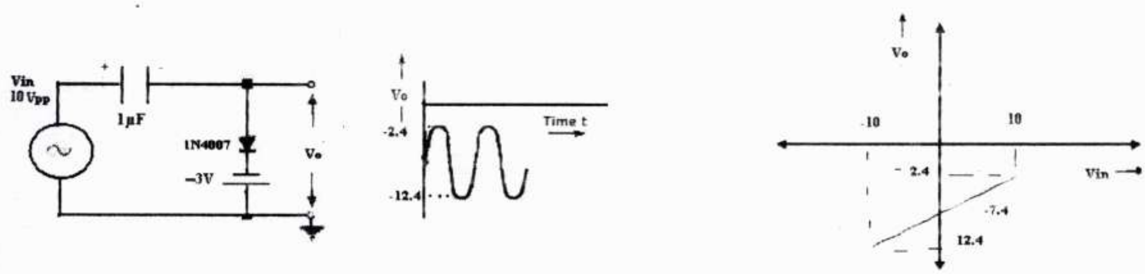
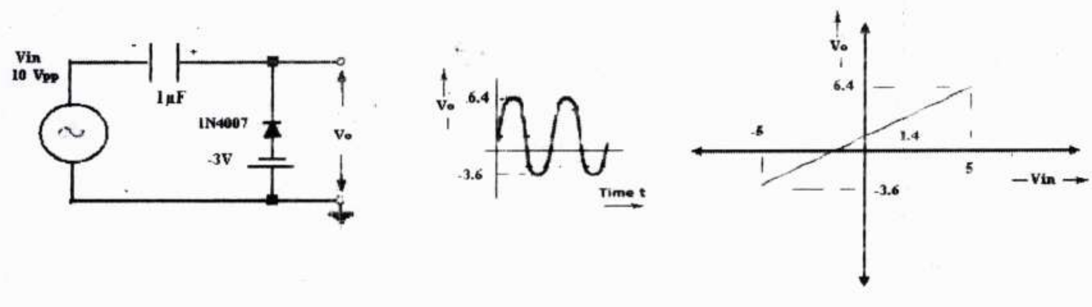


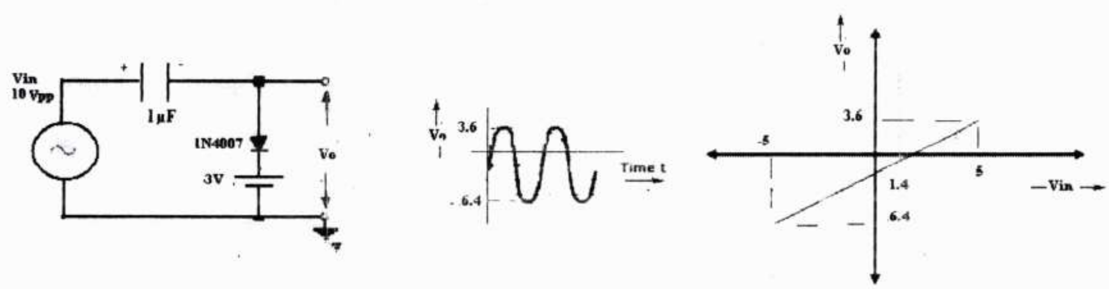
4. **Negative clamper with clamping level at -3V**



5. Positive clamper with clamping level at -3V



6. Negative clamper with clamping level at +3V



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PROCEDURE

CLIPPING

1. Set up the circuit as per the circuit diagram.
2. Apply 10Vpp,1 KHz input sine wave to the circuit from the signal generator.
3. Observe the output wave form on the CRO. Apply the input to X channel and output to channel Y and observe the waveforms simultaneously. Switch AC-DC coupling switch to DC mode.
4. To observe the transfer characteristics, keep the XY mode switch pressed and view the output.
5. Draw the output considering the diode drop.

CLAMPING

1. Set up the circuit as per the circuit diagram.
2. Apply 10Vpp, 1 KHz input sine wave to the circuit from the signal generator.
3. Observe the output wave form on the CRO. Apply the input to X channel and output to channel Y and observe the waveforms simultaneously. Switch AC-DC coupling switch to DC mode.
4. To observe the transfer characteristics, keep the XY mode switch pressed and view the output.
5. Draw the output considering the diode drop.

RESULT

Various clipping and clamping circuits are studied and plotted the output waveforms and transfer characteristics.

VIVA QUESTIONS

1. How the anode & cathode terminals of diode can be identified?
2. What are the applications of the clipper?
3. How the required clamping can be achieved?
4. What are the applications of the clamper?

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EXPT.No-3

RC COUPLED AMPLIFIER

AIM

To design and set up an RC-coupled CE amplifier using bipolar junction transistor and to plot its frequency response.

COMPONENTS AND EQUIPMENTS REQUIRED

SL NO	COMPONENT	SPECIFICATION	QUANTITY
1	Resistor	47K,10K,2.2K,680Ω	1
2	Capacitor	10μF,10μF,22μF	1
3	Transistor	BC 107	1
4	CRO		1
5	DC source		1
6	Signal generator		1
7	Connecting wires		
8	Bread board		1

THEORY

RC-coupled CE amplifier is widely used in audio frequency applications in radio and TV receivers. It provides current, voltage and power gains. Base current controls the collector current of a common emitter amplifier. A small increase in base current results in a relatively large increase in collector current. Similarly, a small decrease in base current causes large decrease in collector current. The emitter-base junction must be forward biased and the collector base junction must be reverse biased for the proper functioning of an amplifier. In the circuit diagram, an NPN transistor is connected as a common emitter ac amplifier. R_1 and R_2 are employed for the voltage divider bias of the transistor. Voltage divider bias provides good stabilisation independent of the variations of β. The input signal V_{in} is coupled through C_{C1} to the base and output voltage is coupled from collector through the capacitor C_{C2}. The input impedance of the amplifier is expressed as $Zin = R_1 II R_2 II(1+h_{FE}\ re))$ and output impedance as $Z_{out} = R_C\ II\ R_L$ where r_e is the internal emitter resistance of the transistor given by the expression = 25 mV/I_E, where 25 mV is temperature equivalent voltage at room temperature.

Selection of transistor: Transistor is selected according to the frequency of operation, and power requirements. Low frequency gain of a BJT amplifier is given by the expression. Voltage gain $A_v = -h_{FE}RL/ Ri$. In the worst case with $R_L = R_i$; $A_V = -h_{FE}$. h_{FE} of any transistor will vary in large ranges, for BC107 (an AF driver) varies from 100 to 500. Therefore a transistor must be selected such that its minimum guaranteed h_{FE} is greater than or equal to A_V required.

Selection of supply voltage :V_{CC} For a distortion less output from an audio amplifier,the operating point must be kept at the middle of the load line selecting V_{CEQ} = 50% V_{CC} (= 0:5V_{CC}). This means that the output voltage swing in either positive or negative direction is half of V_{CC} . However, V_{CC} is selected 20% more than the required voltage swing. For example, if the required output swing is 10 V, V_{CC} is selected 12 V.

Selection of collector current I_C: The nominal value of I_C can be selected from the data sheet. Usually it will be given corresponding to h_{FE} bias. It is the bias current at which h_{FE} is measured. For BC107 it is 2mA, for SL100 it is 150mA, and for power transistor 2N3055 it is 4 A.

Design of emitter resistor R_E: Current series feedback is used in this circuit using R_E. It stabilizes the operating point against temperature variation. Voltage across R_E must be as high as possible. But, higher drop across R_E will reduce the output voltage swing. So, as a rule of thumb, 10% of V_{CC} is fixed across R_E.

Design of R_C: Value of R_C can be obtained from the relation $R_C = 0{:}4V_{CC}/I_C$ since remaining 40% of V_{CC} is dropped across R_C.

Design of potential divider R_1 and R_2: Value of I_B is obtained by using the expression $I_B = I_C/h_{FEmin}$. At least $10I_B$ should be allowed to flow through R_1 and $9I_B$ through R_2 for the better stability of bias voltages. If the current through R_1 and R_2 is near to I_B, slight variation in I_B will a affect the voltage across R_1 and R_2. In other words, the base current will load the voltage divider. When I_B gets branched into the base of transistor, $9I_B$ flows through R_2. Values of R_1 and R_2 can be calculated from the dc potentials created by the respective currents.

Design of bypass capacitor C_E: The purpose of the bypass capacitor is to bypass signal current to ground. To bypass the frequency of interest, reactance of the capacitor X_{CE} computed at that frequency should be much less than the emitter resistance. As a rule of thumb, it is taken $X_{CE} \leq R_E/10$.

Design of coupling capacitor C_C: The purpose of the coupling capacitor is to couple the ac signal to the input of the amplifier and block dc. It also determines the lowest frequency that to be amplified. Value of the coupling capacitor C_C is obtained such that its reactance X_C at the lowest frequency (say 100 Hz or so for an audio amplifier $\leq$ Rin/10.Here Rin = $R_1 II R_2 II (1 + h_{FE}$ re) where re is the internal emitter resistance of the transistor given by the expression re= 25 mV/I_E at room temperature.

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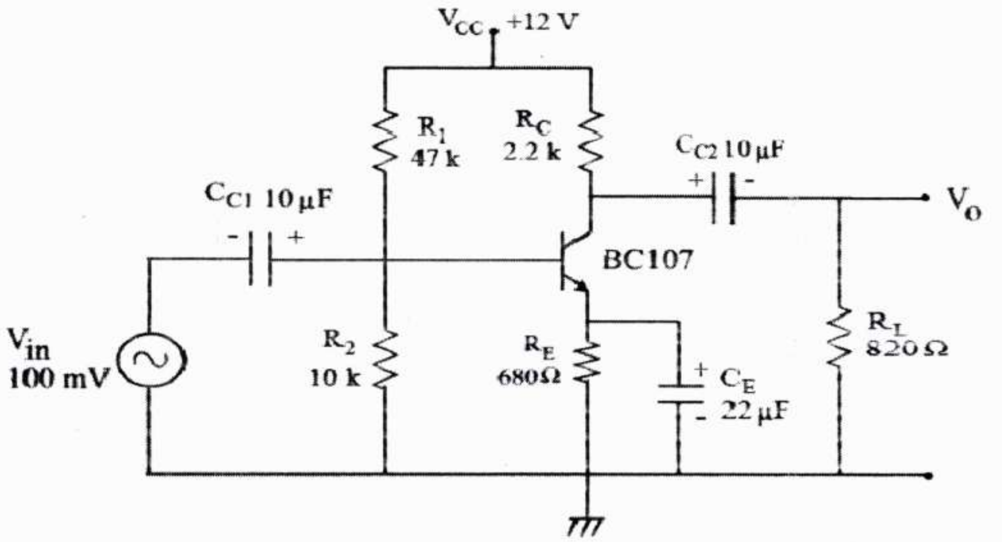
CIRCUIT DIAGRAM



DESIGN

Output requirements: Mid-band voltage gain of the amplifier = 50 and required output voltage swing = 10 V.

Selection of transistor: Select transistor BC107 since its minimum guaranteed h_{FE}(= 100) is more than the required gain (=50) of the amplifier.

DC biasing conditions:
V_{CC} = 12 V, I_C = 2 mA.
V_{RC} = 40% of V_{CC} = 4.8 V.
V_{RE} = 10% of V_{CC} = 1.2 V and
V_{CE} = 50% of V_{CC} = 6 V.

Design of Rc:
V_{RC}= Ic x Rc= 4.8
V_Rc= 4.8/2mA = 2.4 kΩ. Use 2.2 kΩ

Design of R_E:
V_{RE}= I_E x R_E= 1.2
V_{RE}= 1.2/2mA = 600 Ω. Use 680 Ω

Design of potential divider $R_1$and R_2:
I_B= I_C/ h_{FE}= 2 mA/ 100 = 20 μA.
Assume the current through R_1= **10**I_B and that through R_2= **9**I_B to avoid loading potential divider by the base current.
V_{R2}= Voltage across R_2= V_{BE}+V_{RE}= 0.7 + 1.2 = 1.9 V
V_{R2}= 9 I_B x R_2
R_2= 1.9/(9 x 20 μA). = 10.6 k Ω. Use 10 kΩ.
V_{R1}= Voltage across R_1= Vcc-V_{R2}= 12 – 1.9 = 10.1 V
V_{R1}= 10 I_B x R_1

R_1= 10.1/10 x 20 μA. = 50 kΩ. Use 47 kΩ.

Design of R_L:
Gain of the common emitter amplifier is given by the expression A_V = -(rc/re). Where rc = $R_C II R_L$ and re = 25 mV=IE = 25 mV/2 mA = 12.5Ω .
Since the required gain = 50, substituting it in the expression we get, R_L = 845Ω .
Use 820Ω std.

Design of coupling capacitor Cc_1 and Cc_2:
X_{C1} should be less than the input impedance of the transistor. Here, Rin is the series impedance.
Then $X_{C1} \leq$ Rin/10.
Here Rin = $R_1 II R_2 II(1 + h_{FE}$ re).
We get Rin = 1.1 KΩ.
Then $X_{C1} \leq 110$.
So, $C_{C1} \geq 1/(2 \pi x f_L x 110)$= 14 μF. Use 15μ F std.
Similarly, $X_{C2} \leq$Rout/10, where Rout = R_C. Then $X_{CE} \leq 240$:
So, $C_{C2} \geq 1/(2 \pi x f_L x 240$ = 6.6 μF. Use 10μF std.

Design of bypass capacitor C_E:
$X_{CE} \leq R_E/ 10$
Then $C_E \geq 1/ (2\pi$ x 100 x 68) = 23 μF. Use 22μF.

PROCEDURE

1. Test all the components using a multimeter. Set up the circuit and verify dc bias conditions. To check dc bias conditions, remove input signal and capacitors in the circuit.

2. Connect the capacitors in the circuit. Apply a 100 mV peak to peak sinusoidal signal from the function generator to the circuit input. Observe the input and output waveforms on the CRO screen simultaneously.

3. Keep the input voltage constant at 100 mV, vary the frequency of the input signal from 0 to 1 MHz or highest frequency available in the generator. Measure the output amplitude corresponding to different frequencies and enter it in tabular column.

4. Plot the frequency response characteristics on a graph sheet with gain in dB on y-axis and logf on x-axis. Mark log f_L and log f_H corresponding to 3 dB points.

5. Calculate the bandwidth of the amplifier using the expression BW= f_H- f_L.

6. Remove the emitter bypass capacitor CE from the circuit and repeat the steps 3 to 5 and observe that the bandwidth increases and gain decreases in the absence of CE.

TABULAR COLUMN

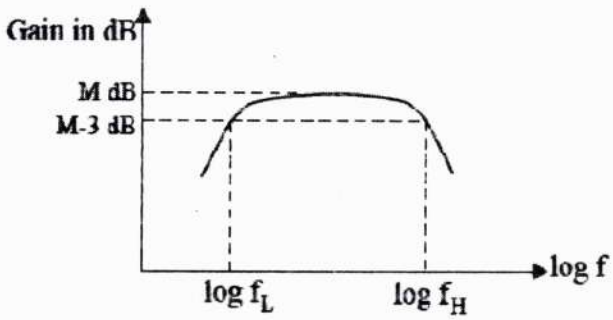
1) DC Conditions

DC CONDITIONS	V_{CC}	V_{R1}	V_{R2}	V_{RC}	V_{RE}	V_{CE}
Theoretical	12V	10.1V	1.9V	4.8V	1.2V	6V
Practical						

2) Frequency Response

F (Hz)	$V_o(v)$	Log F	Gain(dB)=20log(V_o/V_{in})

EXPECTED GRAPH



With C_E

RESULT

Designed and set up an RC coupled amplifier and studied its frequency response.

With C_E:

Mid-band gain of the amplifier = dB
Bandwidth of the amplifier = Hz

VIVA QUESTIONS

1. Differentiate between ac and dc load lines? Explain their importance in amplifier analysis.
2. Why is the centre point of the active region chosen for dc biasing?
3. What happens if extreme portions of the active region are chosen for dc biasing?
4. Draw the output characteristics of the amplifier and mark the load-line on it. Also markthe three regions of operation on the output characteristics.
5. Which are the different forms of coupling used in multi-stage amplifiers?
6. Draw hybrid and hybrid-_ equivalent models of a transistor in the CE configuration.
7. Draw the Ebers-Moll model of a BJT.
8. What are self bias and fixed bias?
9. Give a few applications of RC-coupled amplifier.
10. How is the input of the RC coupled amplifier phase shifted by 180^0at the output?

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EXPT NO 4

CASCADE AMPLIFIER

Aim To design, set up and study a two stage RC coupled CE amplifier using BJT.

Components and equipments required Transistor, dc source, capacitors, resistors, bread board, signal generator, multimeter and CRO.

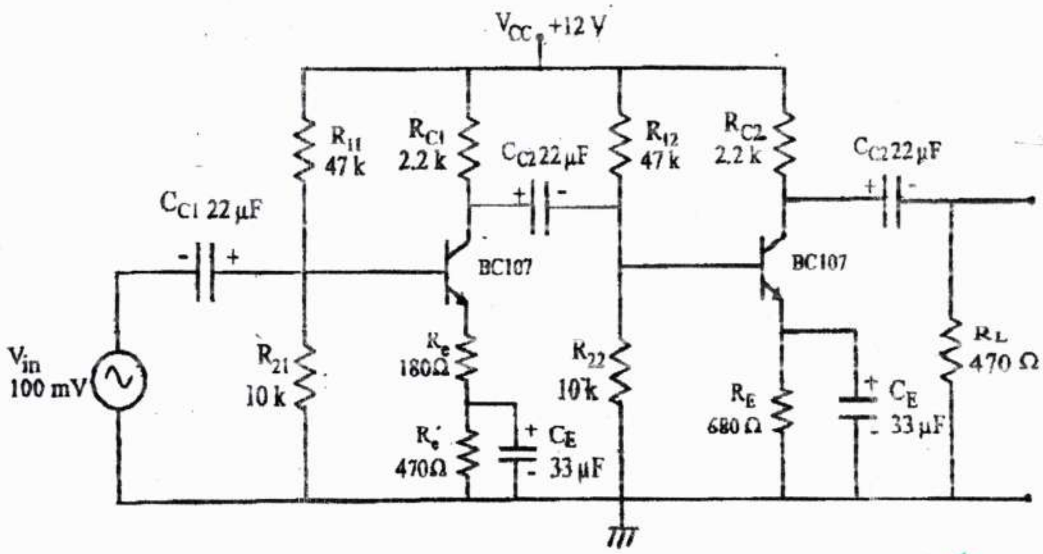
Theory Multistage amplifiers are used in cascade to improve parameters such as voltage gain, current gain, input impedance and output impedance etc. Common emitter stages are cascaded to increase the voltage gain. A two stage amplifier provides an overall voltage gain of $A_1 A_2$, where A_1 and A_2 are the gains of first and second stages respectively. Since each stage provides a phase inversion, the final output signal is in phase with the input signal.

The input impedance of the second stage is in parallel with R_{C1} of the first stage. The ac voltage gain of the first stage is $A_1 = R_{C1}||R_{in2}/(r_e + R_e)$ where R_{in2} is the input resistance of the second stage. $R_{in2} = R_{12}||R_{22}||(1 + h_{FE}r_e)$

The ac voltage gain of the second stage is $A_2 = (R_{C2}||R_L)/r_e$

Care must be taken while selecting A_1 and A_2. If A_1 is large, the input to the second stage will become too high. This may pull out the transistor of the second stage from active region. For example, if we need an overall voltage gain of 100, select $A_1 = 4$ and $A_2 = 25$. Gain of the first stage can be controlled by a negative feed back in series with the emitter. This is achieved by the unbypassed resistor R_e.

Circuit diagram



Design

Output requirements: Mid-band voltage gain of the amplifier = 100.

Selection of transistor Select transistor BC107 because it has h_{FE} more than the required voltage gain.

Assume the gains $A_1 = 4$ and $A_2 = 25$ since $A = A_1 A_2$ and A_1 should be a lower value to avoid high input voltage to second stage. High input to the second stage will lead to the clipping of the output waveform.

DC **biasing conditions** $V_{CC} = 12$ V, $I_C = 2$ mA, $V_{RC} = 40\%$ of $V_{CC} = 4.8$ V, $V_{RE} = 10\%$ of $V_{CC} = 1.2$ V and $V_{CE} = 50\%$ of $V_{CC} = 6$ V.

Design of R_{C1} and R_{C2} Take $R_{C1} = R_{C2} = R_C$.

$V_{RC} = I_C \times R_C = 4.8$ V. From this we get, $R_C = 2.4\ k$. Use $2.2\ k$ std.

Design of R_E R_E of first stage is split into $R_e + R_{e'}$.

$V_{RE} = I_E \times R_E$. Because, $I_E \approx I_C$, $V_{RE} = I_C \times R_E = 1.2$ V.

From this, we get $R_E = 600\ \Omega$. Select $680\ \Omega$ std.

Design of voltage divider R_1 and R_2

Take $R_{11} = R_{12} = R_1$ and $R_{21} = R_{22} = R_2$. From the data sheet of BC107 we get h_{FE}min is 100.

$I_B = I_C/h_{FE} = 2\ mA/100 = 20\ \mu A$

Assume the current through $R_1 = 10I_B$ and that through $R_2 = 9I_B$ for the stability of the potential divider bias circuit.

$V_{R2} =$ Voltage across $R_2 = V_{BE} + V_{RE}$

i.e., $V_{R2} = V_{BE} + V_{RE} = 0.6$ V $+ 1.2$ V $= 1.8$ V. Also $V_{R2} = 9I_B R_2 = 1.8$ V.

Then $R_2 - 1.8/9 \times 20 \times 10^{-6} = 10\ k$.

$V_{R1} =$ voltage across $R_1 = V_{CC} - V_{R2} = 12V - 1.8V = 10.21\ V$

Also $V_{R1} = 10\ I_B R_1 = 10.2$ V. Then $R_1 = \frac{10.2}{10 \times 20 \times 10^{-6}} = 51\ k$. Select $47\ k$.

Design of R_e and $R_{e'}$

Gain of the first stage is given by the expression

$A_1 = \frac{R_C \| R_{in2}}{(r_e + R_e)}$ where $R_e = R_E$ - $R_{e'}$ and $R_{in2} = R_1 \parallel R_2 \parallel (1 + h_{FE} r_e) = 1.1\ \Omega$

Here, $r_e = 25\ mV/I_E = 25\ mV/2\ mA = 12.5\ \Omega$ at room temperature.

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Substituting the values of A_1, R_C, r_e and R_{in2}, we get $R_e = 173\ \Omega$. Use $180\ \Omega$.

$R_{e'} = R_E - R_e = 680\ \Omega - 180\ \Omega = 500\ \Omega$. Use $470\ \Omega$.

Design of R_L

Gain of the second stage is given by the expression $A_2 = (R_C \parallel R_L)/r_e = 25$.

Substituting the values of A_2, R_C and r_e, we get $R_L = 363\ \Omega$. Use $470\ \Omega$.

Design of coupling capacitors C_{C1}, C_{C2} and C_{C3}

To permit the lowest frequency f_L (say 100 Hz), X_{C1} should be less than or equal to the input resistance R_{in1}.

As a rule of thumb, $X_{C1} \leq R_{in1}/10$. Here $R_{in} = R_1 \parallel R_2 \parallel (1 + h_{FE} r_e) = 1.1\ k$.

Then $X_{C1} \leq 110\ \Omega$. So $C_{C1} \geq \frac{1}{2}\pi f_L \times 110 \geq 14\ \mu$F. Use 22 μF std.

Take $C_{C2} = C_{C3} = C_{C1} = 22\ \mu$F, because, the input impedance of second stage is approximately same to that of first stage.

Design of bypass capacitors C_E

To bypass the lowest frequency (say 100 Hz), X_{CE} should be less than or equal to the resistance R_E.

i.e., $X_{CE} \leq R_E/10$. Then, $C_E \geq 1/(2\pi \times 100 \times 68) = 23\ \mu$F. Use 33 μF.

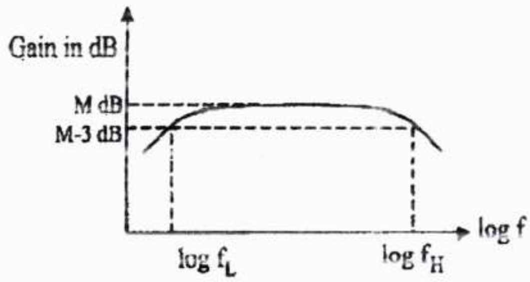
Procedure

1. Test all components using a multimeter. Set up the circuit and verify dc bias conditions.
2. Apply a 100 mV sinusoidal signal from the function generator to the circuit input. Observe the input and output waveforms on the CRO screen simultaneously.
3. Keeping the input amplitude constant, vary the frequency of the input signal from 0 Hz to 1 MHz or more. Measure the output amplitude corresponding to different frequencies and enter it in tabular column.
4. Plot the frequency response characteristics on a graph sheet with gain on y-axis and $\log f$ on x-axis. Mark $\log f_L$ and $\log f_H$ corresponding to 3 dB down to the maximum gain. (Mark f if a semi-log graph sheet is used)
5. Calculate bandwidth of the amplifier using of the amplifier using the expression $BW = f_H - f_L$.

Graph

V_{in}=100 mV

f in Hz	V_o in Volts	Gain (dB)



Result

Gain of the first stage = ······

Gain of the second stage = ······

Bandwidth of the amplifier = ······ Hz

HOD ECE

EXPT.No-5

RC PHASE SHIFT OSCILLATOR

AIM

To design and set up an RC phase shift oscillator using BJT and to observe the sinusoidal output waveform.

COMPONENTS AND EQUIPMENTS REQUIRED

SL NO	COMPONENT	SPECIFICATION	QUANTITY
1	Transistor	BC 107	3
2	Capacitors	0.01μF, 1μF,22 μF	3,1,1
3	Resistors	47K,10K,4.7K ,680Ω,2.2K	1,1,2 ,1,1
4	Potentiometer	4.7K pot	1
5	Breadboard		
6	CRO		
7	DC Source		

THEORY

An oscillator is an electronic circuit for generating an ac signal voltage with a dc supply as the only input requirement. The frequency of the generated signal is decided by the circuit elements. An oscillator requires an amplifier, a frequency selective network, and a positive feedback from the output to the input. The Barkhausen criterion for sustained oscillation is A β= 1 where A is the gain of the amplifier and β is the feedback factor. The unity gain means signal is in phase. (If the signal is 180 out of phase, gain will be 1.) If a common emitter amplifier is used, with a resistive collector load, there is a 180 phase shift between the voltages at the base and the collector. Feedback network between the collector and the base must introduce an additional 180 phase shift at a particular frequency.

In the figure shown, three sections of phase shift networks are used so that each section introduces approximately 60 phase shift at resonant frequency. By analysis, resonant frequency f can be expressed by the equation,

$$f = \frac{1}{2\pi RC\sqrt{\left(6 + 4\left({}^{R_C}/_{R}\right)\right)}}$$

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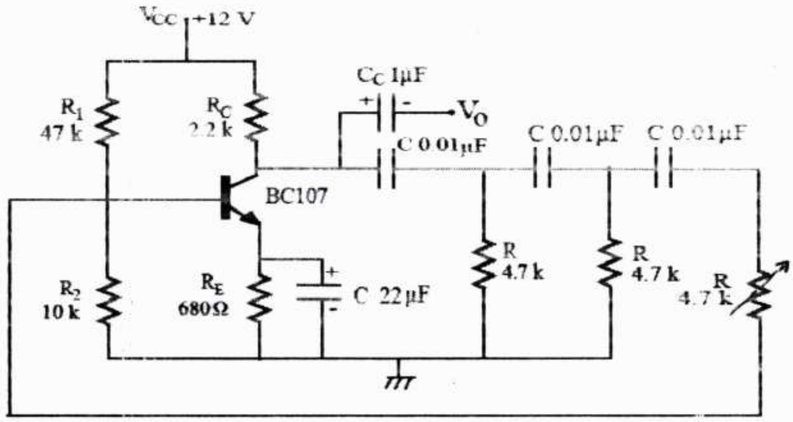
The three section RC network offers a β of 1/29. Hence the gain of the amplifier should be 29. For this, the requirement on the h_{FE} of the transistor is found to be

$$h_{FE} \geq 23 + 29(R/R_C) + 4(R_C/R)$$

The phase shift oscillator is particularly useful in the audio frequency range.

CIRCUIT DIAGRAM



DESIGN

Output requirements: Sine wave with amplitude 10 V_{PP} and frequency 1 kHz.

Design of the amplifier: Select transistor BC107.It can provide a gain more than 29 because its minimum h_{FE} is 100.

DC biasing conditions:
V_{CC} = 12 V, I_C = 2 mA,
V_{RC} = 40% of V_{CC} = 4:8 V,
V_{RE} = 10% of V_{CC} = 1:2 V and
V_{CE} = 50% of V_{CC} = 6 V.

Design of Rc:
V_{RC}= Ic x Rc= 4.8
VRc= 4.8/2mA = 2.4 kΩ.Use 2.2 kΩ.

Design of R_E:
V_{RE}= I_E x R_E= 1.2
V_{RE}= 1.2/2mA = 600 Ω. Use 560 Ω.

Design of $R_1$and R_2:
I_B= I_C/ h_{FE}= 2 mA/ 100 = 20 μA.
Assume the current through R_1= 10I_B and that through R_2= 9I_B to avoid loading potential divider by the base current.
V_{R2}= Voltage across R_2= V_{BE}+V_{RE}= 0.7 + 1.2 = 1.9 V
V_{R2}= 9 I_B x R_2
R_2= 1.9/9 x 20 μA. = 10.6 k Ω. Use 10 kΩ.

V_{R1}= Voltage across R_1= Vcc-V_{R2}= 12 – 1.9 = 10.1 V
V_{R1}= 10 I_B x R_1, R_1= 10.1/10 x 20 μA. = 50 kΩ. Use 47 kΩ.

Design of bypass capacitor C_E:
$X_{CE} \leq R_E/10$
Then $C_E \geq 1/(2\pi \times 100 \times 68)$ = 23 μF. Use 47 μF.
Design of frequency selective network:
Required frequency of oscillation is 1kHz.
$f = 1 / 2\pi RC \sqrt{(6 + 4 Rc/R)}$ = 1 kHz
The frequency determined by R and Rc must be selected in such a way to avoid loading of amplifier. So R is taken as 2Rc

R=2Rc=2 x 2.4K=4.8KΩ .Use 4.7KΩ
Then $C = 1/(2 \pi \times 4.8 \times 10^3 \times 1 \times 10^3 \times \sqrt{8})$.
C=.014μF.Use .01μF.

TABULAR COLUMN

DC CONDITIONS

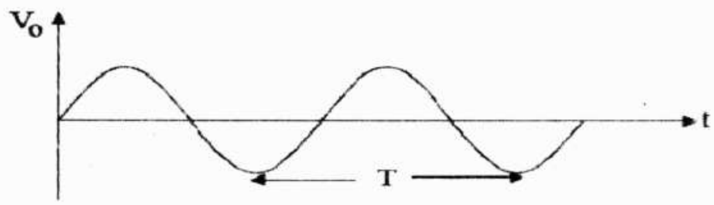
DC CONDITIONS	V_{CC}	V_{R1}	V_{R2}	V_{RC}	V_{RE}	V_{CE}
Theoretical	12V	10.1V	1.9V	4.8V	1.2V	6V
Practical						

PROCEDURE

1. Set up the amplifier part of the oscillator and ensure that the transistor is operating as an amplifier.ie check the DC conditions.
2. Connect the feedback network and observe the sine wave on CRO and measure its amplitude and frequency.

MODEL GRAPH

OUTPUT WAVEFORM



RESULT

Designed and set up theRC phase shift oscillatorand obtained the output waveforms. Observed frequency =

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VIVA QUESTIONS

1. List the disadvantages of RC phase shift Oscillator.
2. What are the Barkhausen criterion?
3. What is the difference between amplifier and oscillator?
4. What is an Oscillator?
5. What is a beat frequency oscillator?
6. What is sustained Oscillation?
7. What is meant by resonant Circuit Oscillators?

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EXP NO : 6

SERIES VOLTAGE REGULATOR

AIM

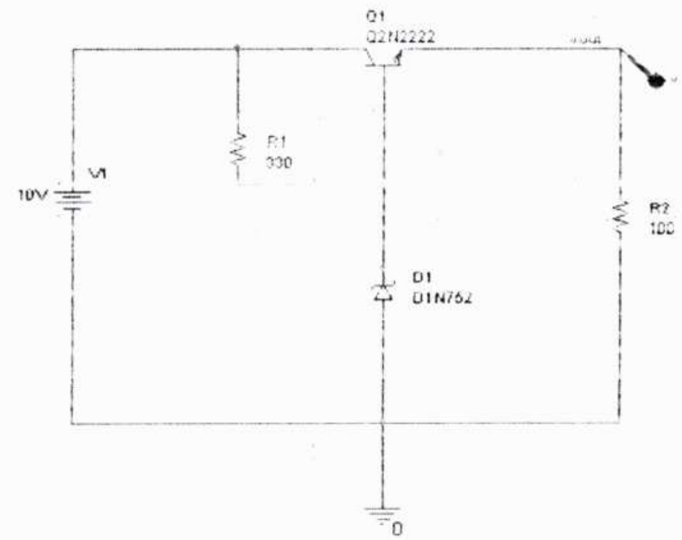
To verify and simulate a series voltage regulator – line and load characteristics

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

CIRCUIT DIAGRAM

(i) VOLTAGE LINE REGULATION



PROCEDURE

1. Create a new project and a new schematic page

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regulator is $V_o = V_Z - V_{BE}$. Since, Vz is constant; any change in Vo must cause a change in V_{BE} in order to maintain the above equation. So, when Vo decreases V_{BE} increases, which causes the transistor to conduct more and to produce more load current. this increase in load causes an increase in Vo and makes Vo as constant. Similarly, the regulation action happens when Vo increases.

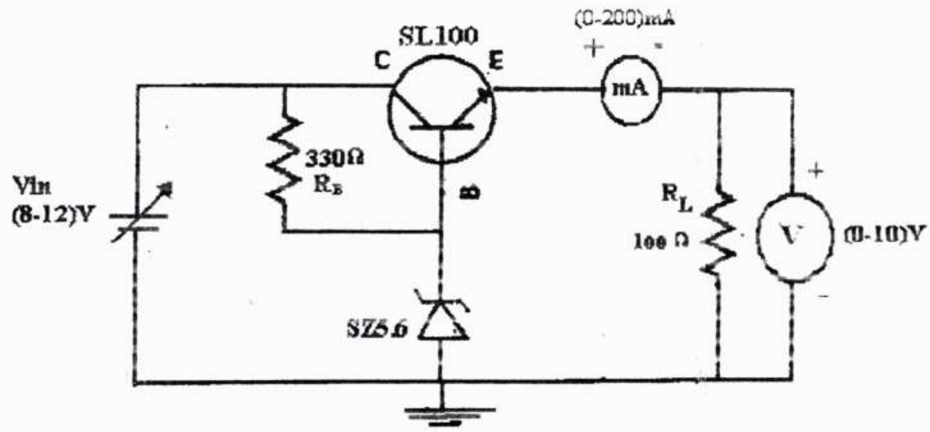
The series resistance should be selected between Rs_{min} and Rs_{max} given by the expression.

$Rs_{min}=(Vi_{(min)} - Vz)/I_s$

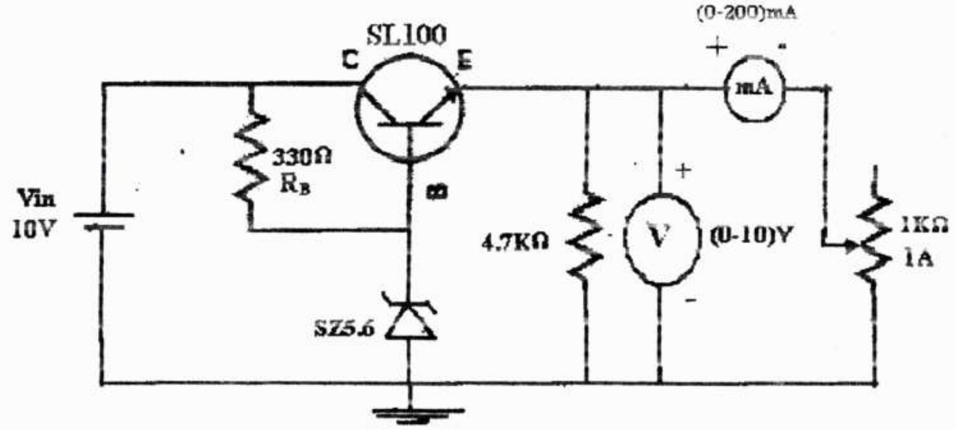
$Rs_{max}=(Vi_{(max)} - Vz)/I_s$

CIRCUIT DIAGRAM

I)Line Regulation



ii)Load Regulation



DESIGN

Since I_L=50mA, SL100 is used. Nominal rating of SL100 is V_{CE}=5V, I_L=150mA, h_{fe}=40-300

Requirements: V_{out}=5V,I_L=50mA,V_{in}=(8-12)V

Selection of zener diode: I_{Zmin}=10mA I_{Zmax}=30mA

Selection of R_B:

$R_{Bmax}=V_{inmax}-V_z/(I_{z(min)}+I_B)$=12-5.6/(10+0.7)mA =597.6Ω

$R_{Bmin}=V_{inmin}-V_z/(I_{z(max)}+I_B)$=8-5.6/(30+0.7)mA =78Ω

$R_B=(R_{Bmax}+R_{Bmin})/2$=338 Ω (Use 330 Ω)

Selection of R_L(Load regulation):

I_L=1mA

R_L=Vout/I_L= 5/1mA=5KΩ. Use 4.7KΩ

Selection of R_L (Line regulation):

R_L=Vout/Iz= 5/50mA=100Ω

Power rating of $R_L= I_L^2 R_L=(50mA)^2*100=0.25W$. Use 100Ω, 0.25W resistor

PROCEDURE

i). Line Regulation

1. Connect the circuit as shown in the circuit diagram. Keep output current in a constant value.
2. Note down the output voltage when the input voltage varies from 8 to 12V in steps of 1V.
3. Plot the line regulation graph V_{in} along x-axis and V_{out} along y-axis.
4. Calculate the percentage line regulation using expression

Percentage line regulation=($\Delta V_{out}/\Delta V_{in}$)x100

ii). Load Regulation

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1. Connect the circuit as shown in the circuit diagram.
2. Keep the input voltage as constant ie 10V.
3. Note down the output voltage when the load current varies from 0mA(NL) to 100mA(FL) by varying rheostat.
4. Plot the load regulation graph I_L along x-axis and Vout along y-axis.
5. Calculate the percentage load regulation using expression

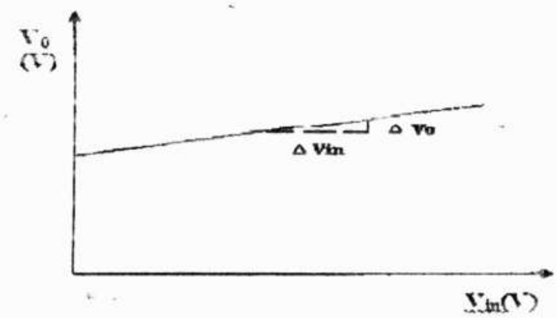
$$\text{percentage load regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} x100$$

OBSERVATION COLOUMN & CALCULATIONS

i) Line Regulation

I_L=.....mA

Vin(V)	Vo(V)



ii) Load Regulation

Vin=.....V

I_L(mA)	Vo(V)

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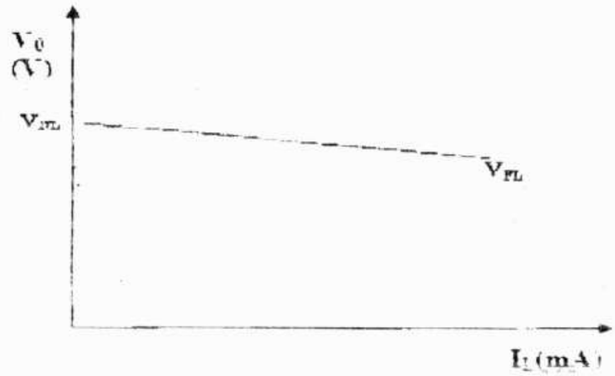

CALCULATIONS

$$\text{percentage load regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 =$$

$$\text{percentage line regulation} = (\Delta V_{out} / \Delta V_{in}) \times 100 =$$

RESULT

Series voltage regulator circuit is set up and studied. Plotted load and line regulation characteristics.

% Line Regulation=.....
% Load Regulation=......

VIVA QUESTIONS

1. Define voltage regulator.
2. Give the advantages of series voltage regulator. .
3. Explain the feedback mechanism in series voltage regulator.
4. In series voltage regulator which is control element and explain its function.
5. Define load and line regulation. What is ideal value?
6. Which element determines output ripple?
7. What determines maximum load current allowed in this circuit?
8. Mention the applications of series voltage regulator.
9. Define no load voltage and full load voltage.
10. Explain the term percentage regulation.

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PART B

SIMULATION

EXPERIMENTS

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FAMILIARIZATION OF PSPICE SIMULATION SOFTWARE

Aim:

To familiarize with PSPICE simulation software environment.

Theory:

OrCAD is a proprietary software tool suite used primarily for electronic design automation (EDA). The software is used mainly by electronic design engineers and electronic technicians to create electronic schematics and electronic prints for manufacturing printed circuit boards. The name OrCAD is a portmanteau, reflecting the company and its software's origins: **Or**egon + **CAD**(Computer Aided Design).

Products

OrCAD is a suite of products for EDA (Electronic Design Automation), and includes a schematic editor (Capture), a circuit simulator (PSpice) and a PCB designer.

OrCAD Capture

OrCAD Capture is a schematic capture application, and part of the OrCAD circuit design suite. Capture is a design entry program you need to prepare your circuit for simulation. This means placing and connecting part symbols, defining component values and other attributes, defining input waveforms, enabling one or more analyses, and marking the points in the circuit where you want to see results.

When the simulation process begins, Capture first generates files describing the parts and connections in the circuit. These files are the netlist file and the circuit file. Capture exports netlist data to the simulator, OrCAD EE. Capture can also export a hardware description of the circuit schematic to Verilog or VHDL.

OrCAD EE PSpice

The Simulation Program with Integrated Circuit Emphasis (SPICE) became an industry standard for circuit simulation. The PC-compatible version (PSPICE) is used here.PSpice is an acronym for ***Personal Simulation Program with Integrated Circuit Emphasis***. PSpice was a modified version of the academically developed SPICE, and was commercialized by MicroSim in 1984.

OrCAD EE PSpice is a SPICE circuit simulator application for simulation and verification of analog and mixed-signal circuit. PSpice can be thought of as a software-based breadboard of your circuit that you can use to test and refine your design before ever touching a piece of hardware. OrCAD EE typically runs simulations for circuits defined in OrCAD Capture.A circuit to be analyzed using PSpice is described by a circuit description file, which is processed by PSpice and executed as a simulation. PSpice creates an output file to store the simulation results, and such results are also graphically displayed within the OrCAD EE interface. PSpice uses high-resolution graphics so you can

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view the results of a simulation both on the screen and in printed form. On the screen, waveforms appear as plots displayed in Probe windows within the PSpice workspace.

Analyses

The type of simulation performed by PSpice depends on the source specifications and control statements.

PSpice supports the following types of analyses:

- **DC Analysis** - It is used for circuits with time–invariant sources (e.g. steady-state DC sources). It calculates all nodal voltages and branch currents over a range of values. Supported types include Linear sweep, Logarithmic sweep, and Sweep over List of values.
- **Transient Analysis** - It is used for circuits with time variant sources (e.g., sinusoidal sources/switched DC sources). It calculates all nodes voltages and branch currents over a time interval and their instantaneous values are the outputs.
- **AC Analysis** - It is used for small signal analysis of circuits with sources of varying frequencies. It calculates the magnitudes and phase angles of all nodal voltages and branch currents over a range of frequencies.

The operating temperature of an analysis can be set to any desired value, and nodal parameters are assumed to be measured at a nominal temperature, by default 27 °C. **Minimum requirements to run a DC sweep analysis**

Circuit should contain one of the following:

- voltage source with a DC specification (VDC, for example).
- current source with a DC specification (IDC, for example).

Minimum requirements to run a transient analysis

Circuit should contain one of the following:

•An independent source with a transient specification .

•An initial condition on a reactive element.

•A controlled source that is a function of time.

PSpice output file

The PSpice output file is an ASCII text file that contains:

•the netlist representation of the circuit,

•the PSpice command syntax for simulation commands and options (like enabled analyses),

•simulation results, and

•warning and error messages for problems encountered during read-in or simulation.

Its content is determined by:

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•the types of analyses you run,

•the options you select for running PSpice.

PSpice circuit file

A **PSpice circuit description file** (*.cir) contains the configuration data for circuit simulation with the OrCAD EE PSpice simulator. PSpice Circuit files are typically generated by OrCAD Capture or other schematic capture application, and may also be entered manually in a text editor. The circuit file contains the component netlist, simulation options, analyses statements, and the output control statements. The component netlist comprises a list of all circuit elements, along with the node names connected to their terminals.

Circuit files

The circuit files contain five types of statements, some of which are optional. The statement types are:

- **The title**
- **Device statements**
- **Control statement**
- **Comment lines**
- **The .END statement**

Steps for circuit analysis

There are **Four main steps** involved in **circuit simulation** using PSpice.They are:

Step 1. Creating a New Project and Schematic Diagram.

Step 2. Selecting circuit components, connecting them together and setting component

Values, properties and saving the schematic diagram.

Step 3. Creating a New Simulation Profile and setting up the simulation.

Step 4. Simulating the circuit and observing the simulation results.

To create a new PSpice project

1. From the Windows Start menu, choose the OrCAD 16.0 program folder and then the

   Orcad Capture to start Capture.

2. Create a project: [File] →[New] →[Project]. Name the project and choose "Analog or

   Mixed A/D". Set the location. (You should create a new directory for your project since

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PSpice will generate a bunch of project files in this folder.) In the next window choose "Create a blank project." A work area has now been created.

3. Select [Place] → [Part]. Place necessary circuit components (you might need to add libraries for necessary circuit elements to become available). In the parts window there should be at least the ANALOG(R, L & C components), DIODE (Diodes, e.g. 1N400x series, 1N914, 7400(Digital logic circuits, e.g. Gates, Counters, Shift Registers) OPAMP (Op-amps used -μA 741, LF411) and SOURCE (DigClock, VAC, VDC, VPULSE, VSIN) libraries.
4. Find the part you want to add and press OK.
5. Click where you want to place the part on your schematic. (Press R to rotate the part by 90 degrees)
6. When you are finished with the part, right click and select End Mode to return to the pointer.
7. Select Parts => Wire. The pointer changes to a cross-hair.
8. Drag cursor from one connection point to another. Clicking on any valid connection will end the wire.
9. When you are finished, right click the mouse and select End Wire to return to the pointer.
10. PSpice uses node-voltage method for circuit simulation and, therefore, needs a reference node with "zero voltage". So the ground is selected using 0/SOURCE.
11. To change a part's value, double-click the value of the part. A new window will pop up where you can type in the value you want.
12. Aliases can be used to label the input and output nodes. This makes the node easier to find when you start plotting out your data. V(Vout) is simpler than finding V(R1:1).Go to Place => Net Alias .Enter a name, i.e., Vout or Vin . Place the label on the wire connected to the node.
13. Set up the required analysis: [PSpice] →[New Simulation Profile]. Name the new profile. Simulation settings window will pop up. From this window it is possible to change the analysis type (DC, AC, Transient), as well as analysis parameters. Then click "Apply" and "Ok" to save the simulation profile.
14. After the parameters are set you can start simulation from Capture in either of the

following ways:

•From the PSpice menu select Run.

•Click the Simulate button on the PSpice toolbar.

When you enter and set up your circuit this way, Capture automatically generates the simulation files and starts PSpice.

15. A new window will pop up that can display what PSpice calls traces. If the desired trace (graph) is not displayed then click [Trace] →[Add Trace].

Result:

PSPICE simulation software environment is familiarized.

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Experiment 1

RC DIFFERENTIATING AND INTEGRATING CIRCUITS

AIM:

To verify and simulate Input and Output Waveforms of RC Differentiating and Integrating Circuit

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

PROCEDURE 1:

1. Create a new project and a new schematic page .

2. Place the necessary circuit components and source. Select the circuit ground. Interconnect the components using Wire tool. After that place voltage probe at the input and output.

3. Set up the required analysis in the Simulation settings window.

4. Under Analysis type, select **Time domain (Transient) Sweep**. Select **General Settings** option. Set the **Run to time** and **Maximum step size** values. Then save the simulation profile.

5. After the parameters are set you can start simulation by selecting Run option.

6.The Input and Output Waveforms of circuit will be shown in the graph.Observe the Graph.

PROCEDURE 2:

1. Create a new project and a new schematic page.

2. Place the necessary circuit components and source .Select the circuit ground. Interconnect the components using Wire tool. After that place voltage probe at the input and output.

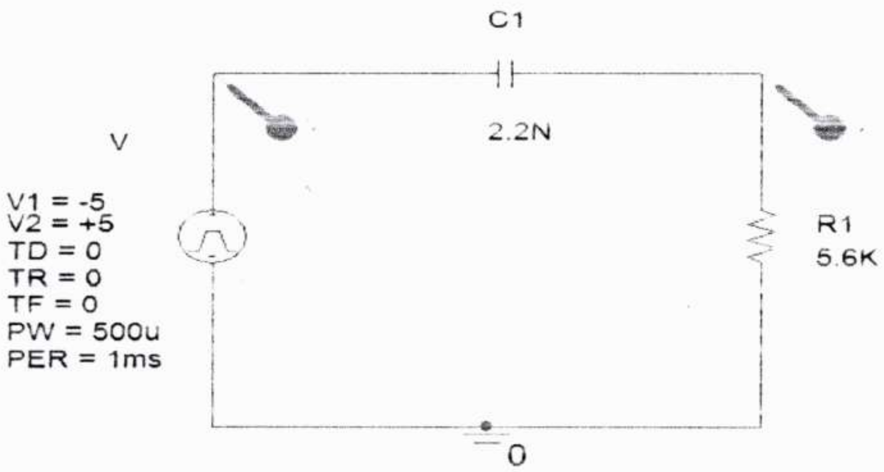
3. Set up the required analysis in the Simulation settings window.

4. Under Analysis type, select **Time domain (Transient) Sweep**. Select **General Settings** option.Set the **Run to time** and **Maximum step size** values. Then save the simulation profile.

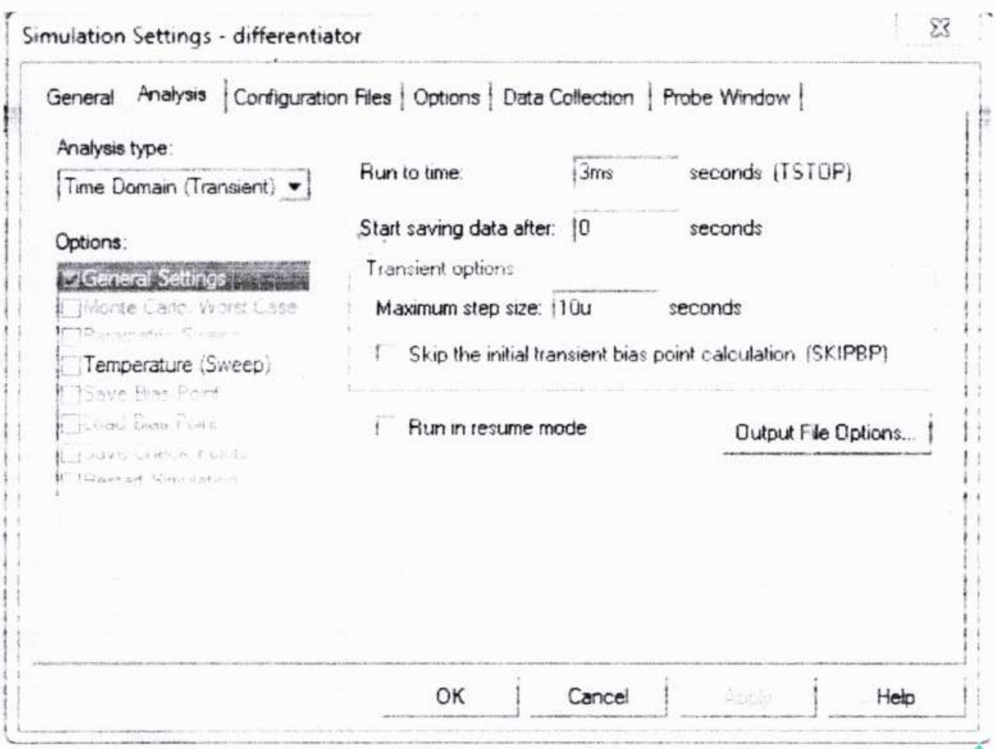
5. After the parameters are set you can start simulation by selecting Run option.

6. The Input and Output Waveforms of circuit will be shown in the graph.Observe the Graph.

CIRCUIT DIAGRAM:



PROFILE SETTINGS:



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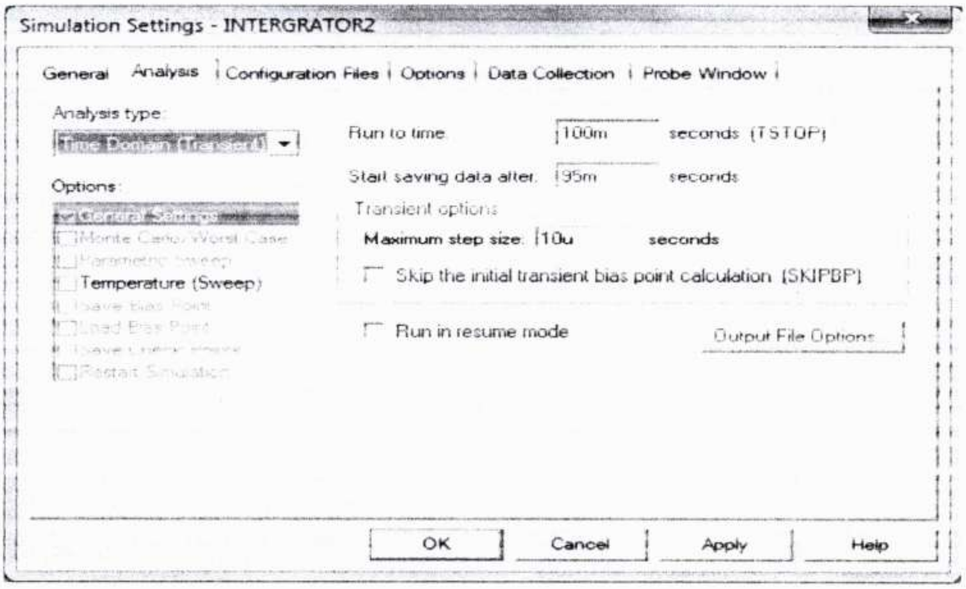
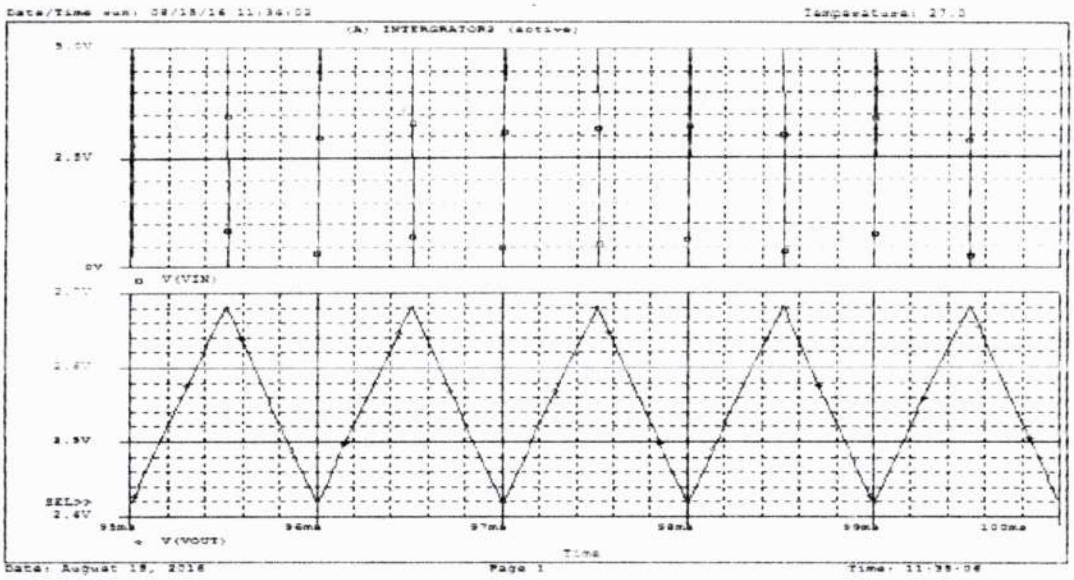
PROFILE SETTINGS:



OBSERVATION:



RESULT:

The Input and Output Waveforms of RC Differentiating and Integrating Circuits are verified and simulated using PSPICE simulation software.

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EXPT.No-2

CLIPPING CIRCUITS

AIM:

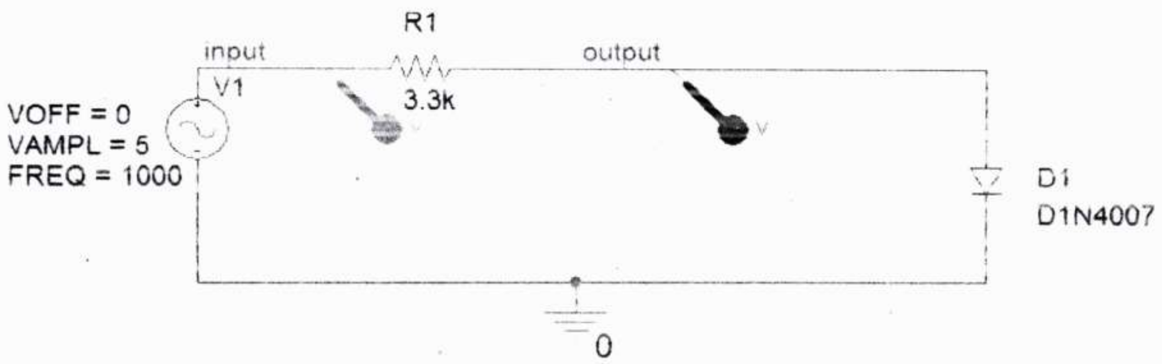
To verify and simulate the input and output waveforms of clipper circuits.

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

CIRCUIT DIAGRAM:

POSITIVE CLIPPER



PROCEDURE:

1. Create a new project and a new schematic page

2. Place necessary circuit components and source. Select the circuit ground

Interconnect the components using Wire tool. After that place current probe at the resistor.

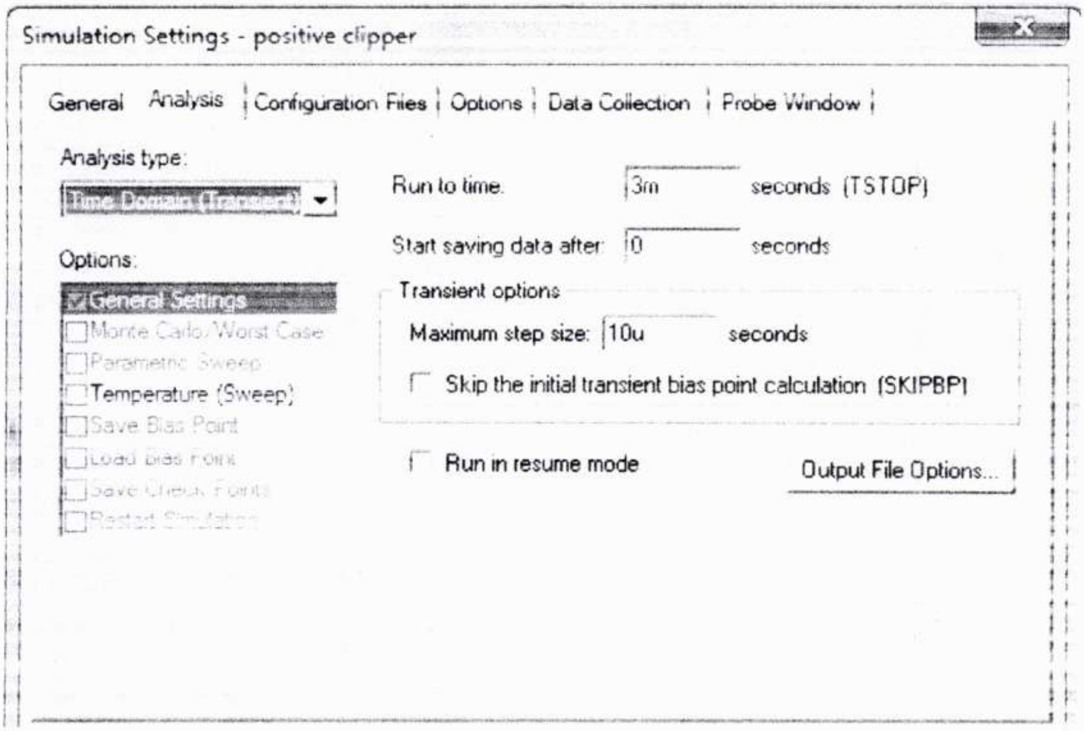
3. Set up the required analysis in the Simulation settings window.

4. Under Analysis type, **Time domain (Transient) Sweep**. Select **General Settings** option. Set the **Run to time** and **Maximum step size** values. Then click "Apply" and "Ok" to save the simulation profile.

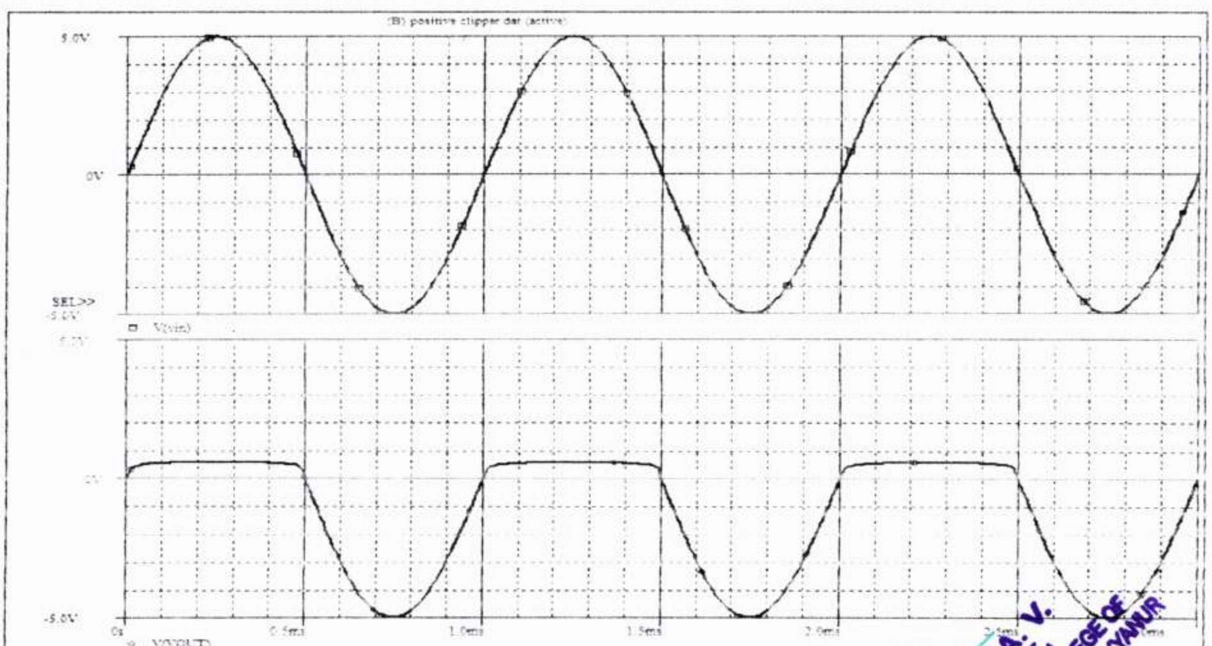
5. After the parameters are set you can start simulation by selecting Run option.

6. Input and Output Waveforms will be shown in the graph. Observe the Graph.

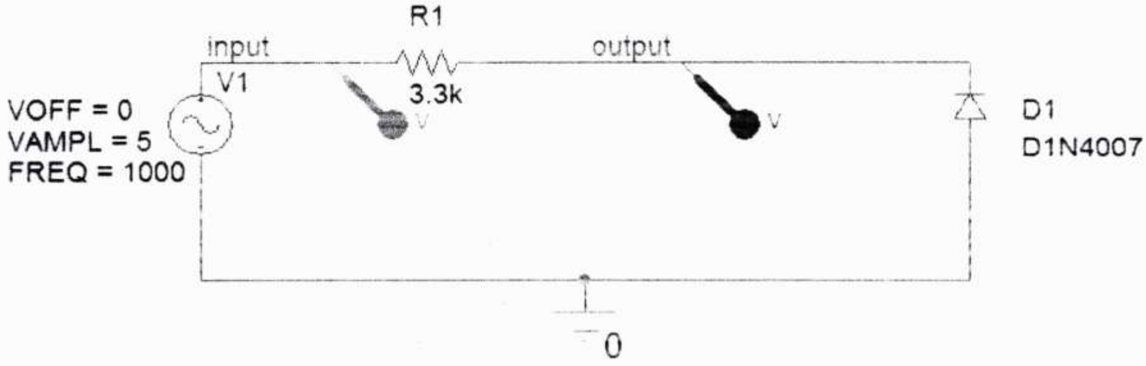
SIMULATION PROFILE



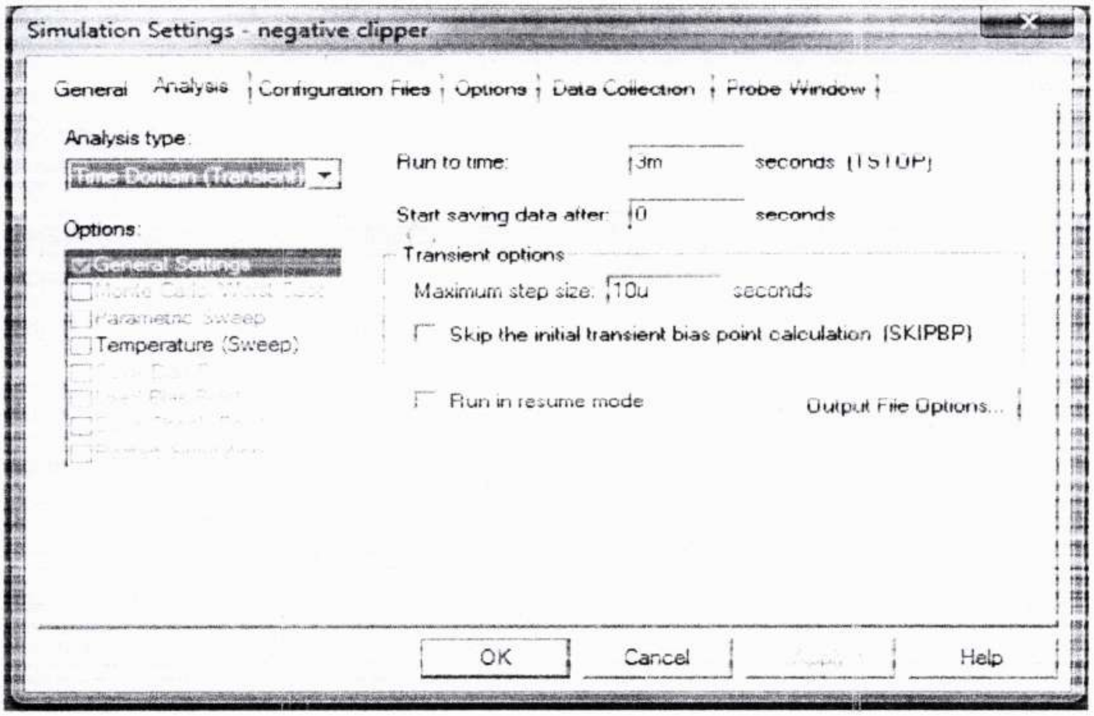
INPUT AND OUTPUT WAVEFORMS:



NEGATIVE CLIPPER



SIMULATION PROFILE



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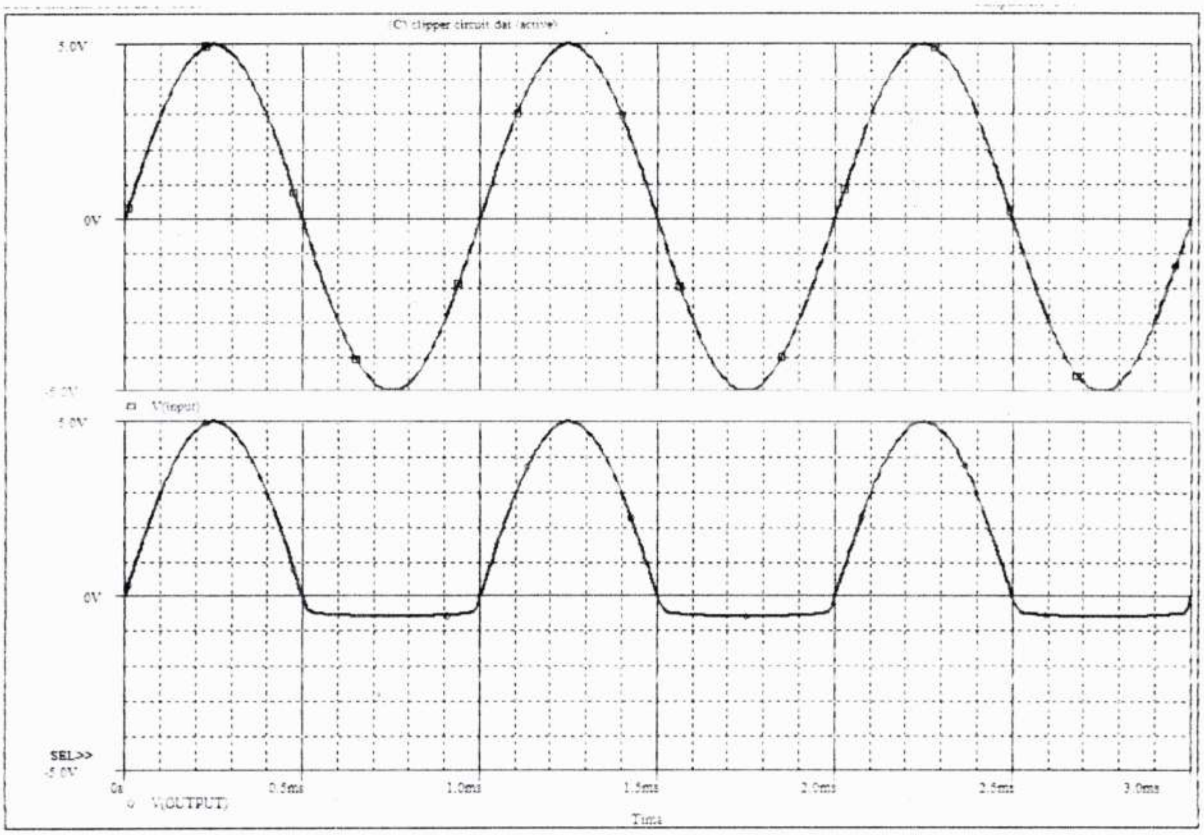
INPUT AND OUTPUT WAVEFORMS:



RESULT:

Input and output waveforms of clipping circuits are verified and simulated using PSPICE simulation software

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CLAMPING CIRCUITS

AIM:

To verify and simulate the Input and Output Waveforms of Positive and Negative Clamper Circuits.

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

PROCEDURE:

1. Create a new project and a new schematic page for both circuits.

2. Place necessary circuit components and source. Select the circuit ground.Interconnect the components using Wire tool. Place voltage probe at the input and output.

3. Set up the required analysis in the Simulation settings window.

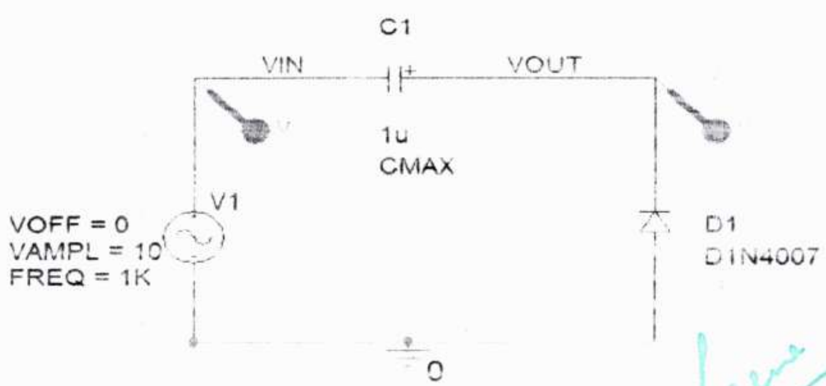
4. Under Analysis type, **Time domain (Transient) Sweep**. Select **General Settings** option. Set the **Run to time** and **Maximum step size** values. Then save the simulation profile.

5. After the parameters are set you can start a simulation by selecting Run option.

6. Input and Output Waveforms will be shown in the graph. Observe the Graph.

CIRCUIT DIAGRAM:

POSITIVE CLAMPER



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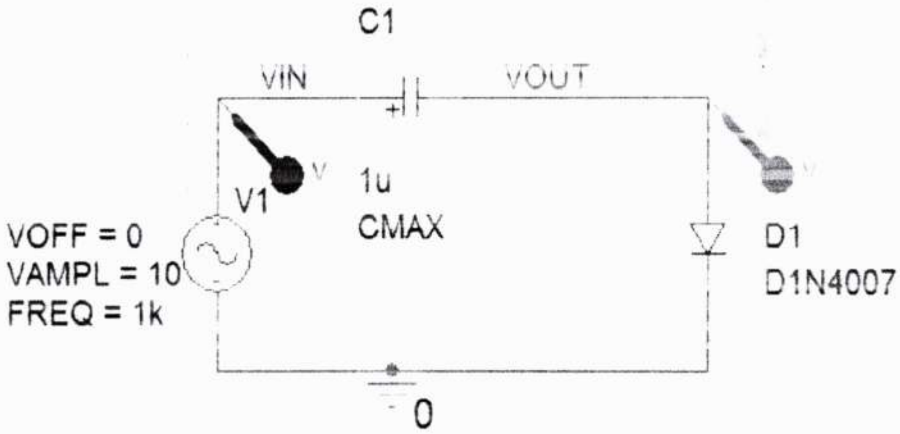
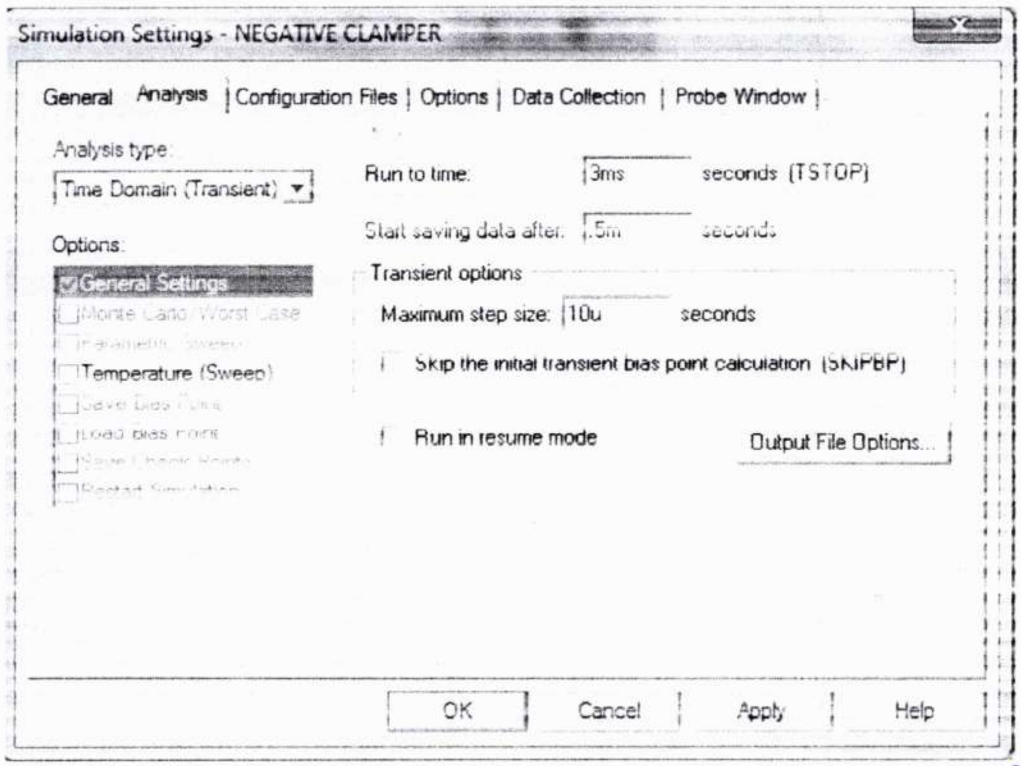
CIRCUIT DIAGRAM:

NEGATIVE CLAMPER



PROFILE SETTINGS:



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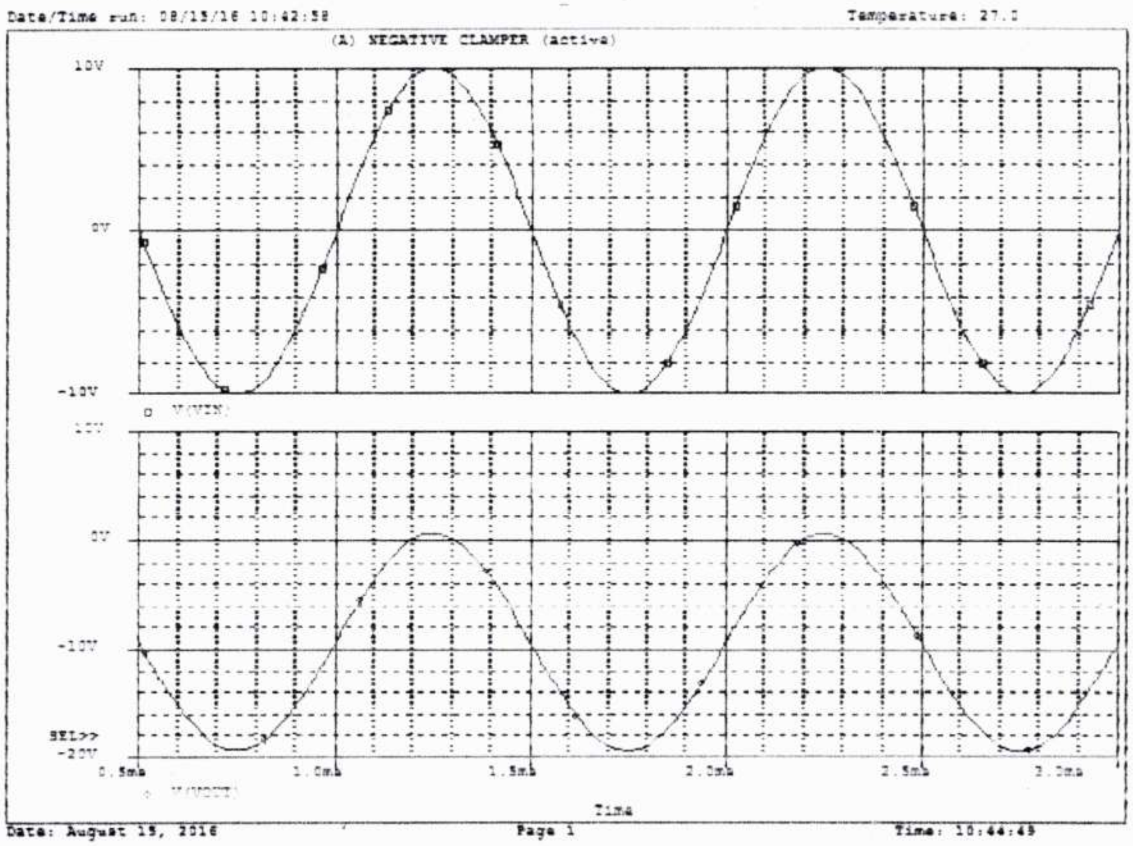
OBSERVATION:



RESULT:

Input and Output Waveforms of Positive and Negative Clamper circuits are simulated and verified using PSPICE simulation software.

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EXPT NO:3

CASCADE AMPLIFIER

AIM:

To verify and simulate the Input and Output Waveforms of Positive and Negative Clamper Circuits.

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

PROCEDURE:

1. Create a new project and a new schematic page
2. Place necessary circuit components and sources. Select the circuit ground. Interconnect the components using Wire tool.
3. Set up the required analysis in the Simulation settings window.
4. Under Analysis type, select **AC Sweep/Noise**. Enter necessary parameter values (**start,end** and **increment** values for Logarithmic sweep type). Then click "Apply" to save the simulation profile.
5. After the parameters are set you can start a simulation by selecting Run option.
6. Input and Output Waveforms will be shown in the graph. Observe the Graph.

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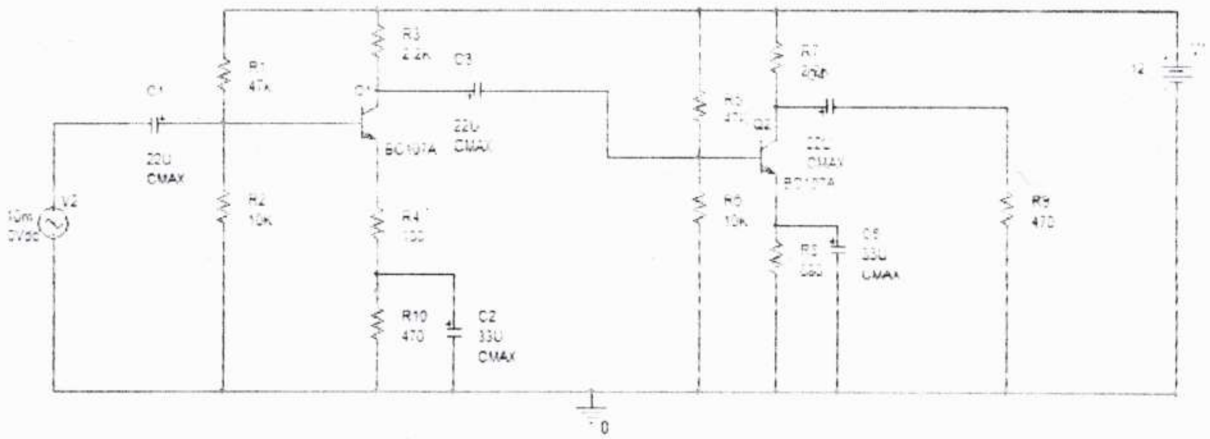
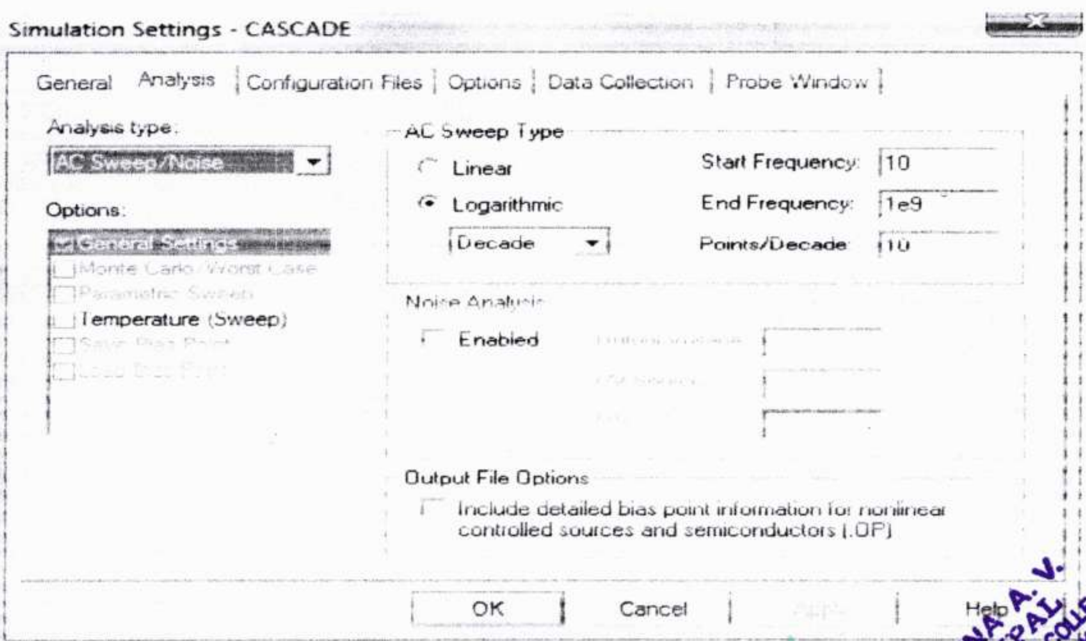
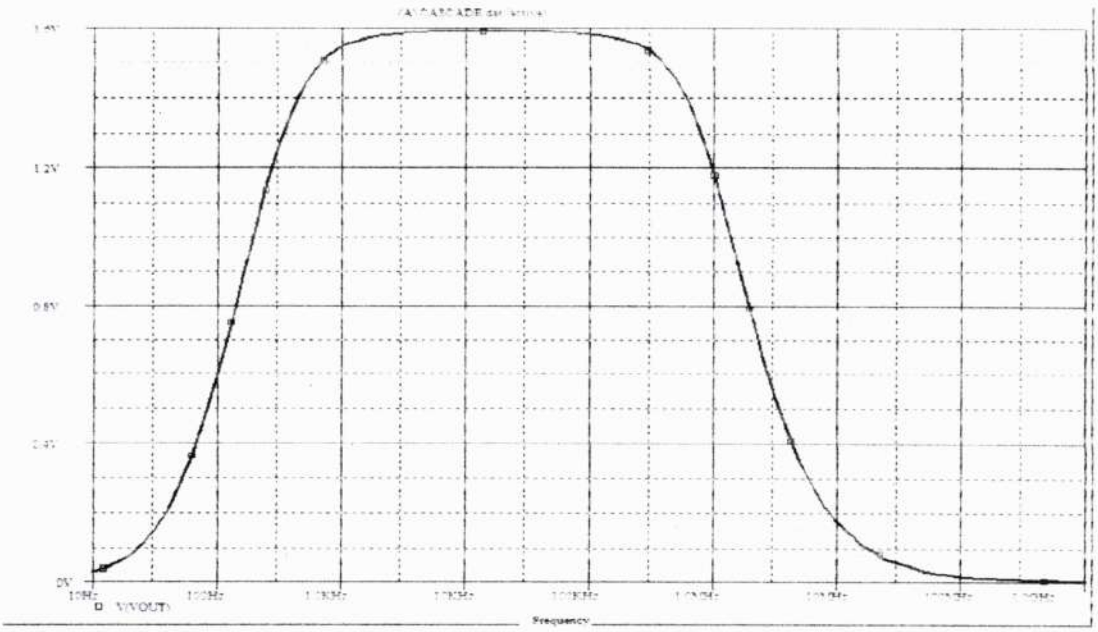
CIRCUIT DIAGRAM



SIMULATION RESULTS



OUTPUT GRAPH



RESULT:

Frequency response of Cascade Amplifier was simulated using PSPICE simulation software.

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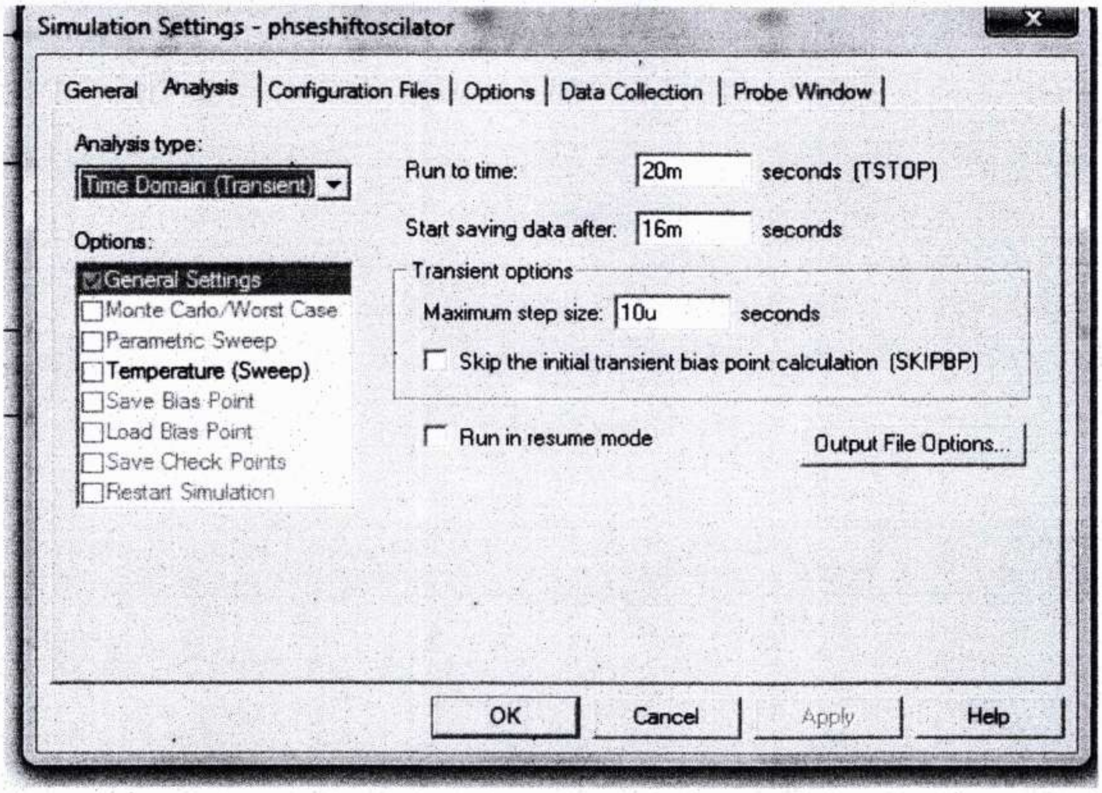
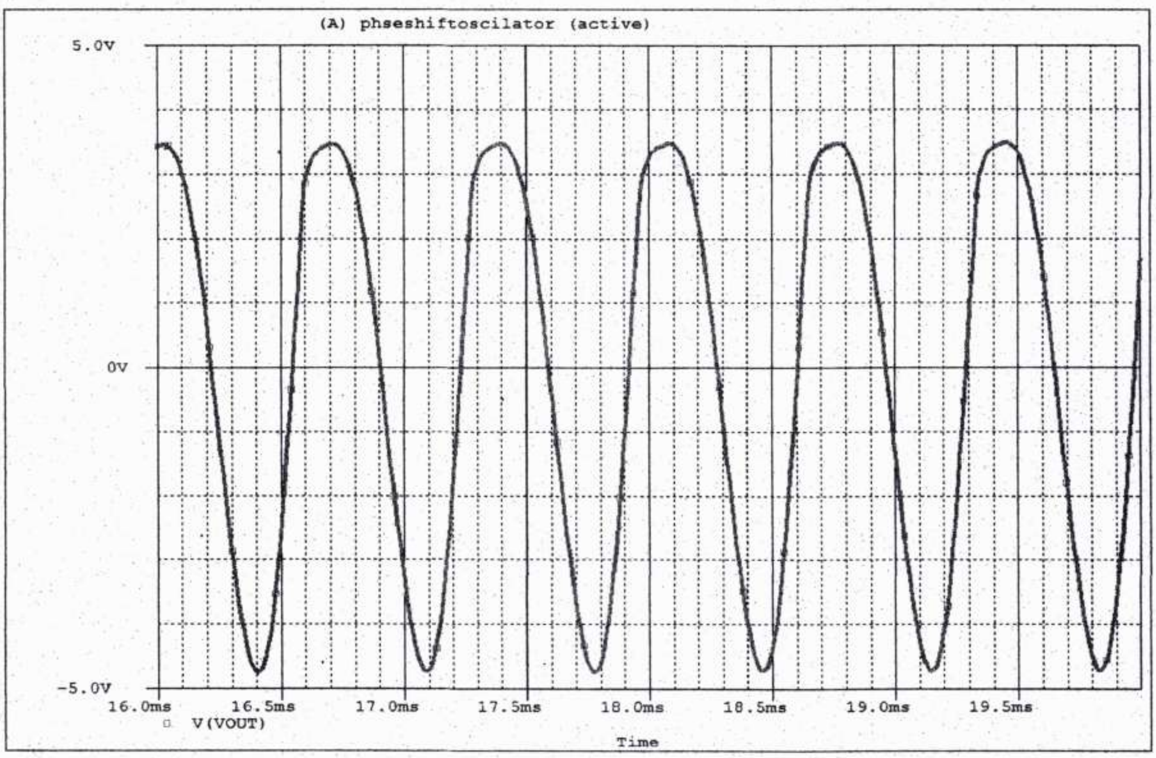
SIMULATION PROFILE



OUTPUT



RESULT: RC Phase Shift Oscillator was simulated using PSPICE simulation software.

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EXPT NO:4

RC PHASE SHIFT OSCILLATOR

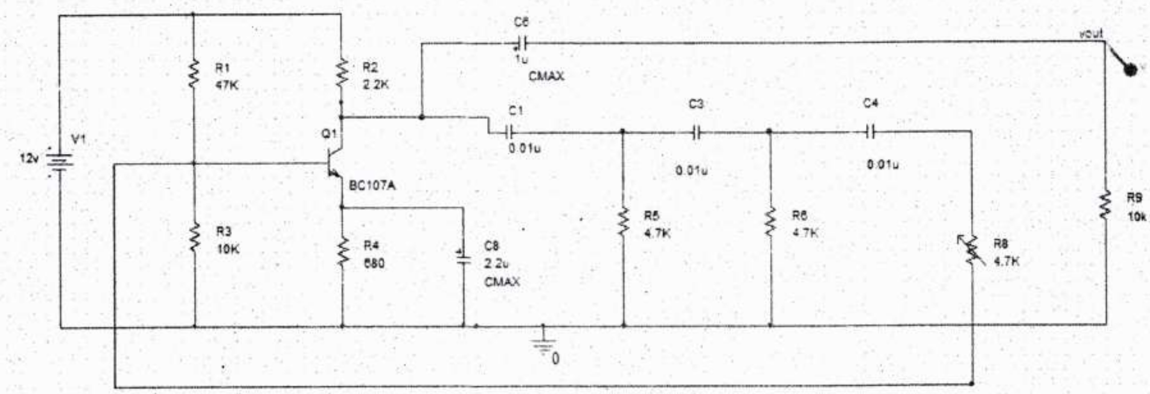
AIM:

To verify and simulate the RC Phase Shift Oscillator

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

CIRCUIT DIAGRAM



PROCEDURE

1. Create a new project and a new schematic page for both circuits.
2. Place necessary circuit components and source. Select the circuit ground. Interconnect the
1. components using Wire tool. Place voltage probe at the input and output.
2. Set up the required analysis in the Simulation settings window.
3. Under Analysis type, **Time domain (Transient) Sweep**. Select **General Settings** option.
4. Set the **Run to time** and **Maximum step size** values. Then save the simulation profile.
5. After the parameters are set you can start a simulation by selecting Run option.
6. Output Waveform will be shown in the graph. Observe the Graph.

EXPT NO-5

RC COUPLED AMPLIFIER

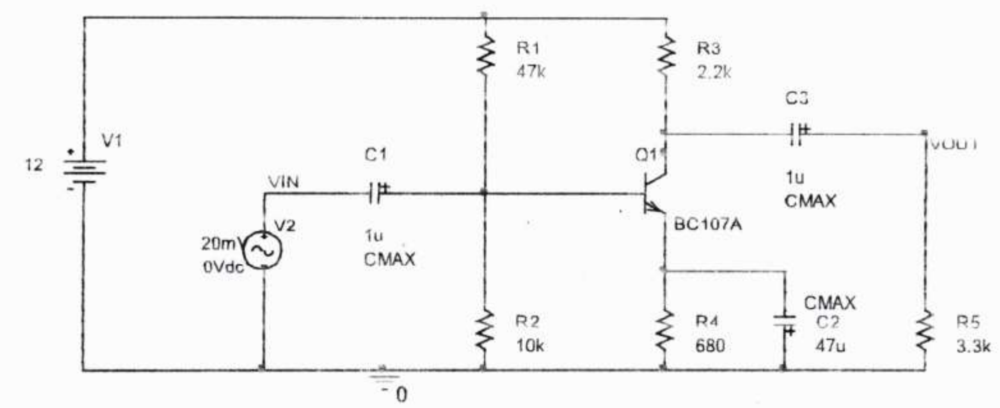
AIM:

To obtain frequency response of RC Coupled Amplifier

EQUIPMENT REQUIRED:

PC installed with ORCAD Simulation Software.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Create a new project and a new schematic page
2. Place necessary circuit components and sources. Select the circuit ground. Interconnect the components using Wire tool.
3. Set up the required analysis in the Simulation settings window.
4. Under Analysis type, select **AC Sweep/Noise**. Enter necessary parameter values (**start,end** and **increment** values for Logarithmic sweep type). Then click "Apply" to save the simulation profile.
5. After the parameters are set you can start a simulation by selecting Run option.
6. Input and Output Waveforms will be shown in the graph. Observe the Graph.

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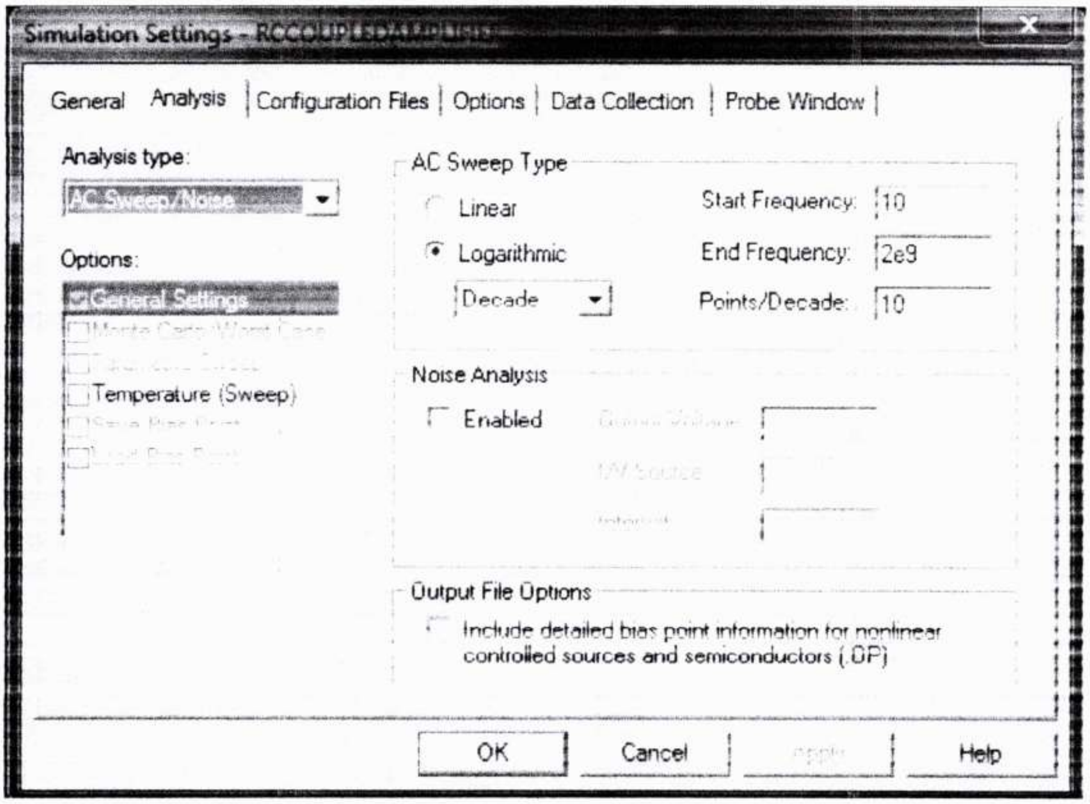
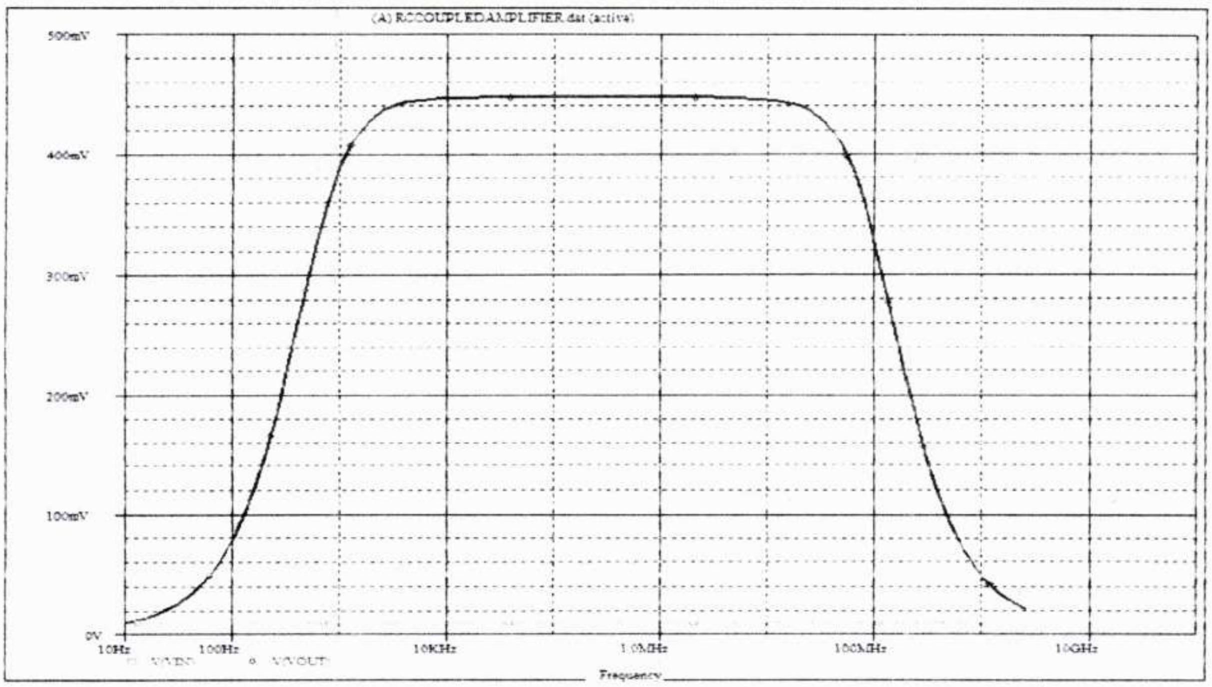
SIMULATION PROFILE



OUTPUT GRAPH



RESULT:

Frequency response of RC Coupled Amplifier was simulated using PSPICE simulation software.

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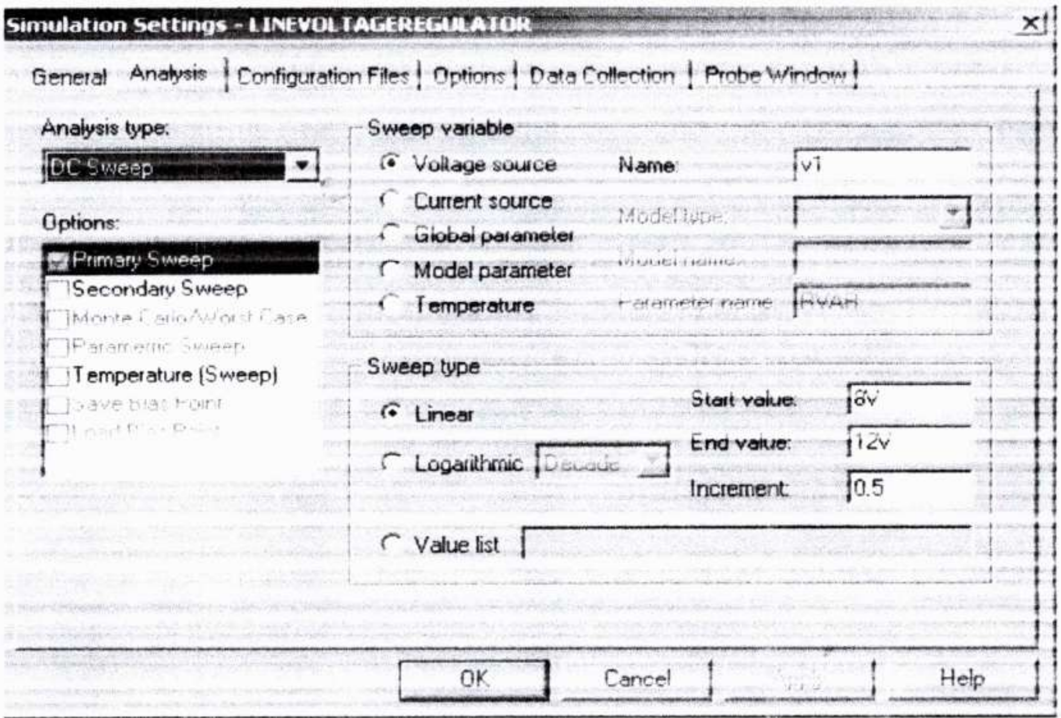
2. Place necessary circuit components and sources. Select the circuit ground. Interconnect the components using Wire tool. After that place voltage probe at the input and output
3. Set up the required analysis in the Simulation settings window.
4. Under Analysis type, select **DC Sweep**. Enter necessary parameter values (**start,end** and **increment** values for linear sweep type). Then click "Apply" to save the simulation profile.
5. After the parameters are set you can start a simulation by selecting Run option.
6. Waveforms will be shown in the graph. Observe the Graph.
7. On the output waveform click the option **Plot → Axis Setting → Y axis→ User defined** (select the data range 0 to 5 V)

SIMULATION PROFILE



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EXPT NO 6

SERIES VOLTAGE REGULATOR

AIM

To design a series voltage regulator to obtain an output DC voltage of 5V from 8-12V DC input. The maximum load current is 50mA. Obtain line and load regulation graphs.

COMPONENTS REQUIRED

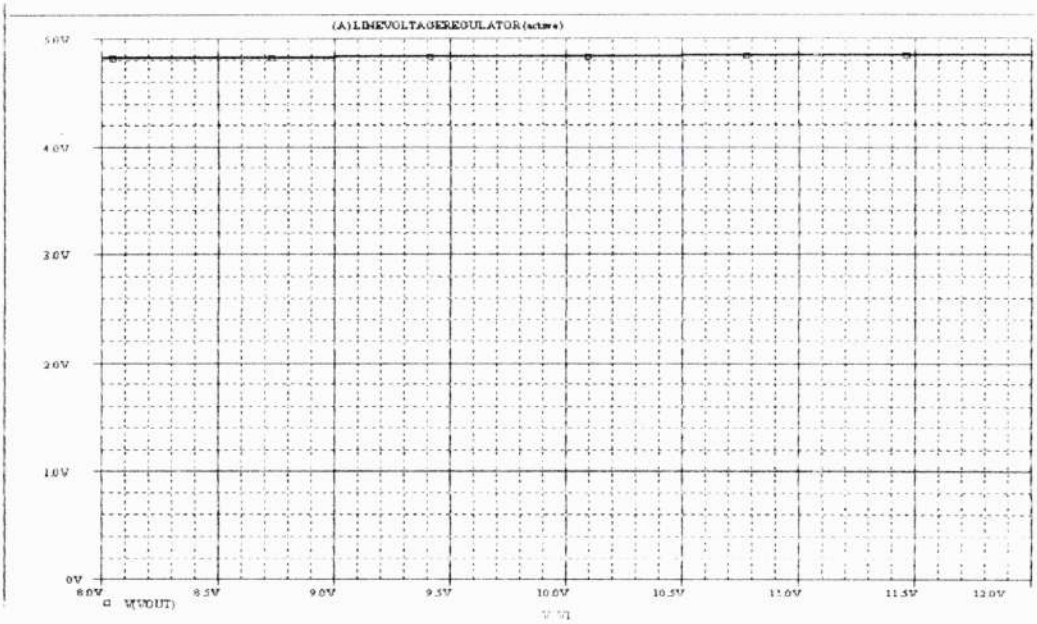
SL NO:	COMPONENT	ECIFICATION	UANTITY
1	Transistor	SL100	1
2	Zenerdiode	SZ5.6	1
3	Rheostats	1KΩ/1A	1
4	Resistor	100Ω/0.25W, 330Ω/1W,4.7K	1
5	Voltmeters	0-10V	1
6	Ammeters	0-100mA	1
7	DC Source	0-30 V	2
8	Bread board		1
9	Connecting Wires		

THEORY

Voltage regulator is a device designed to maintain the output voltage as nearly constant as possible. It monitors the output voltage and generates feed back that automatically increases are decreases the supply voltage to compensate for any changes in output voltage that might occur because of change in load are changes in load voltages.

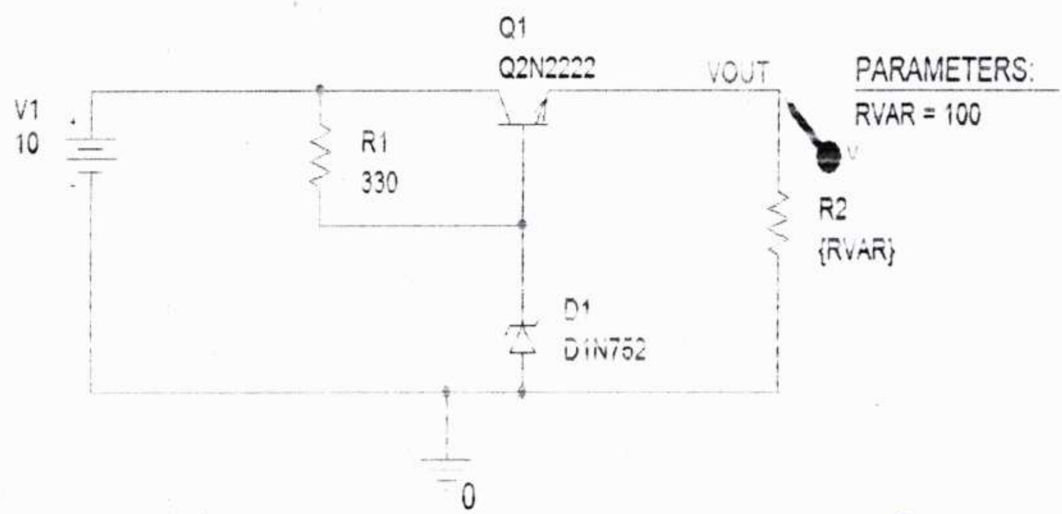
In transistorized series voltage regulator the control element is a transistor which is in series with load. It is a circuit that combines a zener regulator and an emitter follower. The zener diode must be operated in reverse break down region, where it provides constant voltage irrespective of changes in applied voltages. The output voltage of the series voltage

OUTPUT



CIRCUIT DIAGRAM

(ii) VOLTAGE LOAD REGULATION



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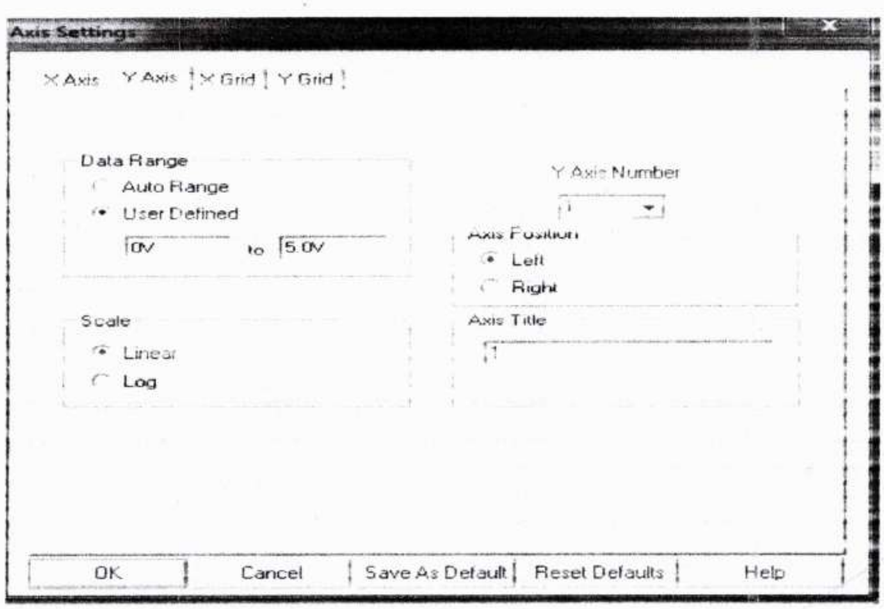
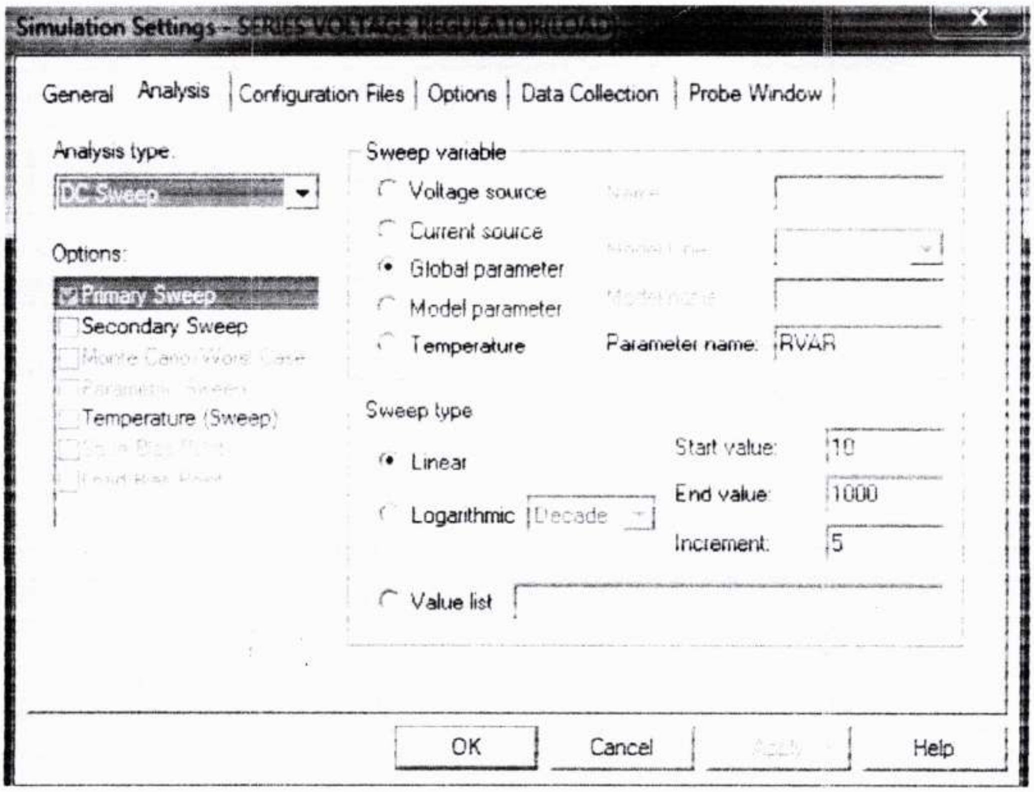
PROCEDURE

(i) LOAD REGULATION

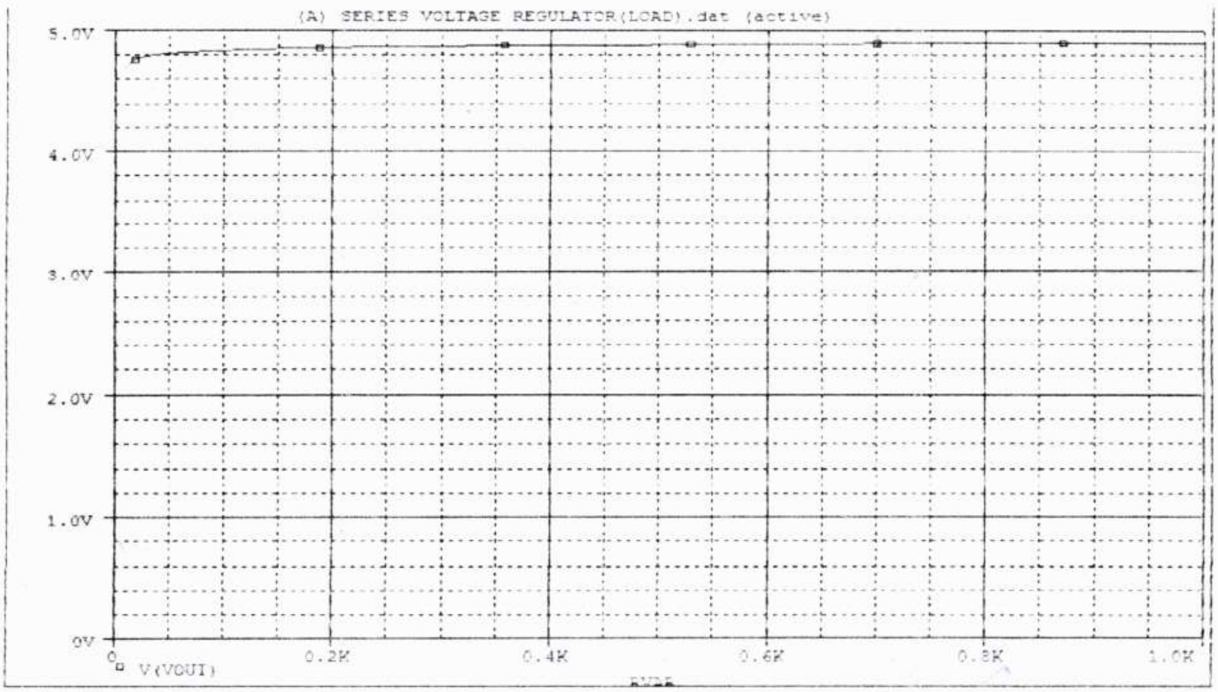
1. Create a new project and a new schematic page
2. Draw the circuit diagram as per the line regulation then change resistor R2 value to **{RVAR}** then select **PARAMETERS** tool from part search and initialize the value of **RVAR to100**
3. Set up the required analysis in the Simulation settings window.
4. Under Analysis type, select **DC Sweep** and select **Global Parameter** under sweep variable and give the parameter name as RVAR
5. Enter necessary parameter values (**start,end** and **increment** values for linear sweep type). Then click "Apply" to save the simulation profile.
6. After the parameters are set you can start a simulation by selecting Run option.
7. Waveforms will be shown in the graph. Observe the Graph.
8. On the output waveform click the option **Plot → Axis Setting → Y axis→ User defined** (select the data range 0 to 5 V)

SIMULATION PROFILE





OUTPUT



RESULT : The series voltage regulator – line and load characteristics was simulated using PSPICE simulation software.

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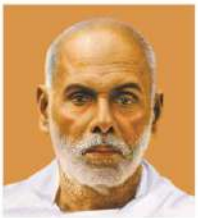
Est. 2003

Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

EEL331

MICROPROCESSORS AND MICROCONTROLLERS LAB
LAB MANUAL

For S5 EEE B.Tech. Degree Courses
(As per the APJ Abdul Kalam Technological University Syllabus)

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY
Promoted by Sree Bhakthi Samvardhini Yogam
(Affiliated to KTU, Recognised by AICTE)

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2021 – 2022

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LAB RULES

1. Safety is first, work is next.
2. Each lab group will be assigned an area to store lab materials. Please store your components and other equipment only in your assigned area.
3. Make sure TEST instruments are set for proper FUNCTION AND RANGE prior to taking a measurement.
4. Equipment should not be removed, transferred to any location without permission from the laboratory staff.
5. Do not remove any parts or equipment from the lab without prior permission from the course coordinator or laboratory staff.
6. Report all equipment problems to laboratory staff.
7. Do not write on equipments and work table.
8. Do not put suspected defective parts back in the bins. Give them to laboratory staff for testing or disposal.
9. Return components and connecting wires, when you are finished with them.
10. Each group is responsible for the Lab bench. After the Lab exercise is over, all equipment should be powered down and disconnected from the socket, all probes, cords, etc. returned to their proper position. Do not cut and drop wires on the Lab bench. Your Lab grade will be affected if your bench is not tidy when you leave the Lab.
11. Lab clean up (to be accomplished at the end of each lab session):
    - i. Turn off test equipment.
    - ii. Put hand tools back on the pegboard rack.
    - iii. Clean bench top.
    - iv. Put stools under the bench.

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MICROCONTROLLER 8051

- Processor: Intel 8051
- External clock Frequency: 12 MHz clock
- Memory:
  - System EPROM: 0000-3FFFH & C000 FFFFH
  - System RAM: 4000-40FFH
  - Additional RAM: 0000-3FFFH & C000-FEFFH
  - Monitor Buffer: 4000-40FFH
  - User program/ Data RAM Area: 4100-BFFFH
  - User data RAM area: 0000-3FFFH & C000-FEFFH
  - Memory mapped I/O: FF00-FF1FH, FFC0-FFFFH
  - Memory mapped I/O expansion: FF20-FFBFH
- Note:
  - The RAM area is from 4000 – 40FF should not be accessed by the user since it is used as scratch pad by the monitor program.

- INPUT/OUTPUT
  - Parallel: 24 I/O lines using one number of 8255.
  - Serial: one number of RS232c serial interfaces using 8051 serial port.
  - Timer: 8051 has two 16 bit timer namely timer 0 and timer 1.
    89C51 has 3 16 bit timer/counter
  - Printer: one entrains compatible printer interface through 8255 – I Port.
  - Interrupt: 8051 provides 5 interrupt sources. Among them two are External interrupts called INTO and INT1 (active low signals)

- LCD interface: 16X2 LCD display Module.

- IBM PC keyboard interface.

- Onboard Battery Backup: on board battery backup facility is provided for 64Kb RAM 4000-BFFFH.

System Power Consumption:

- +5V: 1 amp
- +12V: 200mA
- -12V: 100mA

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- +30V: 300mA

- Bus Expansion:
  - A VXT bus has been incorporated in Micro – 51 LC which facilitates to patch up any extra hardware. All address data and control signals are brought out to this bus. An unlimited number of add-on boards could be added this way to interface to the hardware available on Micro – 51 LC. Using VXT bus VBMB cards can be directly interfaced with Micro – 51 LC.

- Note:

The power supply used is meant only for the trainer and the add on boards used along with the trainer. The user is therefore, requested not to use this power supply for any external applications.

8051 Instruction Set

ARITHMETIC OPERATIONS

Mnemonic	Description
ADD A,Rn	Add register to Accumulator
ADD A,direct	Add direct byte to Accumulator
ADD A,@Ri	Add indirect RAM to Accumulator
ADD A,#data	Add immediate data to Accumulator
ADDC A,Rn	Add register to Accumulator with Carry
ADDC A,direct	Add direct byte to Accumulator with Carry
ADDC A,@Ri	Add indirect RAM to Accumulator with Carry
ADDC A,#data	Add immediate data to Acc with Carry
SUBB A,Rn	Subtract Register from Acc with borrow
SUBB A,direct	Subtract direct byte from Acc with borrow
SUBB A,@Ri	Subtract indirect RAM from ACC with borrow
SUBB A,#data	Subtract immediate data from Acc with borrow
INC A	Increment Accumulator
INC Rn	Increment register
INC direct	Increment direct byte
INC @Ri	Increment direct RAM
DEC A	Decrement Accumulator
DEC Rn	Decrement Register
DEC direct	Decrement direct byte
DEC @Ri	Decrement indirect RAM
INC DPTR	Increment Data Pointer

MUL AB	Multiply A & B
DIV AB	Divide A by B
DA A	Decimal Adjust Accumulator

LOGICAL OPERATIONS

Mnemonic	Description
ANL A,Rn	AND Register to Accumulator
ANL A,direct	AND direct byte to Accumulator
ANL A,@Ri	AND indirect RAM to Accumulator
ANL A,#data	AND immediate data toAccumulator
ANL direct,A	AND Accumulator to direct byte
ANL direct,#data	AND immediate data to direct byte
ORL A,Rn	OR register to Accumulator
ORL A,direct	OR direct byte to Accumulator
ORL A,@Ri	OR indirect RAM to Accumulator
ORL A,#data	OR immediate data to Accumulator
ORL direct,A	OR Accumulator to direct byte
ORL direct,#data	OR immediate data to direct byte
XRL A,Rn	Exclusive-OR register to Accumulator
XRL A,direct	Exclusive-OR direct byte to Accumulator
XRL A,@Ri	Exclusive-OR indirect RAM to Accumulator
XRL A,#data	Exclusive-OR immediate data to Accumulator
XRL direct,A	Exclusive-OR Accumulator to direct byte
XRL direct,#data	Exclusive-OR immediate data to direct byte
CLR A	Clear Accumulator
CPL A	Complement Accumulator
RL A	Rotate Accumulator Left
RLC A	Rotate Accumulator Left through the Carry
RR A	Rotate Accumulator Right
RRC A	Rotate Accumulator Right through the Carry
SWAP A	Swap nibbles within the Accumulator

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DATA TRANSFER

Mnemonic	Description
MOV A,Rn	Move register to Accumulator
MOV A,direct	Move direct byte to Accumulator
MOV A,@Ri	Move indirect RAM to Accumulator
MOV A,#data	Move immediate data to Accumulator

JC rel	Jump if Carry is set
JNC rel	Jump if Carry not set
JB bit,rel	Jump if direct Bit is set
JNB bit,rel	Jump if direct Bit is Not set
JBC bit,rel	Jump if direct Bit is set & clear bit

PROGRAM BRANCHING

Mnemonic	Description
ACALL addr11	Absolute Subroutine Call
LCALL addr16	Long Subroutine Call
RET	Return from Subroutine
RETI	Return from interrupt
AJMP addr11	Absolute Jump
LJMP addr16	Long Jump
SJMP rel	Short Jump (relative addr)
JMP @A+DPTR	Jump indirect relative to the DPTR
JZ rel	Jump if Accumulator is Zero
JNZ rel	Jump if Accumulator is Not Zero
CJNE A,direct,rel	Compare direct byte to Acc and Jump if Not Equal
CJNE A,#data,rel	Compare immediate to Acc and Jump if Not Equal
CJNE Rn,#data,rel	Compare immediate to register and Jump if Not Equal
CJNE @Ri,#data,rel	Compare immediate to indirect and Jump if Not Equal
DJNZ Rn,rel	Decrement register and Jump if Not Zero
DJNZ direct,rel	Decrement direct byte and Jump if Not Zero
NOP	No Operation

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Experiment No: 1

Date: __/__/_____

ARITHMETICS OPERATIONS USING 8051

AIM:

To write a assembly language program (ALP) for performing arithmetic operations such as addition, subtraction, multiplication & division using 8051.

ALGORITHM:

1. Start the program
2. Load the two inputs into the memory.
3. Perform addition, subtraction, multiplication & Division.
4. Store the result .
5. Stop the program.

PROGRAMS:

ADDITION

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	C3		CLR C	Clear c
4101	74 20		MOV A,#DATA	Move the data to A register
4103	24 10		ADD A,#DATA	Add the data with A
4105	90 45 00		MOV DPTR,#4500	Set the pointer to 4500
4108	F0		MOVX @DPTR,A	Store the result in memory
4109	80 FE	END	SJMP END	Stop the program.

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MOV Rn,A	Move Accumulator to register
MOV Rn,direct	Move direct byte to register
MOV Rn,#data	Move immediate data to register
MOV direct,A	Move Accumulator to direct byte
MOV direct,Rn	Move register to direct byte
MOV direct,direct	Move direct byte to direct
MOV direct,@Ri	Move indirect RAM to direct byte
MOV direct,#data	Move immediate data to direct byte
MOV @Ri,A	Move Accumulator to indirect RAM
MOV @Ri,direct	Move direct byte to indirect RAM
MOV @Ri,#data	Move immediate data to indirect RAM
MOV DPTR,#data16	Load Data Pointer with a 16-bit constant
MOVC A,@A+DPTR	Move Code byte relative to DPTR to Acc
MOVC A,@A+PC	Move Code byte relative to PC to Acc
MOVX A,@Ri	Move External RAM (8- bit addr) to Acc
MOVX A,@DPTR	Move Exernal RAM (16- bit addr) to Acc
MOVX @Ri,A	Move Acc to External RAM (8-bit addr)
MOVX @DPTR,A	Move Acc to External RAM (16-bit addr)
PUSH direct	Push direct byte onto stack
POP direct	Pop direct byte from stack
XCH A,Rn	Exchange register with Accumulator
XCH A,direct	Exchange direct byte with Accumulator
XCH A,@Ri	Exchange indirect RAM with Accumulator
XCHD A,@Ri	Exchange low-order Digit indirect RAM with Acc

BOOLEAN VARIABLE MANIPULATION

Mnemonic	Description
CLR C	Clear Carry
CLR bit	Clear direct bit
SETB C	Set Carry
SETB bit	Set direct bit
CPL C	Complement Carry
CPL bit	Complement direct bit
ANL C,bit	AND direct bit to CARRY
ANL C,/bit	AND complement of direct bit to Carry
ORL C,bit	OR direct bit to Carry
ORL C,/bit	OR complement of direct bit to Carry
MOV C,bit	Move direct bit to Carry
MOV bit,C	Move Carry to direct bit

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SUBTRACTION

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	C3		CLR C	Clear the carry flag
4101	74 20		MOV A,#DATA	Move the lower nibble of data to A register
4103	94 10		SUBB A,#DATA	Subtract the data to A register
4105	90 45 00		MOV DPTR,#4500	Set the pointer to 4500
4108	F0		MOVX @DPTR,A	Store the result in memory
4109	80 FE	END	SJMP END	Stop the program

MULTIPLICATION

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	74 65		MOV A,#DATA	Move the data to A register
4102	75 F0 08		MOV B,#DATA	Move the data to B register
4105	A4		MUL AB	Multiply A and B
4106	90 45 00		MOV DPTR,#4500	Load the address of data in DPTR
4109	F0		MOVX @DPTR,A	Store the lower byte of product
410A	A3		INC DPTR	Increment data pointer
410B	E5 F0		MOV A,B	Move the content of B in A register
410D	F0		MOVX @DPTR,A	Move the data to DPTR
410E	80 FE	END	SJMP END	

DIVISION

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	74 65		MOV A,#DATA	Move the data to A
4102	75 F0 08		MOV B,#DATA	Move the data to B
4105	84		DIV AB	Divide A and B
4106	90 45 00		MOV DPTR,#4500	Load the address of data in DPTR.
4109	F0		MOVX @DPTR,A	Store the lower byte of product
410A	A3		INC DPTR	Increment data pointer
410B	E5 F0		MOV A,B	Move B to A
410D	F0		MOVX @DPTR,A	Store the A value
410E	80 FE	END	SJMP END	Stop

OBSERVATION:

8 – BIT ADDITION			8 – BIT SUBTRACTION		
INPUT	OUTPUT		INPUT	OUTPUT	
DATA	ADDRESS	DATA	DATA	ADDRESS	DATA
8 – BIT MULTIPLICATION			**8 – BIT DIVISION**		
INPUT	**OUTPUT**		**INPUT**	**OUTPUT**	
DATA	**ADDRESS**	**DATA**	**DATA**	**ADDRESS**	**DATA**

RESULT:.

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Experiment No: 2

Date: __/__/_____

SUM OF A SERIES OF 8 BIT DATA USING 8051

AIM:

To write an assembly language program (ALP) for performing addition of a seriesof8 bit data using 8051.

ALGORITHM:

1. Start the program
2. Load the 16 bit address to data pointer.
3. Put the count value in R0.
4. Get the data to accumulator for addition.
5. Perform addition till the counter is zero,considering carry.
6. Store the results
7. Stop the program.

PROGRAM:

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	90 42 00		MOV DPTR,#4200	Load the source data address in DPTR
4103	E0		MOVX A,@DPTR	Move the count to A
4104	F8		MOV R0,A	Move the count to R0
4105	75 F0 00		MOV B,#00	Clear regB for msbresult
4108	A9 F0		MOV R1,B	Save B value in R1
410A	C3		CLR C	Clear C

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410B	A3	LOOP 2	INC DPTR	Increment datapointer
410C	E0		MOVX A,@DPTR	Move the 1st no. to A
410D	25,F0		ADD A,B	Add the numbers
410F	F5 F0		MOV B,A	Move the result to B
4111	50 12		JNC LOOP1	If no carry decrement the counter
4113	09		INC R1	Increment the carry register
4114	D8 F6	LOOP1	DJNZ R0,LOOP2	Decrement the count,if not zero continue addition
4116	90 45 00		MOV DPTR,#4500	Load the destination dataaddress in DPTR
4119	E9		MOV A,R1	Move msb of result to A
411A	F0		MOVX @DPTR,A	Store msb in memory
411B	A3		INC DPTR	Increment datapointer
411C	E5 F0		MOV A,B	Move lsb of result to A
411E	F0		MOVX @DPTR,A	Store lsb in memory
411F	80 FE	END	SJMP END	

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OBSERVATIONS:

INPUT		OUTPUT	
ADDRES	DATA	ADDRESS	DATA

RESULT:

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Experiment No: 3

Date: __/ __/_____

DATA TRANSFER OPERATION USING 8051

AIM:

To write an assembly language program to perform the data transfer operation using 8051

ALGORITHM

1. Start the program.
2. Load the 16 bit address to data pointer.
3. Put the count value in R0.
4. Move the data from source location to destination location.
5. Check the condition for the loop.
6. Increment the values and store the result.

PROGRAM

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	90 42 00		MOV DPTR,#4200H	Load the source data address in DPTR
4103	E0		MOVX A,@DPTR	Move the count to A
4104	F8		MOV R0,A	Move the count to R0
4105	A3	LOOP1	INC DPTR	Point data pointer to data1
4106	E0		MOVX A,@DPTR	Move data1 to A
4107	75 83 43		MOV DPH,#43	Load data pointer with destination address
410A	F0		MOVX @DPTR,A	Move data1 to destination location

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410B	75 83 42		MOV DPH,#42	Point data pointer to source
410E	D8 04		DJNZ R0,LOOP1	Jump to LOOP1 if R0 not 0
4110	80 FE	END	SJMP END	Stop

OBSERVATIONS:

INPUT		OUTPUT	
ADDRES	DATA	ADDRESS	DATA

RESULT:

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Experiment No: 4

Date: __/__/_____

LARGEST ELEMENT IN AN ARRAY USING 8051

AIM:

To find the largest element in an array using 8051

ALGORITHM:

7. Start the program.
8. Load the data to data pointer.
9. Put the value to R5.
10. Store the result in the specified address.
11. Check the condition for the loop.
12. Increment the values and store the result.
13. Stop the program.

PROGRAM:

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	90,42,00		MOV DPTR,#4200	Load the address to DPTR
4103	E0		MOVX A,@DPTR	Move the count to A
4104	F8		MOV R0,A	Move count to R0
4105	75 40 00		MOV 40H,#00	Value 00 move to SFR
4108	A3		INC DPTR	Increment data pointer
4109	E0	LOOP1	MOVX A,@DPTR	Move 1st data to A
410A	B5 40 08		CJNE A,40H,LOOP3	Jump if[A] not equal to[40]

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410D	A3	LOOP 2	INC DPTR	Increment data pointer
410E	D8 F9		DJNZ R0,LOOP1	Decrement count ,if not zero continue comparison
4110	E5 40		MOV A,40	Move the [40] to A
4112	F0		MOVX @DPTR,A	Store the result
4113	8006		SJMP END	Stop
4115	40 F6	LOOP3	JC LOOP2	Jump to loop2 if carry occur
4117	F5 40		MOV 40,A	Move the A to 40
4119	80 F2		SJMP LOOP2	Short jump
411B	80 FE	END	SJMP END	

OBSERVATION

INPUT		OUTPUT	
ADDRESS	**DATA**	**ADDRESS**	**DATA**

RESULT:

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Experiment No: 5

Date: __/__/_____

SQUARE OF A NUMBER

AIM:

To find square of a number using 8051

ALGORITHM:

1. Start the program.
2. Load the data to data pointer.
3. Put the number to find the square
4. Store the result in the specified address.
5. Stop the program.

SQUARE OF GIVEN NUMBER:

PROGRAM:

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	90 42 00		MOV DPTR,#4200	Load the data addressindptr
4103	E0		MOVX A,@DPTR	Move data to A
4104	F5 F0		MOV B,A	Store it in B
4106	A4		MUL AB	Perform the multiplication
4107	90 45 00		MOV DPTR,#4500	Load theresultaddressindptr
410A	F0		MOVX@DPTR,A	Store lsb
410B	F5 F0		MOV A,B	Move msb to A
410D	90 45 01		MOV DPTR,#4501	Load theresultaddressindptr

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4110	F0		MOVX @DPTR,A	Store msb
4111	80 FE		SJMP 4111	

OBSERVATION:

INPUT		OUTPUT	
ADDRESS	DATA	ADDRESS	DATA

RESULT:

HOD EEE

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Experiment No: 6

Date: __/ __/_____

SQUARE ROOT OF A NUMBER

AIM:

To find square root of a number using 8051

ALGORITHM:

1. Start the program.
2. Load the data to data pointer.
3. Put the number to find the square root
4. Store the result in the specified address.
5. Stop the program.

PROGRAM:

ADDRESS	OPCODE	LABEL	MNEMONCS	COMMENTS
4100	90 42 00		MOV DPTR,#4200	Load thedataaddressindptr
4103	E0		MOVX A,@DPTR	Move data to A
4104	F9		MOV R1,A	Move data to R1
4105	7A 01		MOV R2,#01	Move 1 to R2
4107	E9	LOOP1	MOV A, R1	Move data to R1
4108	8A F0		MOV B, R2	Move R2 to B
410A	84		DIV AB	Devide A by B
410B	FB		MOV R3,A	Move data to A
410C	AC,F0		MOV R4, B	Move B to R4

410E	C3		CLR C	Clear C
410F	9A		SUBB A,R2	Subtract
4110	60 F7		JZ LOOP2	Branch if zero
4112	0A		INC R2	Increment R2
4113	80 E6		SJMP LOOP1	Branch to loop1
4115	90 45 00	LOOP2	MOV DPTR,#4500	Load theresultaddressindptr
4118	EB		MOV A,R3	Move R3 to A
4119	F0		MOVX @DPTR,A	Store the result
411A	80 FE	END	SJMP END	

OBSERVATION:

INPUT		OUTPUT	
ADDRESS	**DATA**	**ADDRESS**	**DATA**

RESULT:

HOD EEE

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Experiment No: 7

Date: __/__/____

HEXADECIMAL TO DECIMAL CONVERSION

AIM:

To perform hexadecimal to decimal conversion.

ALGORITHM:

1. Load the number to be converted into the accumulator.
2. If the number is less than 100 (64H), go to next step; otherwise, subtract 100 (64H) repeatedly until the remainder is less than 100 (64H). Have the count (100's value) in separate register which is the carry.
3. If the number is less than 10 (0AH), go to next step; otherwise, subtract 10 (0AH) repeatedly until the remainder is less than 10 (0AH). Have the count (ten's value) in separate register.
4. The accumulator now has the units.
5. Multiply the ten's value by 10 and add it with the units.
6. Store the result and carry in the specified memory location.

PROGRAM

ADDRESS	OPCODE	LABEL	MNEMONICS	COMMENTS
4100	90 45 00		MOV DPTR,#4500	Load the address of data in DPTR
4103	E0		MOVX A,@DPTR	Move data from external memory to A register.
4104	75 F0 64		MOV B,#64	Move data to B
4107	84		DIV AB	Divide A and B
4108	90 45 01		MOV DPTR,#4501	Load the address of data in DPTR
410B	F0		MOVX @DPTR,A	Store the lower byte of product.
410C	E5 F0		MOV A,B	Move B to A

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410E	75 F0 0A		MOV B,#0A	Move data to B
4111	84		DIV AB	Divide A and B
4112	A3		INC DPTR	Increment data pointer
4113	F0		MOVX @DPTR,A	Store the higher byte
4114	A3		INC DPTR	Increment data pointer
4115	E5 F0		MOV A,B	Move B to A
4117	F0		MOVX @DPTR,A	Store the higher byte
4118	80 FE	END	SJMP END	Stop

OBSERVATION

INPUT		OUTPUT	
ADDRESS	**DATA**	**ADDRESS**	**DATA**

RESULT:

HODEEE

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Experiment No: 8

Date: __/__/_____

STEPPER MOTOR INTERFACING WITH 8051

AIM:

To interface a stepper motor with 8051 microcontroller and operate it.

THEORY:

A motor in which the rotor is able to assume only discrete stationary angular position is a stepper motor. The rotary motion occurs in a step-wise manner from one equilibrium position to the next. Stepper Motors are used very wisely in position control systems like printers, disk drives, process control machine tools, etc.

The basic two-phase stepper motor consists of two pairs of stator poles. Each of the four poles has its own winding. The excitation of any one winding generates a North Pole. A South Pole gets induced at the diametrically opposite side. The rotor magnetic system has two end faces. It is a permanent magnet with one face as South Pole and the other as North Pole.

The Stepper Motor windings A1, A2, B1, B2 are cyclically excited with a DC current to run the motor in clockwise direction. By reversing the phase sequence as A1, B2, A2, B1, anticlockwise stepping can be obtained.

2-PHASE SWITCHING SCHEME:

In this scheme, any two adjacent stator windings are energized. The switching scheme is shown in the table given below. This scheme produces more torque.

ANTICLOCKWISE						CLOCKWISE					
STEP	**A1**	**A2**	**B1**	**B2**	**DATA**	**STEP**	**A1**	**A2**	**B1**	**B2**	**DATA**
1	1	0	0	1	9h	1	1	0	1	0	Ah
2	0	1	0	1	5h	2	0	1	1	0	6h

3	0	1	1	0	6h	3	0	1	0	1	5h
4	1	0	1	0	Ah	4	1	0	0	1	9h

ADDRESS DECODING LOGIC:

The 74138 chip is used for generating the address decoding logic to generate the device select pulses; CS1 & CS2 for selecting the IC 74175.The 74175 latches the data bus to the stepper motor driving circuitry.

Stepper Motor requires logic signals of relatively high power. Therefore, the interface circuitry that generates the driving pulses uses silicon Darlington pair transistors. The inputs for the interface circuit are TTL pulses generated under software control using the Microcontroller Kit. The TTL level of pulse sequence from the data bus is translated to high voltage output pulses using a buffer 7407 with open collector.

PROCEDURE:

Enter the above program starting from location 4100.and execute the same. The stepper motor rotates. Varying the count at R4 and R5 can vary the speed. Entering the data in the look-up TABLE in the reverse order can vary direction of rotation.

PROGRAM1:

ADRESS	OPCODE	LABEL	MNEMONICS	COMMENT
4100	90 FF C0	START	MOV DPTR,#FFC0H	Load the Motor port address into DPTR
4103	74 09		MOV A,#09H	Load data to motor in A
4105	F0		MOVX @DPTR,A	Send the value in A to stepper Motor port address
4106	12 41 1D		LCALL DELAY	Call delay loop
4109	74 05		MOV A,#05	Load data to motor in A

410B	F0		MOVX @DPTR,A	Send the value in A to stepper Motor port address
410C	12 41 1D		LCALL DELAY	Call delay loop
410F	74 06		MOV A,#06	Load data to motor in A
4111	F0		MOVX @DPTR,A	Send the value in A to stepper Motor port address
4112	12 41 1D		LCALL DELAY	Call delay loop
4115	74 0A		MOV A,#0A	Load data to motor in A
4117	F0		MOVX @DPTR,A	Send the value in A to stepper Motor port address
4118	12 41 1D		LCALL DELAY	Call delay loop
411B	80 E3		SJMP START	Repeat the whole process
411D	79 50	DELAY	MOV R1,#50H	Load count in R1
411F	7A FF	LOOP2	MOV R2,#FFH	Load count in R2
4121	DA FE	LOOP1	DJNZ R2,LOOP1	Continue till R2=0
4123	D9 FA		DJNZ R1,LOOP2	Continue till R2=0
4125			RET	Return from subroutine

OBSERVATION:

RESULT:

HOD EEE

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Experiment No: 09

Date: __/__/_____

ADC INTERFACING WITH 8051

AIM

To write an assembly language program for interfacing 8051Micro Controller with ADCinterface

THEORY:

ADC 0809 is a monolithic CMOS device, with an 8 bit analog to digital converter, 8 channel multiplexer and microprocessor control logic. The main features of ADC 0809 are

- 8 bit resolution
- 100μs conversion time
- 8 channel multiplexer with latched control logic
- No need for external zero or full scale adjustments
- Low power consumption(15mW)
- Latched tristate output

PROCESS:

1. A particular input channel is selected by using address decoding.
2. The address is latched into the decoder of the chip on low to high transition of the address latch enable (ALE).
3. The A/D converter successive approximation register is reset on the positive edge of the start of conversion pulse.
4. The conversion is begun on the falling edge of the SOC pulse.
5. End of conversion will go low between 0 and 8 clock pulses after the rising edge of start of conversion.

Calculation:

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Analog Input(V):Trimpot value =3.7v

Digital output =LED Output value

=D7D6D5D4D3D2D1D0

=10101000

Vout $=2^8$*Analog input(v)/Vref=2^8*3.7/4.93

=168

=A8

ALGORITHM:

1. Start the program.
2. Move data 10H to the accumulator to select the channel 0 and to make ALE low.
3. Output data at C8H.
4. Move data 18H to accumulator to select the channel 0 and to make ALE high.
5. Output data at C8H.
6. Stop the program

PROGRAM

The following programs initiate the conversion process, checks the EOC pin ofADC-0809 as to wether the conversion is over and then inputs the data to the processor. its also instructs the processor to store the converted digital data at RAM location 4150.

ADDRESS	OPCODE	LABEL	MNEMONICS	COMMENTS
4100	90 FF C8		MOV DPTR,#FFC8H	Channel selection
4103	74 10		MOV A,#10	ALE Low
4105	F0		MOVX @DPTR,A	Move Adata toFFC8
4106	74 18		MOV A,#18	ALE High
4108	F0		MOVX @DPTR,A	Move Adata toFFC8

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4109	80 FE	END	SJMP END	end

OBSERVATION

RESULT:

HODEEE

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Experiment No: 10

Date: __/ __/_____

DAC INTERFACING WITH 8051

AIM

To write an assembly language program for interfacing 8051 Micro Controller with DAC interface

THEORY:

ADC 0809 is a monolithic CMOS device, with an 8 bit analog to digital converter, 8 channel multiplexer and microprocessor control logic. The main features of ADC 0809 are

- 8 bit resolution
- 100μs conversion time
- 8 channel multiplexer with latched control logic
- No need for external zero or full scale adjustments
- Low power consumption(15mW)
- Latched tristate output

PROCESS:

6. A particular input channel is selected by using address decoding.
7. The address is latched into the decoder of the chip on low to high transition of the address latch enable (ALE).
8. The D/A converter successive approximation register is reset on the positive edge of the start of conversion pulse.
9. The conversion is begun on the falling edge of the SOC pulse.

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10. End of conversion will go low between 0 and 8 clock pulses after the rising edge of start of conversion.

ALGORITHM:

7. Start the program.
8. Move data 10H to the accumulator to select the channel 0 and to make ALE low.
9. Output data at C8H.
10. Move data 18H to accumulator to select the channel 0 and to make ALE high.
11. Output data at C8H.
12. Stop the program

PROGRAM

To generate the square wave at DAC

With (00 H) as input to DAC,the analog output is +5v. Similarly with FF (H) as input, the output is +5v.Outputting digital data 00 and FF at regular intervals to DAC result in a square wave of amplitude 15 v

PROGRAM

ADDRESS	OPCODE	LABEL	MNEMONICS	COMMENTS
4100	90 FF C8		MOV DPTR,#FFC8	Set the data pointer to FFC8
4103	74 00	START	MOV A,#00	Move 00 to A register
4105	F0		MOVX @DPTR,A	Transfer Adata to FFC8
4106	12 41 12		LCALL DELAY	Call subroutine
4109	74 FF		MOV A,#FF	Move FF to A register
410B	F0		MOVX @DPTR,A	Transfer Adata to FFC8

410C	12 41 12		LCALL DELAY	Call subroutine
411F	02 41 03		LJMP START	Repeat the process
4112	79 05	DELAY	MOV R1,#05	Load R1 with count 05
4114	7A FF	LOOP2	MOV R2,#FF	Load R2 WITH count FF
4116	DA FE	LOOP1	DJNZ R2,LOOP1	Decrement and continue till R2=0
4118	D9 FA		DJNZ R1,LOOP2	Decrement and continue till R1=0
411A	22		RET	Return from subroutine

OBSERVATION

RESULT:

HOD EEE

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Experiment No: 11

Date: __/__/_____

LED BLINKING CIRCUIT USING ARDUINO

AIM

To write a program to blink LEDsby interfacing 8051 with arduino

THEORY:

* LED BLINK
* LEDs connected on pin no 10, 11, 12 & 13
* blink each LED with 1 second delay

PROGRAM:

```
void setup() {
 // put your setup code here, to run once:
pinMode(10,OUTPUT); // define mode of pin no 10 as OUTPUT
pinMode(11,OUTPUT);
pinMode(12,OUTPUT);
pinMode(13,OUTPUT);
}

void loop() {
 // put your main code here, to run repeatedly:
digitalWrite(10,HIGH); // switch on LED by changing the voltage of pin no 10 to 5V
delay(1000); // wait for 1000 milli seconds
digitalWrite(10,LOW); // switch on LED by changing the voltage of pin no 10 to 0V
delay(1000) ;
```

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```
digitalWrite(11,HIGH);
delay(1000) ;
digitalWrite(11,LOW);
delay(1000) ;

digitalWrite(12,HIGH);
delay(1000) ;
digitalWrite(12,LOW);
delay(1000) ;

digitalWrite(13,HIGH);
delay(1000) ;
digitalWrite(13,LOW);
delay(1000) ;
}
```

RESULT:

HOD EEE

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Experiment No: 12

Date: __/ __/_____

TEMPERATURE MEASUREMENT USING ARDUINO

AIM

To write a program to measure the temperature of surroundings using LM35 and displaying it on the serial monitor of Arduino.

THEORY :

LM35 is a temperature sensorthat provides analog voltage proportional to the temperature. LM35 output is given to analog pin A1 of Arduino UNO. This analog voltage is converted to its digital form and processed to get the temperature reading.

INTERFACING DIAGRAM:

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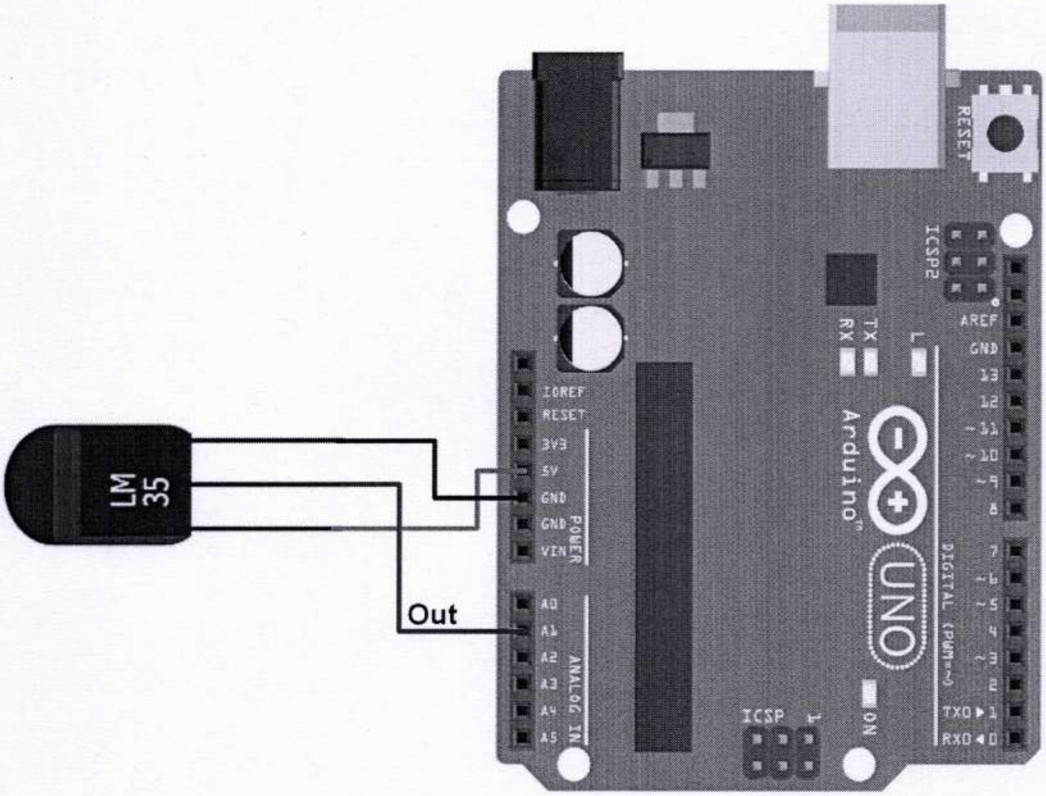

PROGRAM :

```
constint lm35_pin = A1;        /* LM35 O/P pin */

void setup() {
Serial.begin(9600);
}

void loop() {
inttemp_adc_val;
floattemp_val;
temp_adc_val = analogRead(lm35_pin);       /* Read Temperature */
temp_val = (temp_adc_val * 4.88);   /* Convert adc value to equivalent voltage */
temp_val = (temp_val/10);    /* LM35 gives output of 10mv/°C */
```

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```
Serial.print("Temperature = ");
Serial.print(temp_val);
Serial.print(" Degree Celsius\n");
delay(1000);
}
```

RESULT:

HOD EEE

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Experiment No. 1(a)

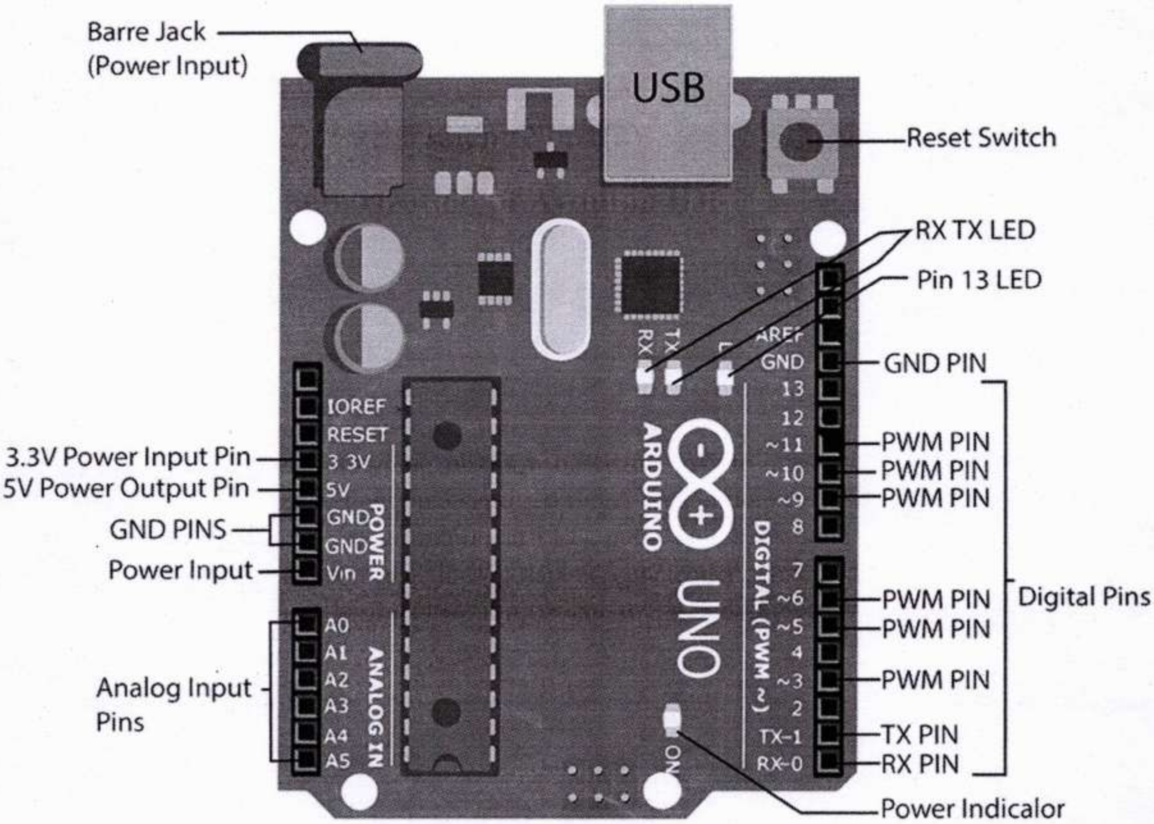
Familiarization of Arduino IDE

Aim:

a) Familiarization of Arduino IDE

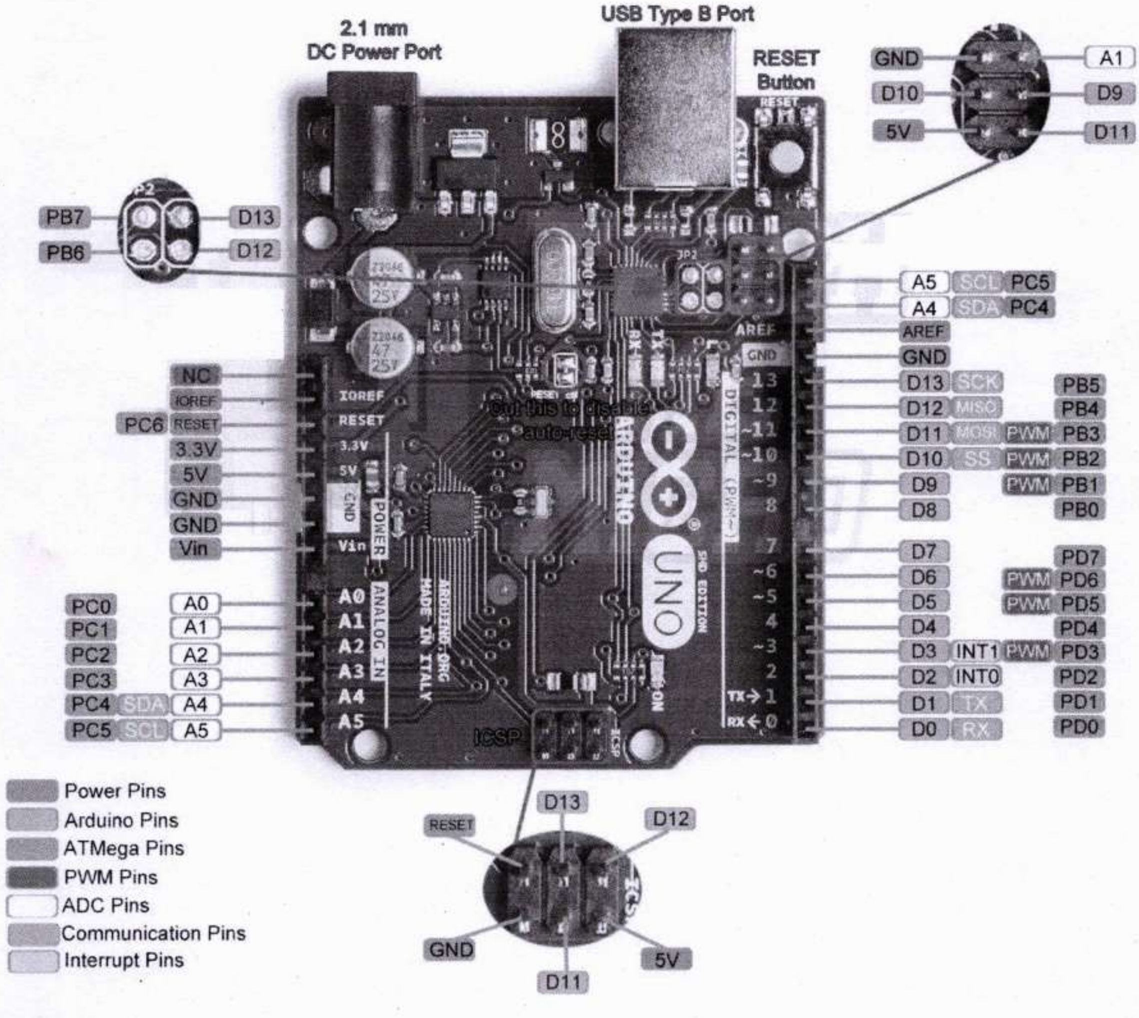
Theory: Introduction to Arduino board

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.



Arduino Uno

Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems which are inexpensive , cross-platform , Simple, clear programming environment , Open source and extensible hardware etc.



Pin Diagram of Arduino Uno

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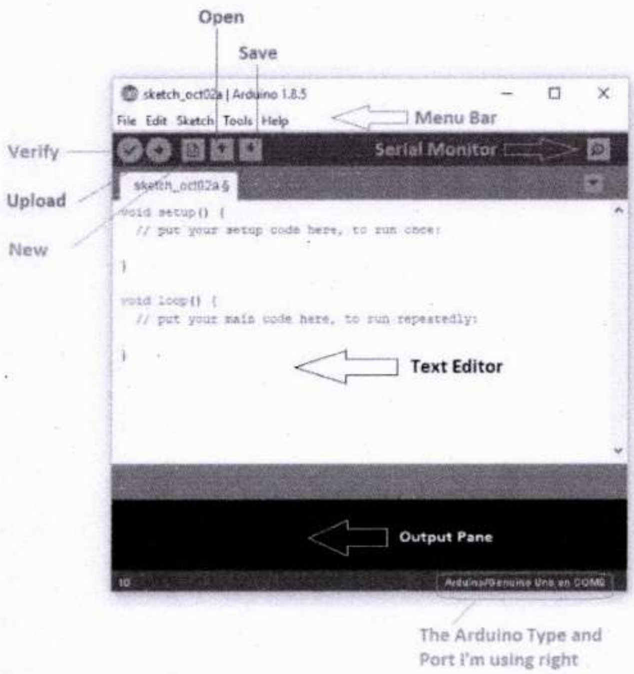
The basic structure of the Arduino programming language is fairly simple and runs in at least two parts. These two required parts, or functions, enclose blocks of statements. Where setup() is the preparation, loop() is the execution. Both functions are required for the program to work.



The setup function should follow the declaration of any variables at the very beginning of the program. It is the first function to run in the program, is run only once, and is used to set **pinMode** or initialize serial communication.

The loop function follows next and includes the code to be executed continuously-reading inputs, triggering outputs etc. This function is the core of all Arduino programs and does the bulk of the work. Curly braces ({})define the beginning and the end of function blocks and statement blocks such as the void loop() function and the for and if statements.

Programming using Arduino IDE

Step 1 − Download Arduino IDE Software: You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

Step 2 − Power up your board: The Arduino Uno automatically draw power from either, the USB connection to the computer or an external power supply. Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4 − Launch Arduino IDE

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Arduino Instruction Set

Structure

- setup()
- loop()

Control Structures

- if
- if...else
- for
- switch case
- while
- do... while
- break
- continue
- return
- goto

Further Syntax

- ; (semicolon)
- {} (curly braces)
- // (single line comme
- /* */ (multi-line comi
- #define
- #include

Arithmetic Operators

- = (assignment operator)
- + (addition)
- - (subtraction)
- * (multiplication)
- / (division)
- % (modulo)

Comparison Operators

- == (equal to)
- != (not equal to)
- < (less than)
- > (greater than)
- <= (less than or equal to)
- >= (greater than or equal to)

Boolean Operators

- && (and)
- || (or)
- ! (not)

Pointer Access Operators

- * dereference operator
- & reference operator

Variables

Constants

- HIGH | LOW
- INPUT | OUTPUT
- true | false
- integer constants
- floating point constants

Data Types

- void
- boolean
- char
- unsigned char
- byte
- int
- unsigned int
- word
- long
- unsigned long
- float
- double
- string - char array
- String - object
- array

Functions

Digital I/O

- pinMode()
- digitalWrite()
- digitalRead()

Analog I/O

- analogReference()
- analogRead()
- analogWrite() - *PWM*

Advanced I/O

- tone()
- noTone()
- shiftOut()
- pulseIn()

Time

- millis()
- micros()
- delay()
- delayMicroseconds()

Math

- min()
- max()
- abs()
- constrain()
- map()
- pow()
- sqrt()

Trigonometry

- sin()
- cos()
- tan()

Random Numbers

- randomSeed()
- random()

Bits and Bytes

- lowByte()
- highByte()
- bitRead()
- bitWrite()
- bitSet()
- bitClear()
- bit()

Step 5 – Open your first project: Once the software starts, you have two options –

- Create a new project.
- Open an existing project example.

To create a new project, select File → **New**.

To open an existing project example, select File → Example → Basics → Blink.

Here, we are selecting just one of the examples with the name **Blink**. It turns the LED on and off with some time delay. You can select any other example from the list.

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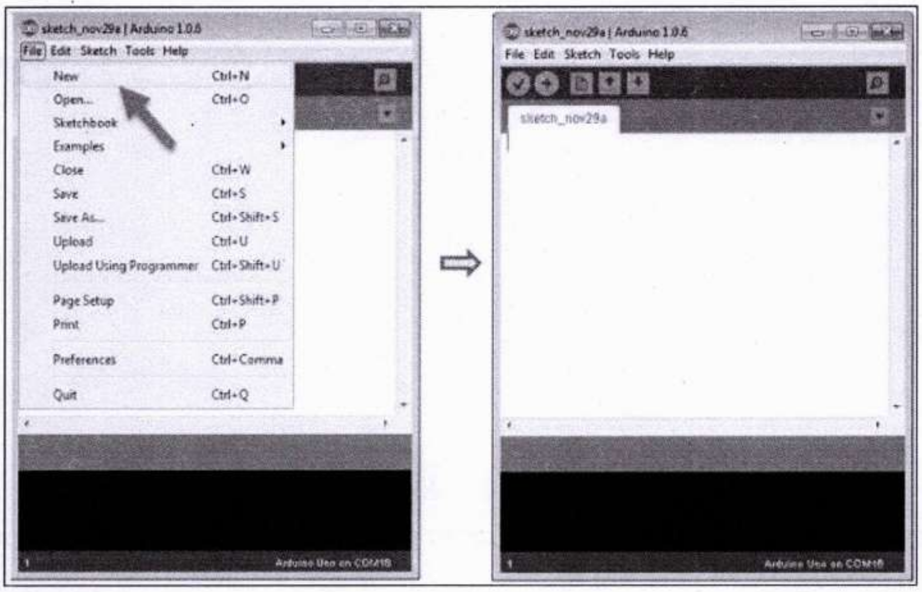
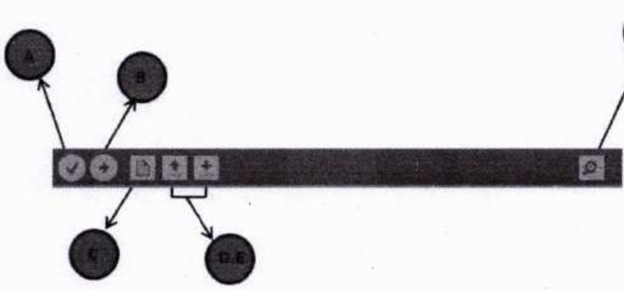


Step 6 – Select your Arduino board: To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools → Board and select your board

Step 7 – Select your serial port: Select the serial device of the Arduino board. Go to **Tools → Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

Step 8 – Upload the program to your board: Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar. Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.



A – Check if there is any compilation error.

B – Upload a program to the Arduino board.

C – Shortcut to create a new sketch.

D – Open one of the example sketch.

E – Used to save your sketch.

F – Serial monitor for serial data transfer

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Experiment No. 1 (b)

LED control using Arduino

Aim:

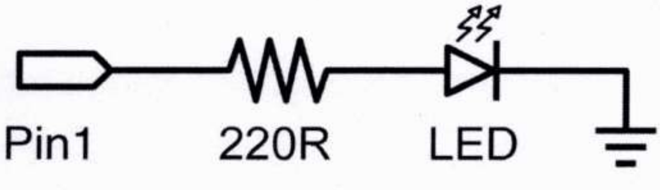
a) Blinking inbuilt LED with different on off time delays
b) Blinking externally interfaced LED with different on off time delays

Hardware required:

No.	Item	Specification	Quantity
1	Arduino board	Arduino Uno	1
2	LED		1
3	Resistor	220 Ohm	1
4	Bread board and connection wires		

Connection Diagram:

Circuit for blinking of Internal LED (No External connection required)



Circuit for blinking of external LED on Pin 1

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Sample Program for external LED blink on Pin-1:

```
void setup()                    // run once
{
pinMode(1, OUTPUT);             // sets pin 1 as output
}
void loop()                     // run over and over again
{
digitalWrite(1, HIGH);          // turns the LED on
delay(1000);                    // pauses for 1 second
digitalWrite(1, LOW);           // turns the LED off
delay(1000);                    // pauses for 1 second
}
```

Output:

Result:

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Experiment No. 2

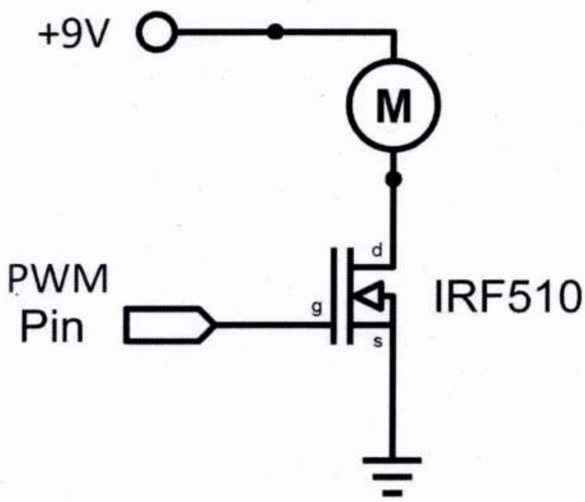
DC Motor Speed Control using Arduino

Aim: To control the speed of a DC motor using MOSFET driven by PWM signal from Arduino module

Hardware required:

No.	Item	Specification	Quantity
1	Arduino board	Arduino Uno	1
2	MOSFET or MOSFET based motor driver board	IRF 510	1
3	DC Motor	9V	1
4	Bread board and connection wires		

Connection Diagram:



Study: To control a load with more than 40ma current requirement using the Arduino, a MOSFET or transistor could be used to switch higher current loads. Also motor speed control requires voltage variation, which could be achieved by using the PWM variable voltage signal available from the PWM enabled digital pins of the Arduino.

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Sample Program for DC motor speed control:

```
void setup()
{
pinMode(5, OUTPUT);                // sets PWM Pin 5 as output
}
void loop()
{
for (int i=0; i<255; i++)          // Motor speed increasing
{
analogWrite(5, i);                 // turns MOSFET on
delay(250);                        // pauses 1/4 second
}
delay(1000);                       // pauses 1 second

for (int i=255; i>0; i--)          // Motor speed decreasing
{
analogWrite(5, i);                 // turns MOSFET on
delay(250);                        // pauses 1/4 second
}
delay(1000);                       // pauses 1 second
}
```

Output:

Result:

HOD EEE

Experiment No. 3

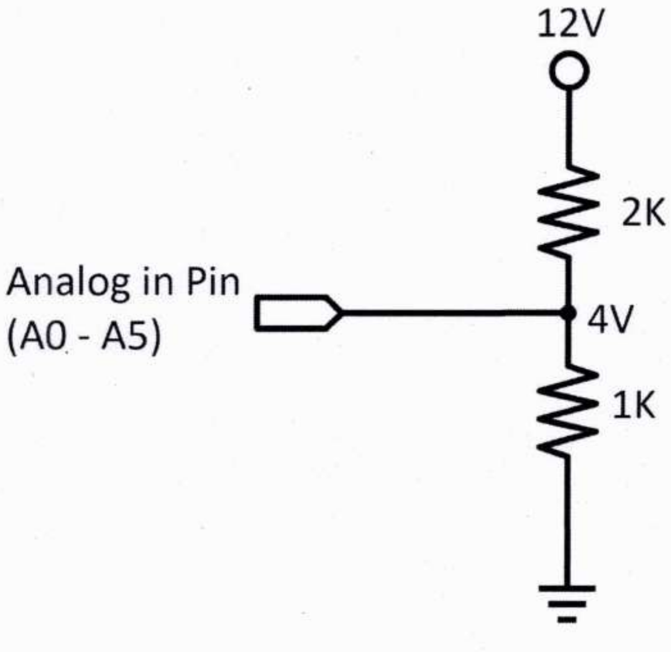
Voltage Measurement using Arduino

Aim: Arduino based voltage measurement of 12V solar PV module or 12V battery and displaying the measured value using I2C LCD display.

Hardware required:

No.	Item	Specification	Quantity
1	Arduino board	Arduino Uno	1
2	LCD display with I2C adapter	16x2 (1602) Character (5x7 Dot Matrix Character and Cursor) Green Backlight LCD Display with attached 4 pin I2C adapter	1
3	Voltage Source	9V Battery	1
4	Resistor	1K, 2K	1 each
4	Bread board and connection wires		1

Connection Diagram:



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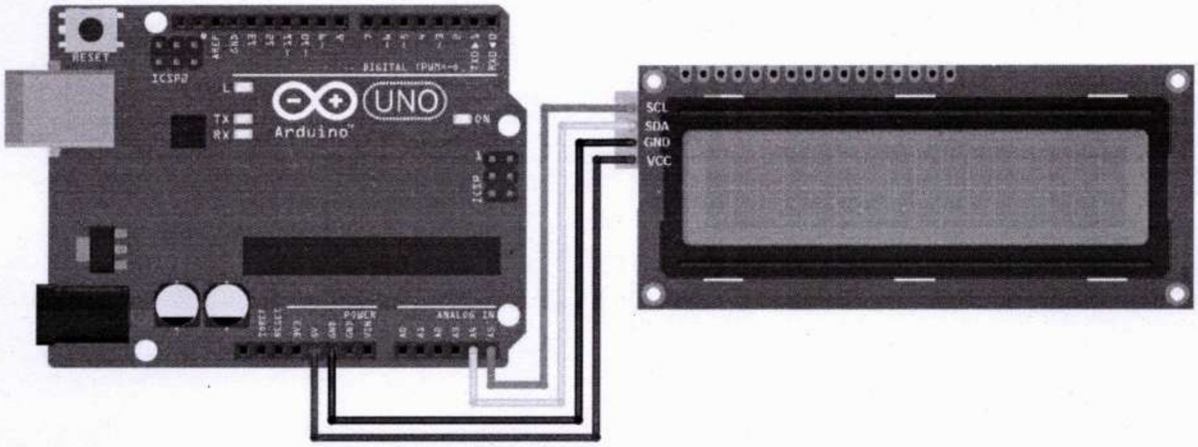

Study:

Arduino can measure only a maximum of 5V on the analog pins, and hence a potential divider arrangement using resistors is used to reduce the voltage to be measured, and later a multiplication factor is used in the program to scale the obtained value to actual voltage value.

LCD 16X2: An electronic device that is used to display data and the message is known as LCD 1602. It includes 16 Columns and 2 Rows so it can display 32 characters (16×2=32) in total. Every character will be made with 5×8 (40) Pixel Dots and the total pixels within this LCD can be calculated as 32 x 40 or 1280 pixels. The data register inside the display is used to save the date to exhibit on the LCD.

I2C Protocol: The Inter-Integrated Circuit (I2C) Protocol is a protocol intended to allow multiple peripheral digital integrated circuits to communicate with one or more controller chips. I2C requires only two wires to communicate in serial mode, but those two wires can support up to 1008 peripheral devices, each having an address. Each I2C bus consists of two signals: SDA (Serial Data) - the data signal and SCL (Serial Clock)- the clock signal. The clock signal is always generated by the Master or the current bus controller.

I2C Line	Pin in Arduino
SDA	A4, SDA
SCL	A5, SCL

Sample Program:

```
#include <Wire.h>                  // library for I2C
#include <LiquidCrystal_I2C.h>  // Arduino library for I2C LCD displays
LiquidCrystal_I2C lcd(0x27,20,4);  //Set the LCD address to 0x27 (default)

void setup()
{
 lcd.init();                   // Initialize the lcd
 lcd.backlight();              // Turn on backlight of lcd
 lcd.setCursor(2,0);           //Setting display curser position (Col 2, Row 0)
 lcd.print("VOLTMETER");          // Show on LCD display from cursor position
 }

void loop()

{
 lcd.setCursor(0,1);              // Set Cursor to (Column 0, Row 1)
 lcd.print("VOLT =");             // Display the characters
 float mf = 3;                    // Multiplication factor corresponding to resistors
 int x = analogRead(A0);          // Read input Voltage from A0
 float value = (x*mf*5)/1024;     // Convert input to actual voltage value
 lcd.setCursor(6,1);              //Set Cursor to (Column 6, Row 1)
 lcd.print(value);                // Display the voltage
 delay(500);                      // Delay 0.5s
}
```

Output:

Result:

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Experiment No. 4

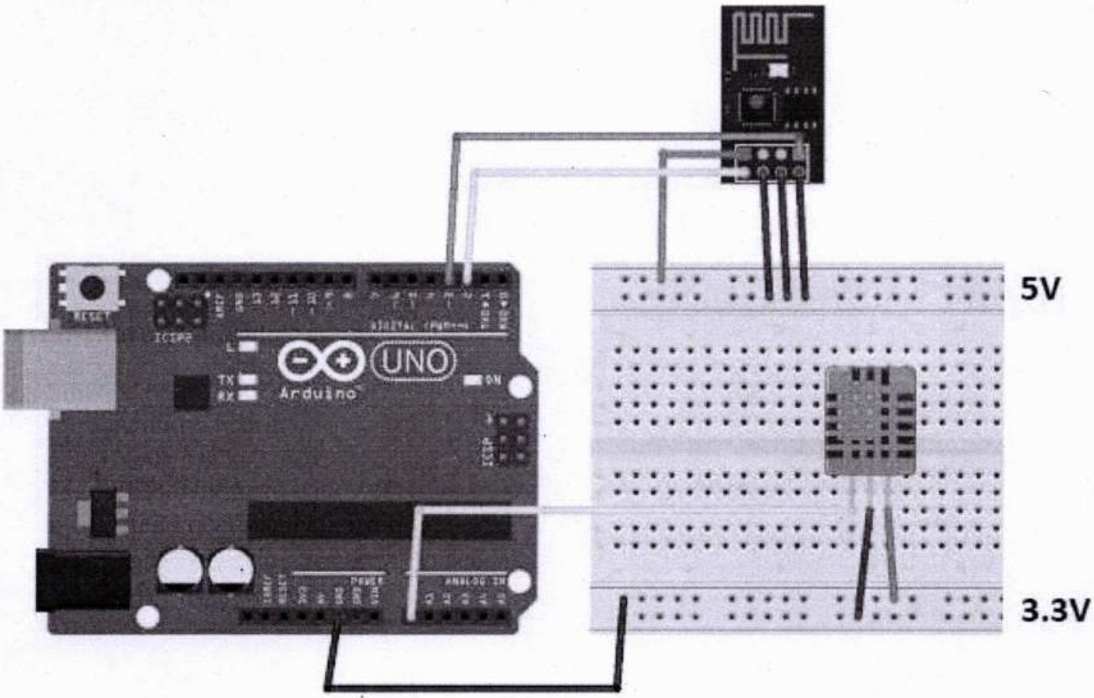
Uploading data to Thinkspeak Cloud

Aim: Write a program to upload multiple sensor data (say, humidity and temperature) to Thinkspeak cloud through wifi network

Hardware required:

No.	Item	Specification	Quantity
1	Arduino board	Arduino Uno	1
2	Node MCU	ESP8266	1
3	Sensors to read data	2 parameters (eg; DHT11)	1
4	Bread board and connection wires		

Connection Diagram:



Connection diagram for Arduino Thinkspeak cloud data transfer

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Steps:

1. Create a Thinkspeak account using a mail address
2. Create a channel with two field parameters and note down the Write API key
3. Create a wifi network and note down the SSID and password
4. Download necessary library files for Thinkspeak and add it to IDE
5. Develop the Arduino interface with ESP and sensors
6. Develop the program with serial monitor with 9600 baud rate
7. Verify and upload the program, and monitor the Thinkspeak cloud for data storage

Sample Code: follow references

Output:

1. Think speak account and channel details:
2. Wifi network setting up:
3. Thinkspeak library file addition:
4. Circuit development and pin selection:
5. Program development and testing:

Result:

References:

1. Arduino Project Hub, https://create.arduino.cc/projecthub/neverofftheinternet/thingspeak-arduino-weather-station-70b4bb
2. OIT Design Pro, https://iotdesignpro.com/projects/temperature-humidity-monitoring-over-thingspeak-using-arduino-esp8266

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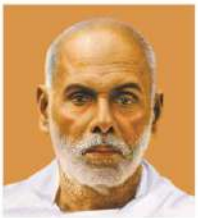
Est. 2003

Sree Narayana Guru College of Engineering & Technology

CHALAKKODE P.O., KOROM, PAYYANUR, KANNUR-670 307



DEPARTMENT OF MECHANICAL ENGINEERING

SREE NARAYANA GURU COLLEGE OF ENGINEERING &
TECHNOLOGY,

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY)

COMPUTER AIDED DESIGN AND ANALYSIS LAB.

Department of Mechanical Engineering

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MEL332	COMPUTER AIDED DESIGN & ANALYSIS LAB	CATEGORY	L	T	P	CREDITS
		PCC	0	0	3	2

Preamble:

- To introduce students to the basics and standards of engineering design and analysis related to machine components.
- To make students familiarize with different solid modelling and analysis soft wares
- To convey the principles and requirements ofmodelling and analysis of machine elements.
- To introduce the preparation of part modelling and assembly modelling of machineries
- To introduce standard CAD packages to perform Finite Element Analysis of machine parts

Prerequisite:

EST 110 - Engineering Graphics

MEL 201 - Computer Aided Machine Drawing

Course Outcomes - At the end of the course students will be able to

CO1	Gain working knowledge in Computer Aided Design and modelling procedures.
CO2	Gain knowledge in creating solid machinery parts.
CO3	Gain knowledge in assembling machine elements.
CO4	Gain working knowledge in Finite Element Analysis.
CO5	Solve simple structural, heat and fluid flow problems using standard software

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	2	-	-
CO2	3	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	-	-	-	2	2	-	-
CO4	3	1	3	-	-	-	-	1	2	3	-	-
CO5	3	3	2	-	-	-	-	2	3	3	-	-

Mark Distribution

Total Marks	CIE Marks	ESE marks	ESE duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	15 marks
Regular class work/Modelling and Analysis/Lab Record and Class Performance	30 marks
Continuous Assessment Test (minimum two tests)	30 marks

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Continuous Assessment test pattern

Bloom's Taxonomy	Continuous Assessment Tests	
	Test 1 - PART A MODELLING (marks)	Test 2 - PART B ANALYSIS (marks)
Remember	10	10
Understand	10	10
Apply	20	20
Analyse	15	15
Evaluate	20	20
Create	25	25

End semester examination pattern

End semester examination shall be conducted on modelling and analysis and based on complete syllabus. The following general guidelines should be maintained for the award of marks

Part A Assembly Modelling – 35 marks.

Part B Analysis – 30 marks.

Viva Voce – 10 marks.

Conduct of University Practical Examinations

The Principals of the concerned Engineering Colleges with the help of the Chairmen/Chairperson will conduct the practical examination with the approval from the University and bonafide work / laboratory record, hall ticket, identity card issued by college are mandatory for appearing practical University examinations. No practical examination should be conducted without the presence of an external examiner appointed by the University.

References Books:

1. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007
2. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003
3. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
4. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education,1987
5. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2012

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Experiment List (Minimum 12 exercises)

SL.NO	PART - A (Minimum 6 models)	COURSE OUTCOMES	HOURS
1	Creation of high end part models (minimum 2 models, Questions for examinations must not be taken from this portions)	CO1, CO2	6
2	Creating assembly models of Socket and spigot joint, Knuckle Joint, Rigid flange couplings, Bushed Pin flexible coupling, Plummer block, Single plate clutch and Cone friction clutch. Pipe joints, Screw jack, Tail stock etc. (minimum 4 models)	CO1, CO2, CO3	12
	PART – B (Minimum 6 problems)		
3	Structural analysis. (minimum 3 problems)	CO4, CO5	6
4	Thermal analysis. (minimum 2 problems)	CO4, CO5	3
5	Fluid flow analysis. (minimum 1 problem)	CO4, CO5	3

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INDEX

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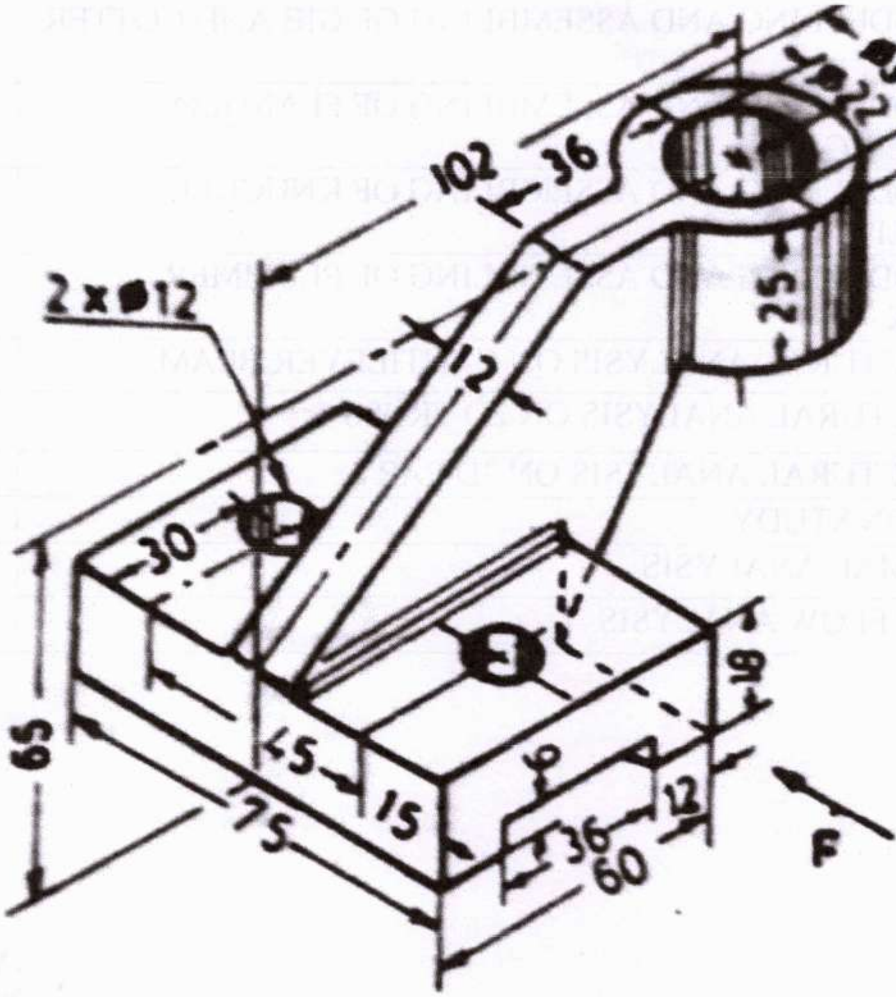
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18
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EXPERIMENT No.1

ORTHOGRAPHIC VIEWS FROM 3D MODELS

Aim: To familiarize the 3D modelling of various design of objects and to generate 2D drawings for shop floor.

Equipments required;

1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, CATIA, PRO-E

2. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4th until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new module 2D drafting and generate 2D drawing of the 3D model created previously.
10. 2D drafting file is an another file that also to be saved and closed.

Leena

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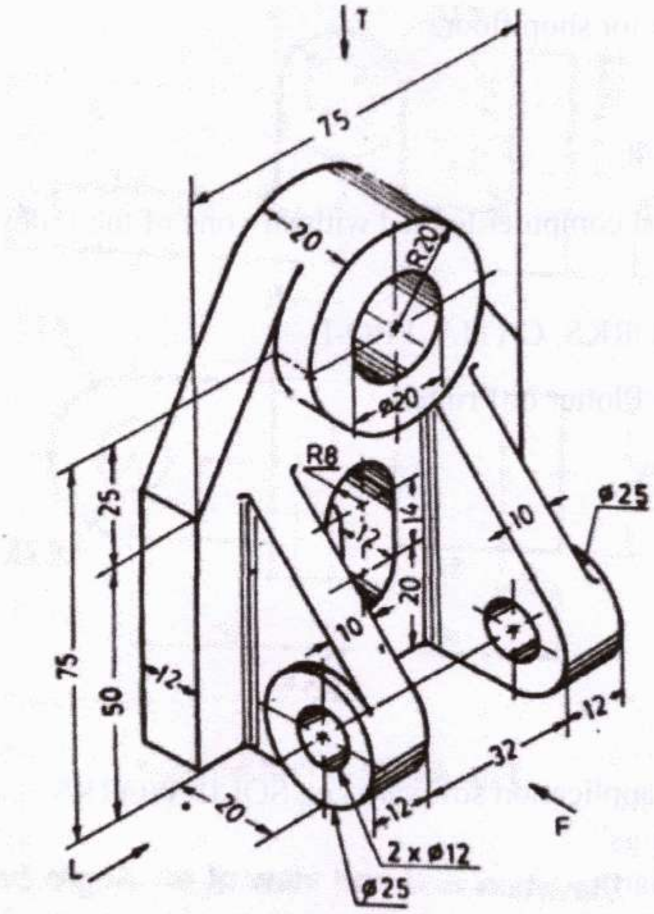

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EXPERIMENT No.2

ORTHOGRAPHIC VIEWS FROM 3D MODELS

Aim: To familiarize the 3D modelling of various design of objects and to generate 2D drawings for shop floor.

Equipments required;

3. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, CATIA, PRO-E

4. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4th until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new module 2D drafting and generate 2D drawing of the 3D model created previously.
10. 2D drafting file is an another file that also to be saved and closed.

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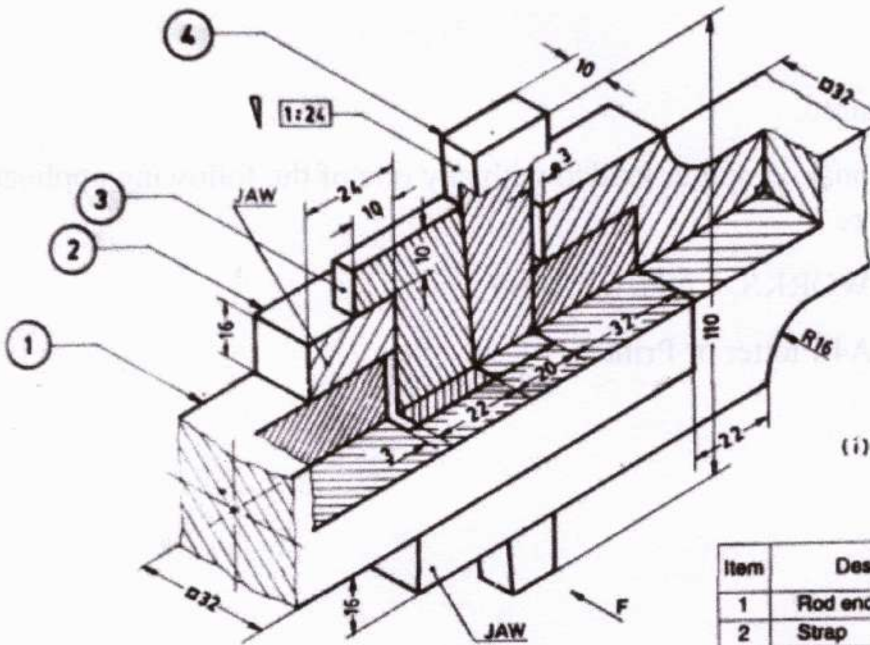

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ITEM LIST

Item	Description	Qty.	Material
1	Rod end (Square)	1	M. S.
2	Strap	1	M. S.
3	Gib	1	M. S.
4	Cotter	1	M. S.

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EXPERIMENT No.3

3D MODELLING AND ASSEMBLING OF GIB AND COTTER JOINT

Aim: To familiarize the 3D modelling of various design of objects and to assemble together to form a product having some engineering functions.

Equipments required;

5. A personal computer loaded with any one of the following application Software.

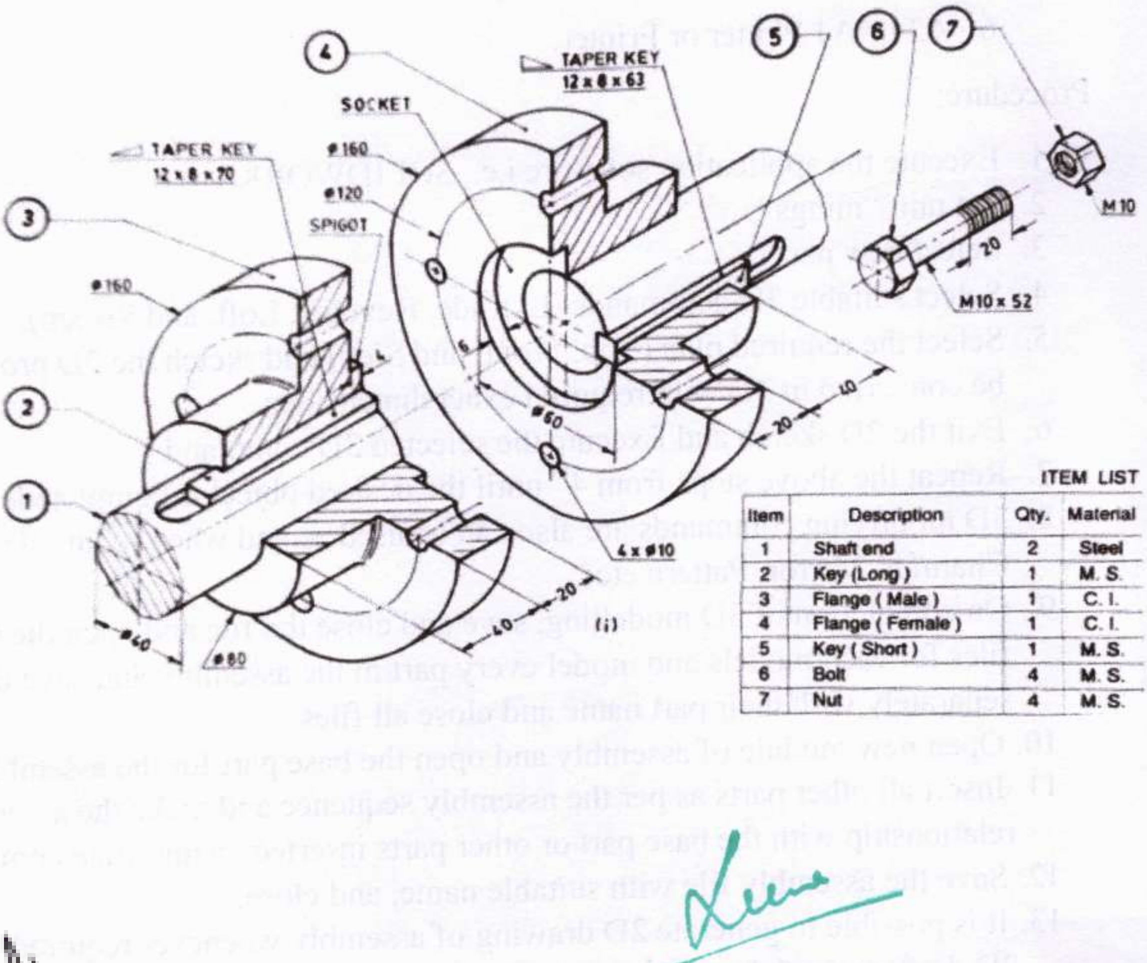
   SOLIDWORKS, CATIA, PRO-E

6. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4th until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new files for each models and model every part in the assembly and save them separately with their part name and close all files.
10. Open new module of assembly and open the base part for the assembly.
11. Insert all other parts as per the assembly sequence and make the assembly relationship with the base part or other parts inserted, using Mate command.
12. Save the assembly file with suitable name, and close.
13. It is possible to generate 2D drawing of assembly whenever required with 2D drafting module.

Leena



ITEM LIST

Item	Description	Qty.	Material
1	Shaft end	2	Steel
2	Key (Long)	1	M. S.
3	Flange (Male)	1	C. I.
4	Flange (Female)	1	C. I.
5	Key (Short)	1	M. S.
6	Bolt	4	M. S.
7	Nut	4	M. S.

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EXPERIMENT No.4

3D MODELLING AND ASSEMBLING OF FLANGED COUPLING

Aim: To familiarize the 3D modelling of various design of objects and to assemble together to form a product having some engineering functions.

Equipments required;

1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, CATIA, PRO-E

2. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4th until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new files for each models and model every part in the assembly and save them separately with their part name and close all files.
10. Open new module of assembly and open the base part for the assembly.
11. Insert all other parts as per the assembly sequence and make the assembly relationship with the base part or other parts inserted, using Mate command.
12. Save the assembly file with suitable name, and close.
13. It is possible to generate 2D drawing of assembly whenever required with 2D drafting module.

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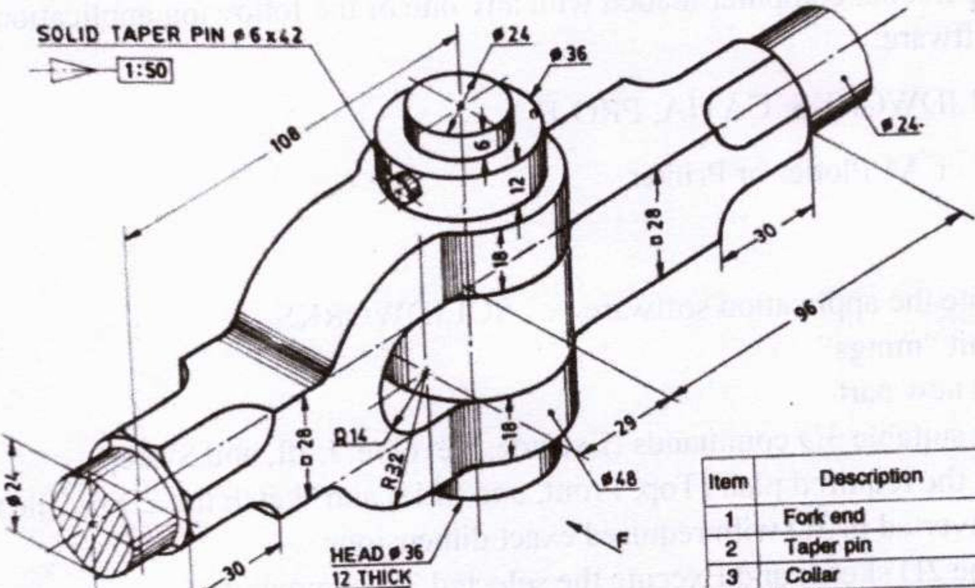

ITEM LIST

Item	Description	Qty.	Material
1	Fork end	1	M. S.
2	Taper pin	1	M. S.
3	Collar	1	M. S.
4	Pin	1	M. S.
5	Eye end	1	M. S.

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EXPERIMENT No.5

3D MODELLING AND ASSEMBLING OF KNUCKLE COUPLING

Aim: To familiarize the 3D modelling of various design of objects and to assemble together to form a product having some engineering functions.

Equipments required;

1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, CATIA, PRO-E

2. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4^{th} until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new files for each models and model every part in the assembly and save them separately with their part name and close all files.
10. Open new module of assembly and open the base part for the assembly.
11. Insert all other parts as per the assembly sequence and make the assembly relationship with the base part or other parts inserted, using Mate command.
12. Save the assembly file with suitable name, and close.
13. It is possible to generate 2D drawing of assembly whenever required with 2D drafting module.

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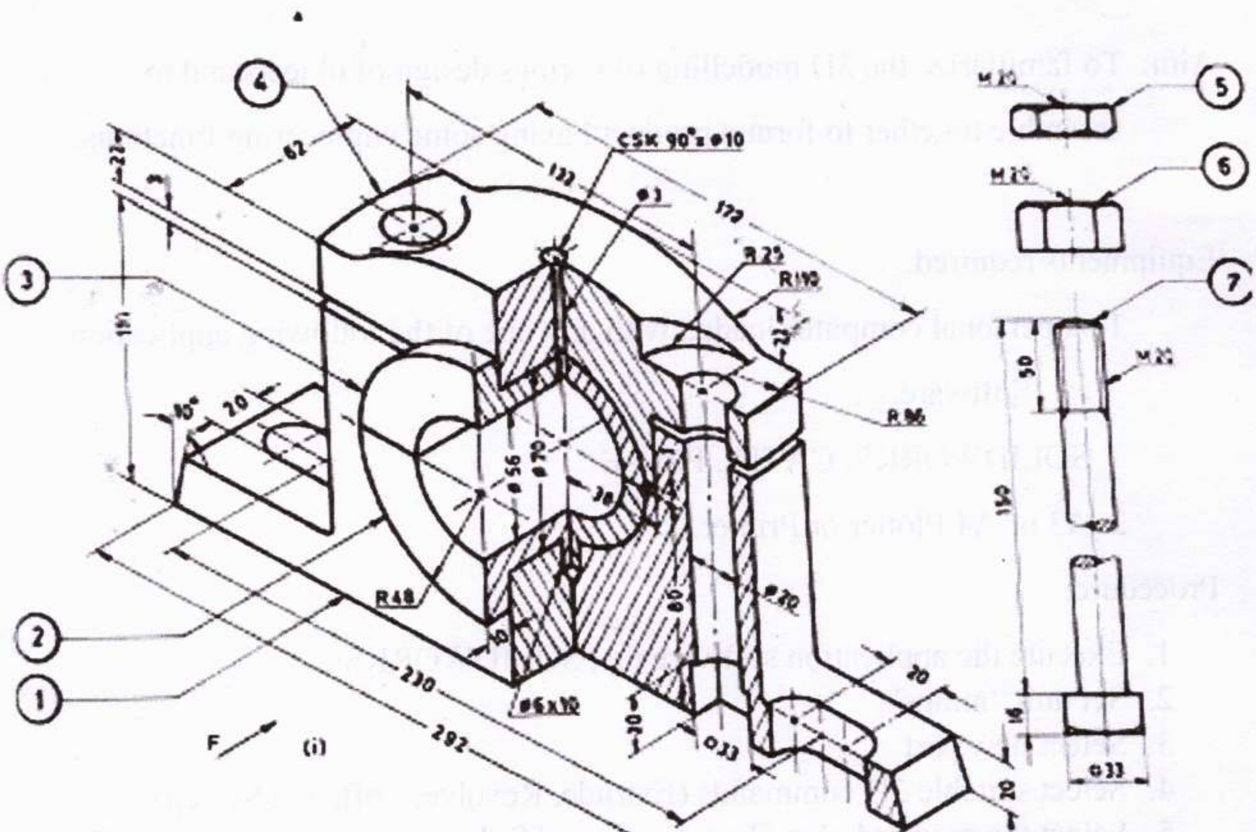

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EXPERIMENT No.6

3D MODELLING AND ASSEMBLING OF PLUMMER BLOCK

Aim: To familiarize the 3D modelling of various design of objects and to assemble together to form a product having some engineering functions.

Equipments required;

1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, CATIA, PRO-E

2. A3 or A4 Plotter or Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS
2. Set unit "mmgs".
3. Select new part.
4. Select suitable 3D commands (Extrude, Revolve, Loft, and Sweep).
5. Select the required plan (Top, Front, and Side) and sketch the 2D profile to be converted in 3D with required exact dimensions.
6. Exit the 2D sketch and Execute the selected 3D command.
7. Repeat the above steps from 4th until the desired object is completed.
8. 3D modifying commands are also can be used as and when required (Fillet, Chamfer, Mirror, Pattern etc)
9. On completion of 3D modelling, save and close the file and open the new files for each models and model every part in the assembly and save them separately with their part name and close all files.
10. Open new module of assembly and open the base part for the assembly.
11. Insert all other parts as per the assembly sequence and make the assembly relationship with the base part or other parts inserted, using Mate command.
12. Save the assembly file with suitable name, and close.
13. It is possible to generate 2D drawing of assembly whenever required with 2D drafting module.

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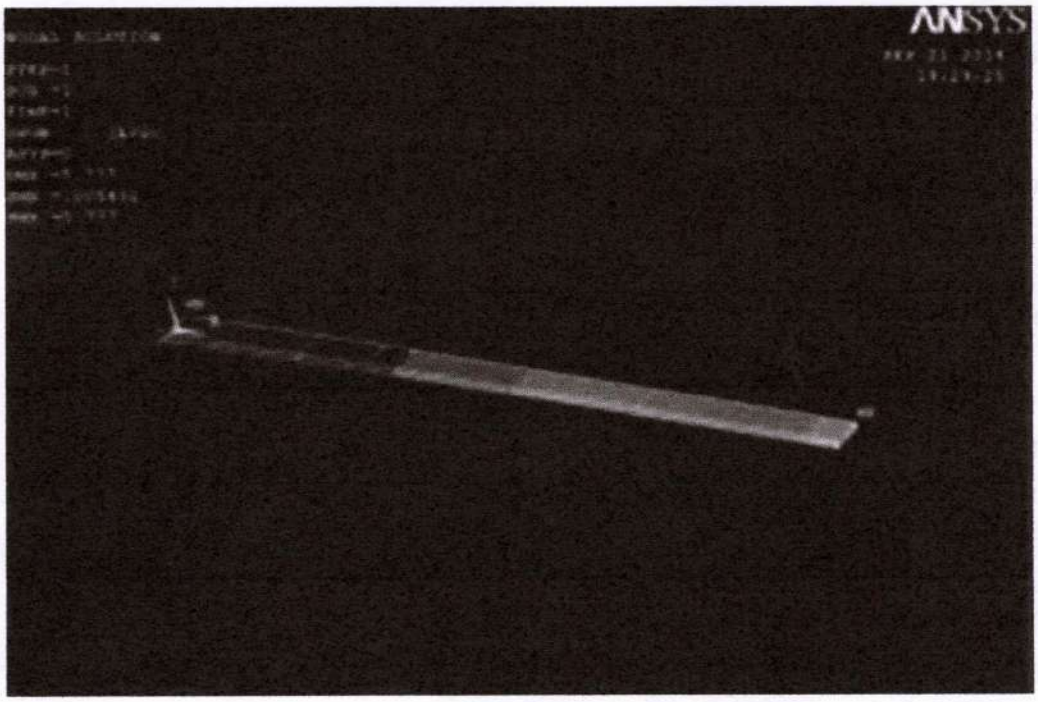

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EXPERIMENT No.7

STRUCTURAL ANALYSIS ON CANTILEVER BEAM

Aim: To familiarize the structural analysis on ANSYS Software

Equipments required;

1. A personal computer loaded with any one of the following application Software.

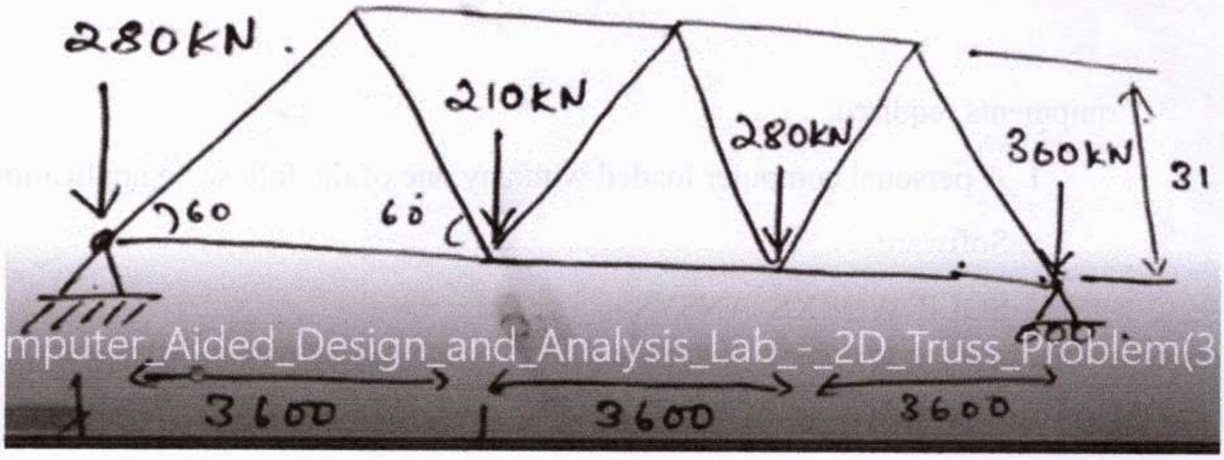
   SOLIDWORKS, ANSYS

2. A4Printer.

Procedure:

1. Execute the application software i.e., ANSYS (Mechanical APDL).
2. Set Preference of study.
3. Model the 2D elements to be studied, as per the requirements.
4. Set the material type.
5. Assign the material properties.
6. Create the meshing of the modelled part.
7. Assign the boundary conditions, by applying degree of freedom and external loads at required positions.
8. Solve problem with given boundary conditions.
9. Open the result of deformation, stress and strain plot.
10. Generate the report.

Leena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HOD ME

EXPERIMENT No.8

STRUCTURAL ANALYSIS ON 2D TRUSS

Aim: To familiarize the structural analysis on ANSYS Software

Equipments required;

1. A personal computer loaded with any one of the following application Software.

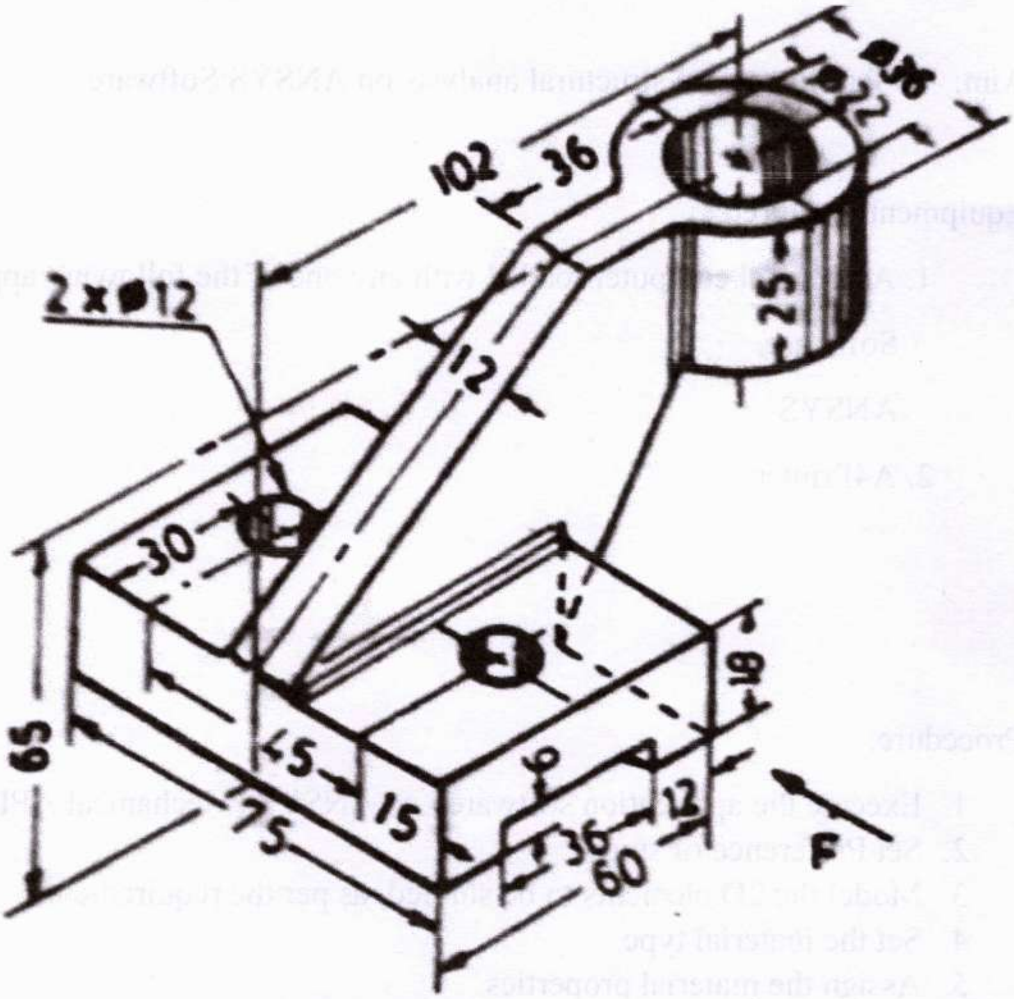
   ANSYS

2. A4Printer.

Procedure:

1. Execute the application software i.e., ANSYS (Mechanical APDL).
2. Set Preference of study.
3. Model the 2D elements to be studied, as per the requirements.
4. Set the material type.
5. Assign the material properties.
6. Create the meshing of the modelled part.
7. Assign the boundary conditions, by applying degree of freedom and external loads at required positions.
8. Solve problem with given boundary conditions.
9. Open the result of deformation, stress and strain plot.
10. Generate the report.

Leena



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EXPERIMENT No.9

STRUCTURAL ANALYSIS ON 3D PART

Aim: To familiarize the structural analysis on SOLIDWORKS Software

Equipments required;

1. A personal computer loaded with any one of the following application Software.

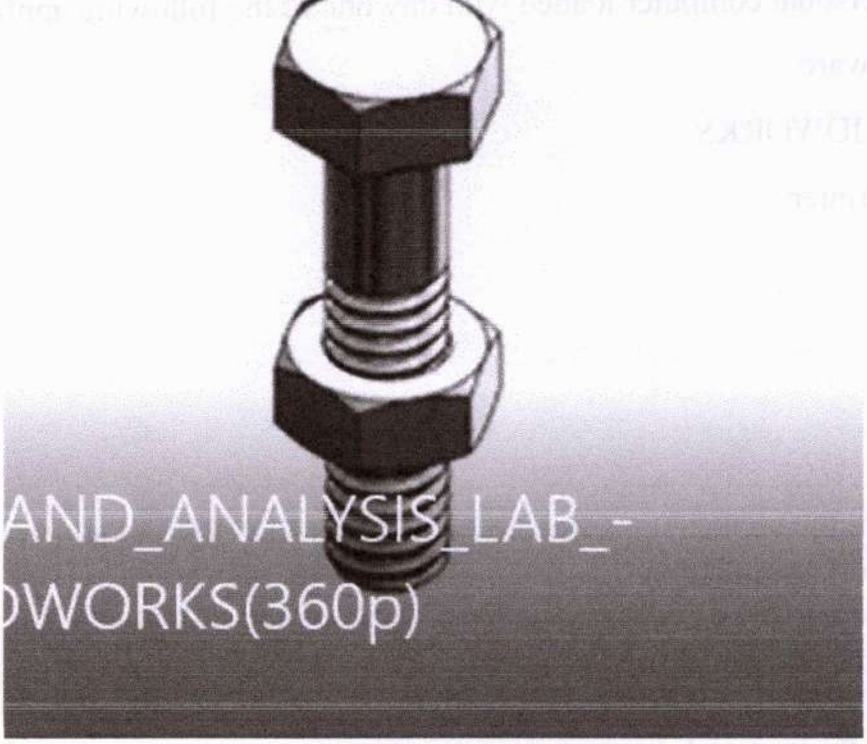
   SOLIDWORKS

2. A4Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS and add in solidworks simulation.
2. Create new study (static).
3. Insert the 3D model.
4. Set the material type.
5. Assign the material properties.
6. Assign the boundary conditions, by applying degree of freedom and external loads at required positions.
7. Create the meshing of the modelled part
8. Solve problem with given boundary conditions.
9. Open the result of deformation, stress and strain plot.
10. Generate the report.

Leena



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EXPERIMENT No.10

MOTION STUDY OF SCREW AND NUT

Aim: To familiarize the motion study on SOLIDWORKS Software

Equipments required;

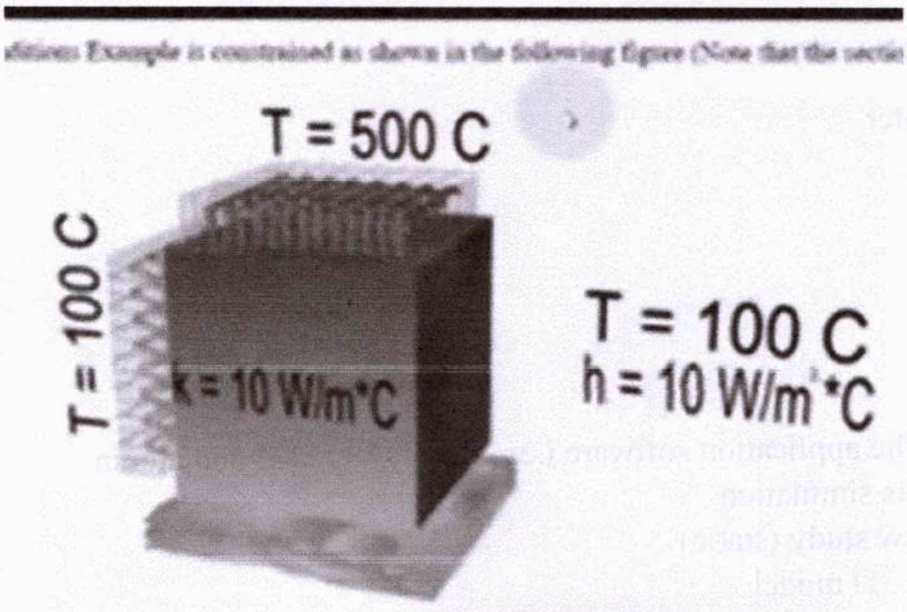
1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS

2. A4Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS and add in solidworks simulation.
2. Create new study (static).
3. Insert the 3D model.
4. Set the material type.
5. Assign the material properties.
6. Assign the boundary conditions, by applying degree of freedom.
7. Play the motion study.



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EXPERIMENT No.11

THERMAL PROBLEM ON MIXED BOUNDARY ANALYSIS

Aim: To familiarize the structural analysis on ANSYS Software

Equipments required;

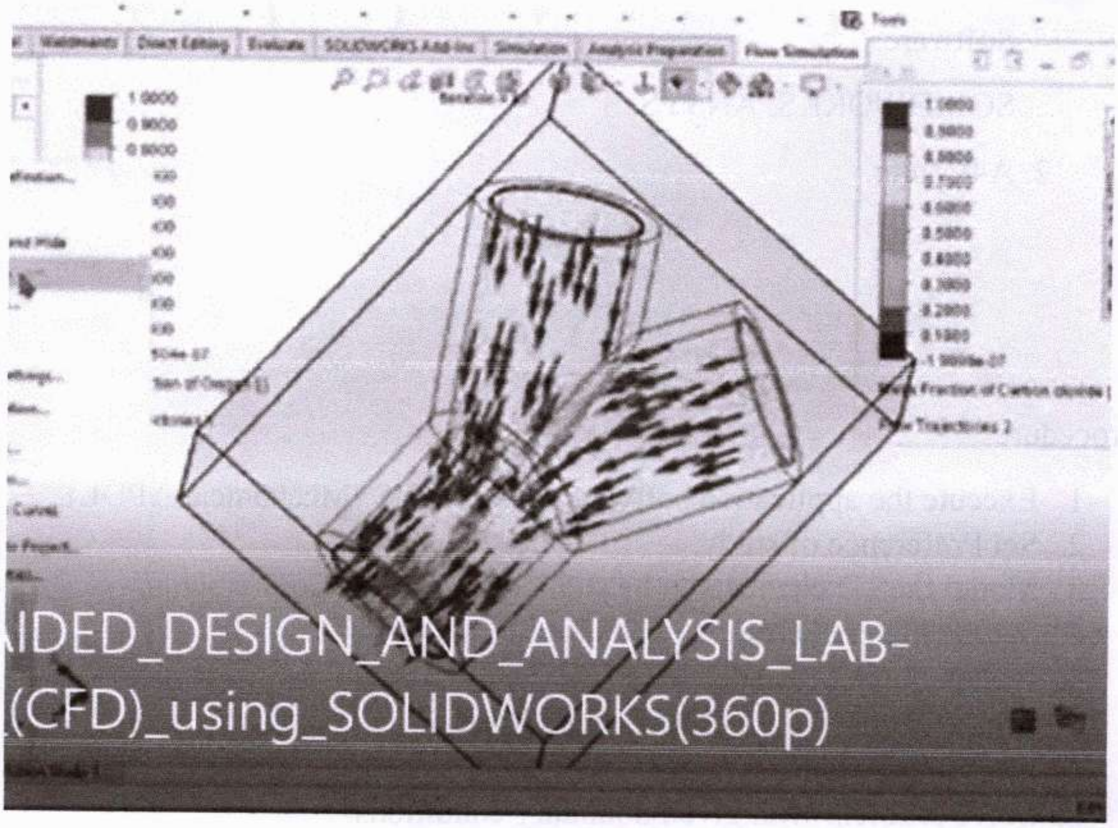
1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS, ANSYS

2. A4Printer.

Procedure:

1. Execute the application software i.e., ANSYS (Mechanical APDL).
2. Set Preference of study.
3. Model the 2D elements to be studied, as per the requirements.
4. Set the material type.
5. Assign the material properties.
6. Create the meshing of the modelled part.
7. Assign the boundary conditions,
8. Solve problem with given boundary conditions.
9. Open the result of deformation, stress and strain plot.
10. Generate the report.



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EXPERIMENT No.12

FLUID FLOW ANALYSIS

Aim: To familiarize the Fluid flow analysis on SOLIDWORKS Software

Equipments required;

1. A personal computer loaded with any one of the following application Software.

   SOLIDWORKS

2. A4Printer.

Procedure:

1. Execute the application software i.e., SOLIDWORKS and add in CFD simulation.
2. Create new study (CFD).
3. Insert the 3D model.
4. Set the material type.
5. Assign the material properties.
6. Assign the boundary conditions, by applying degree of freedom.
7. Run the CFD.
8. View the various results.
9. Generate the report.

HOD ME