SESHADRIRAO GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute Affiliated to JNTUK, Kakinada)

Seshadri Rao Knowledge Village, Gudlavalleru

Department of Electrical and Electronics Engineering

R20

COMPUTER AIDED ELECTRICAL DRAWING

Student Observation Manual

Student Details:

Roll Number : | | | | | | | | | | |

Name of the Student:

Academic Year : **2024-25**

Class & Semester : **IV B.Tech I Semester**

Section :

SESHADRIRAO
GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
Seshadri Rao Knowledge Village, Gudlavalleru

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision:

To be a pioneer in electrical and electronics engineering education and research, preparing students for higher levels of intellectual attainment, and making significant contributions to profession and society.

Mission:

- To impart quality education in electrical and electronics engineering in dynamic learning environment and strive continuously for the interest of stake holders, industry and society.
- To create an environment conducive to student-centered learning and collaborative research.
- To provide students with knowledge, technical skills, and values to excel as engineers and leaders intheir profession.

Program Educational Objectives (PEOs):

PEO1: Graduates will have technical knowledge, skills and competence to identify, comprehend andsolve problems of industry and society.

PEO2: Graduates learn and adapt themselves to the constantly evolving technology to pursue higherstudies and undertake research.

PEO3: Graduates will engage in lifelong learning and work successfully in teams with professional, ethical and administrative acumen to handle critical situations.

Program Outcomes (POs):

Graduates of the Electrical and Electronics Engineering Programwill

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, 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 public health and safety, and 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 theprofessional 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 the 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:** Recognizes the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

1. Apply the knowledge of circuit design, analog & digital electronics to the field of electrical and electronics systems.
2. Analyze, design and develop control systems, industrial drives and power systems using modern tools.

COMPUTER AIDED ELECTRICAL DRAWING

IV Year – I Semester

Practical : 4 **Internal Marks: 15**

Credits : 2 **External Marks: 35**

Course Objectives

- To impart practical knowledge on electrical drawing.
- To familiarize with the application of CAD software

Course Outcomes

Upon successful completion of the course, the students will be able to

- draw the circuit diagram of Godown wiring
- draw the single line diagrams of substations
- design the dimensions of the DC machines
- draw the sectional views and line diagrams of single phase transformers and Induction Machines.
- draw the transmission tower diagrams

List of Experiments

Any 10 of the following experiments are to be conducted:

1. Draw the circuit diagram of Godown wiring with three lamps
2. Draw the single line diagram of 33kV/11kV substation
3. Draw the single line diagram of 11kV/415V substation
4. Design the armature windings of a given DC Machine data and draw the winding diagrams machine with the given dimensions
5. Design the dimensions of a DC machine and draw the General Assembly of a DC Machine in end view.
6. Design the parameters of a single phase core type transformer and draw Sectional elevation and end-view for the given data.
7. Design the parameters of a Three phase core type transformer and draw sectional elevation and end-view for the given data.
8. Draw the half sectional end view and elevation of slip Induction motor with the given dimensions.
9. Draw the half sectional end view and elevation of squirrel cage Induction motor with the given dimensions.
10. Draw the diagram of three-phase Induction motor with DOL starter
11. Draw the line diagram of Three-phase induction motor with star–delta starter.
12. Draw the transmission tower diagram for the given dimensions.

CO – PO & PSO Mapping

Computer Aided Electrical Drawing	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
draw the circuit diagram of Godown wiring	2	1	3	1	3		2		3	2		2	1	3
draw the single line diagrams of substations	2	1	3	1	3		2		3	2		2	1	3
design the dimensions of the DC machines	2	3	3	1	3		2		3	2		2	1	3
draw the sectional views and line diagrams of single phase transformers and Induction Machines.	2	3	3	1	3		2		3	2		2	1	3
draw the transmission tower diagrams	2	3	3	1	3		2		3	2		2		3

Experiment – CO mapping

S.No	List of Experiments	CO1	CO2	CO3	CO4	CO5
1	Draw the circuit diagram of Godown wiring with three lamps	√				
2	Draw the single line diagram of 33kV/11kV substation		√			
3	Draw the single line diagram of 11kV/415V substation		√			
4	Design the armature windings of a given DC Machine data and draw the winding diagrams machine with the given dimensions			√		
5	Design the dimensions of a DC machine and draw the General Assembly of a DC Machine in end view.			√		
6	Design the parameters of a single phase core type transformer and draw Sectional elevation and end-view for the given data.				√	
7	Design the parameters of a Three phase core type transformer and draw sectional elevation and end-view for the given data.				√	
8	Draw the half sectional end view and elevation of slip Induction motor with the given dimensions.				√	
9	Draw the half sectional end view and elevation of squirrel cage Induction motor with the given dimensions.				√	
10	Draw the diagram of three-phase Induction motor with DOL starter				√	
11	Draw the line diagram of Three-phase induction motor with star–delta starter.				√	
12	Draw the transmission tower diagram for the given dimensions.					√

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S.No.	Date	Name of the Experiment Conducted	Page. No	Marks [5M]	Faculty Signature
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Total Marks					
Signature of the Faculty					

INTRODUCTION TO PROGECAD

ProgeCAD is designed for anyone who wants a fast and efficient CAD program with all the power and versatility of standard programs such as AutoCAD by Autodesk, Inc., or Micro Station by Bentley Systems, Inc., at an affordable price. Using today's advanced technology; progeCAD integrates the Microsoft Windows interface with a powerful CAD engine.

ProgeCAD provides unparalleled compatibility with AutoCAD, using most of the same file formats including those for drawings (.dwg files), commands, line types, hatch patterns, and text styles. You can also use AutoCAD menu files and run AutoLISP by Autodesk programs. If you have written your own ADS (AutoCAD Development System by Autodesk) programs, simply recompile them to link with the progeCAD libraries provided on your compact disc. Many third-party ADS programs already support progeCAD. If you have a program that is not already supported, ask your software vendor to provide an progeCAD-compatible version of the program.

ProgeCAD is more compatible with the AutoCAD program than any other CAD product, delivers additional tools with advanced CAD features, and has a seamless Microsoft Windows integration. This powerful program provides a superb combination of features for CAD users like architects, engineers, and designers.

ProgeCAD incorporates all the standard features found in other CAD programs, along with features and capabilities you won't find anywhere else. Its multiple-document interface (MDI) lets you open and work with several drawings at the same time. You can easily copy drawing entities between drawings. In addition, the powerful progeCAD Explorer lets you manage information and settings and quickly copy layers, linetypes, and other information between drawings.

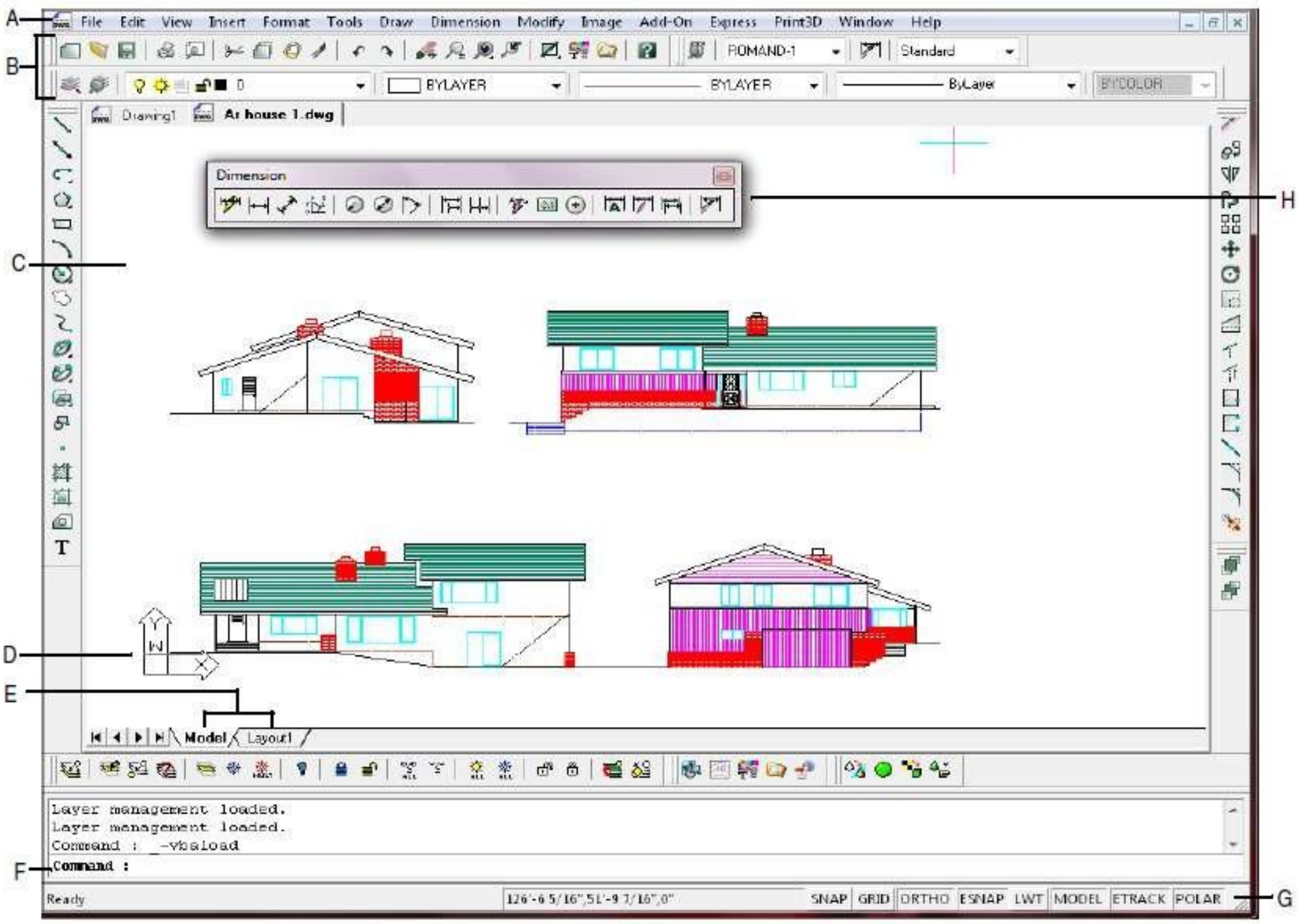
System requirements

You need the following software and hardware to install and run progeCAD:

•Microsoft® Windows 7, Windows Vista®, Windows XP Professional, Windows XP Professional x64 Edition,Windows XP Home Edition.
•Intel Pentium (or faster) processor recommended (single or dual processor)
•1 gigabyte (GB) of RAM minimum for Windows Vista or later, 512 megabytes (MB) of RAM minimum forWindows XP.
•1.5 GB of free hard disk space recommended; 300 MB is required for a full installation, including sample files,electronic documentation, and online Help
•Super VGA (800 x 600) or higher resolution, video adapter, and monitor
•Keyboard and mouse, or other pointing device

Working in progeCAD

You can work with the progeCAD window and its elements in a variety of ways. For example, you can display and rearrange the toolbars, display the command bar, and enable the status bar. The toolbars and command bar can also be floated anywhere on the screen or docked to the edges of the main progeCAD window.



A You can customize the menu bar at the top of the window.

B You can customize the toolbars, changing the appearance and arrangement of tools and adding your own commands and macros.

C Your drawings are displayed in the drawing window.

D The user coordinate system (UCS) icon indicates the orientation of the drawing in three-dimensional space.

E Click a tab to switch between the drawing of your model and a printed layout.

F You can type commands in the command bar. To reposition the command bar, drag it to another location on your screen.

G The status bar displays information such as the name or purpose of a tool, the current cursor coordinates, layer name, and mode settings.

H You can move and dock the toolbars to any location on your screen.

GODOWN WIRING WITH THREE LAMPS

GODOWN WIRING WITH THREE LAMPS

EXP NO: **DATE:**

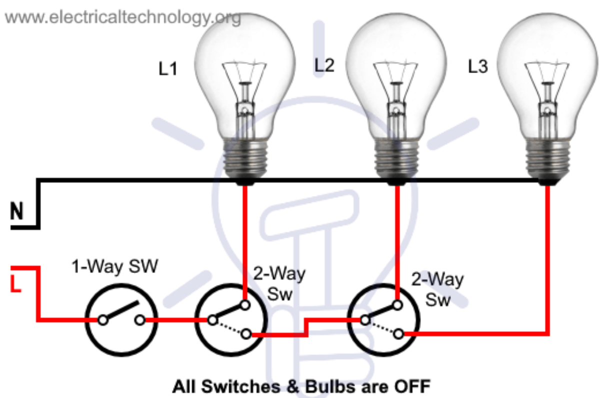
AIM:

Draw the circuit diagram of godown wiring with three lamps

APPARATUS:

1. PC.
2. CAD Software.

CIRCUIT DIAGRAM:



THEORY:

Working of Godown Wiring Circuit

Godown wiring uses to operate lamps/loads in a sequential manner, where only one load operates at a time. As its name implies" Godown wiring ", it is commonly used for light switching in godowns, tunnel-like structures, long passages. etc, where the light is only required for passage or it requires only at one position at a time. The advantage of the godown wiring is the previous load will be turned off when we normally switch ON the next load.

In godown wiring, the loads are not controlled by a random switching. The user should follow a linear sequence in the switching, from one end to another. That is, to close the circuit for a final load the remaining switches should be ON. That is the load is in series with remaining switches from the beginning end. So the circuit opens if any of the previous switches have flipped OFF.

The phase has connected to the common pole of the first switch. The 1st throw of the switch has connected to load. And the 2nd throw has connected to the common pole of the next switch. Initially, common poles of all the switches are positioned to the 1st throw of the SPDT switch. So in such an arrangement, changing the switch position to 2nd throw OFF’s previous load and ON the next one. By this arrangement, an infinite number of loads can be connected in a sequence.

Switch S1 in the circuit is SPST and remaining are SPDT (Refer: electrical abbreviations and full forms), also called as a changeover switch. In godown wiring, the loads and switches are generally connected with equal spacing. The gauge of wire or the load capacity of the wiring should be considered based on the power rating and the number of loads. If the power rating of all the loads is same, the ideal power consumption will be constant. Because even though the circuit has a number of loads only one load will be ON at a time. So, the number of loads makes a change only on the length of wiring and the overall wire resistance. That is the copper loss or the heat loss in the wiring.

Procedure for connections:

- First of all, turn off the main breaker to ensure the main supply is switched OFF.
- Connect all the switches to the earthing / grounding terminals (not shown in the fig)
- Connect the Neutral wire from MCB directly to all the three lamps as shown in fig.
- Connect the Line (Phase or Live) wire to the first terminal of SPST switch.
- Connect the first SPDT switch common (middle) terminal to the second terminal of SPST switch.
- Connect the upper terminal of first SPDT switch to the first lamp.
- Connect the lower terminal of first SPDT switch to the common (middle one) of second SPDT switch.
- Connect the upper and lower terminals of second SPDT switch to the second and third lamps respectively.

Godown wiring circuit is needed in tunnel like structures, warehouses, long passages, big godowns having lots of rooms and different portions. It was the best choice to save electricity and energy consumption where only one load i.e. light bulb can be operate at a time. Nowadays, as CFL and LED bulb which consumes low energy, this type of wiring is avoided due to its complexity ignoring the power consumption.

In this wiring installation, we will be going to control three lights bulbs using one SPST (Single pole single throw or single way) and two SPDT (Single pole double throw or two way) switches.

It is a linear sequence of switching i.e. When a person enter the first room or portion, all lighting points are switched OFF as the first SPST switch is at OFF position.

When he

- Switch ON the SPST, the first lamp switch ON.
- Switch ON the first SPDT, the second lamp switch ON and the previous one switch OFF.
- Switch ON the second SPDT, the third lamp switch ON and the previous (second one) lamp switch OFF.
- Switch OFF the last i.e. second SPDT, the second lamp switch ON and third lamp switch OFF and so on until he reaches to the first SPST switch and the whole circuit can be switch OFF by turning it OFF.

Advantages & Disadvantages of Godown Wiring

Advantages

- It saves energy as only one load point is turned ON at a time.
- The previous light bulb will switch off when turn on the next one.
- It can save the power as well as time.

Disadvantages

- Two or more lighting points can’t be turn on at once.
- It is a complicated wiring

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT →DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Depending on the lighting arrangement in the godown, you can use AutoCAD's Insert command to place lighting symbols or blocks in the appropriate locations. You can create your own blocks or use existing ones available in AutoCAD's libraries.
7. Use the Line or Polyline tool to draw electrical lines between the symbols, representing the wiring connections. Ensure that you maintain a logical flow and follow standard electrical conventions.
8. In the AutoCAD Electrical library or using custom blocks, locate and insert electrical symbols that represent switches, outlets, lights, etc. These symbols can be dragged and dropped into the drawing area.
9. Use the Text tool to add labels, annotations, and other information to your drawing.
10. Save your drawing: Save your work frequently using the Save command or the Ctrl + S shortcut.
11. Once you have completed the wiring diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:-

SINGLE LINE DIAGRAM OF 33kV/11kV SUBSTATION

SINGLE LINE DIAGRAM OF 33kV/11kV SUBSTATION

EXP NO: **DATE:**

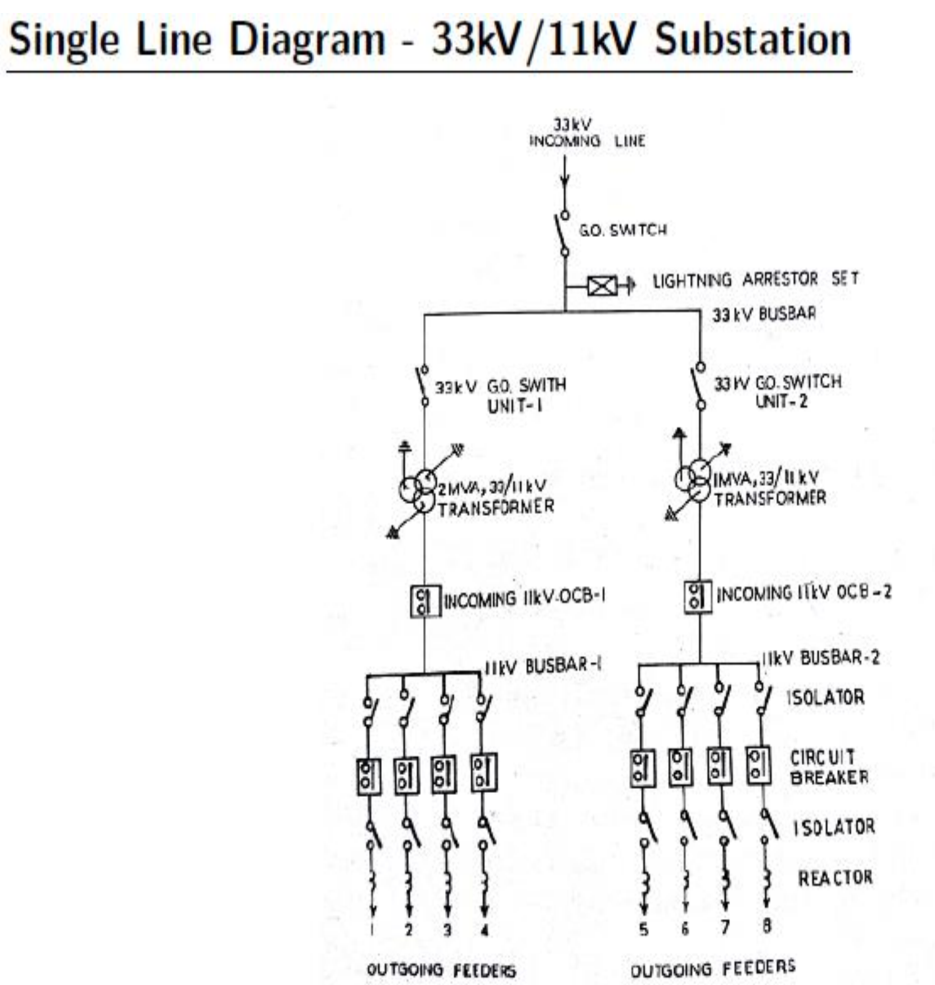
AIM:

Draw the single line diagram of a 33kV/11kV substation

APPARATUS:

1. PC
2. CAD Software

CIRCUIT DIAGRAM:



Theory:

In the modern era, the need for electrical power has increased at an enormous pace. To fulfill the required demand, huge power is needed to be delivered; hence bigger generating stations are to be designed. The electrical power generating stations may be generating electrical energy from water, atomic, thermal, or renewable sources solely contingent on the accessibility of resources and areas where these power stations are built. The areas where power stations are built might not be nearby load centers where the load is consuming power. Therefore transmitting generated power to the load center is of great importance.

There is a need for larger high voltage transmission networks for the purpose of transmission. Usually, power is generated in lower voltage levels and is economical for its transmission in high voltages. However, the distribution of electrical power is achieved in lower voltages pertinent to consumer requirements. Therefore, for maintenance of such voltage levels and deliverance of stability numerous switching stations and transformation stations are created amid consumer ends and electrical power generating stations. The transformation and switching station is generally known as a substation which is further elaborated below.

The electrical substation can be defined as a network of electrical components comprising of power transformers, busbars, auxiliaries, and switchgear etc. The components are interconnected such that creating a sequence of a circuit capable to be switched OFF while running on normal operation through manual commands while in emergency situations it can be switched OFF automatically. The emergency situations may be an earthquake, floods, or short circuit etc.

The single line diagram of the 33kv substation is depicted in the figure below. The connection of the substation is divided as

- Incoming or power feeder connection (33kv Incoming Line)
- Power transformer connection via Lighting Arrestor & Busbar
- Voltage transformer connection for control and metering.
- Outgoing feeder for feeding the other subsequent substations or switchgear.
- Circuit Breaker & Isolator between the incoming and the outgoing lines.

On the incoming 33kv incoming feeder line side, the transformer is connected to the bus bar and the lightning or surge arresters are connected as a phase to the ground as the initial connection equipment. A circuit breaker is connected between the 11kv bus-bar and each incoming and outgoing circuit with the support of the isolator being provided on each side of the circuit breaker.

Major Tasks of Substations

There are numerous tasks associated with **power substations** in the distribution and transmission system. Some of the major tasks that substations perform are as follows.

- It serves as protection hub of the transmission system.
- It maintains the frequency of system confined in targeted limits and has to deal with load shedding.
- It controls the exchange of electrical energy amid consumers and generating stations.
- It is ensuring transient stability along with steady-state stability of the system.
- It delivers sufficient line capacity hence securing supply.
- It helps in reducing the flow of reactive power, hence gaining voltage control.
- Through line carrier, it performs data transmission to ensure monitoring of network, protection, and control.
- It helps in fault analysis and pinning cause for a failure, hence improving the performance of the electrical network.
- It ensures reliable supply through feeding network at numerous points.
- It assists in determining energy transfer with help of transmission lines.

Steps to create substation diagram:

<u>Substation:</u>

Before creating single line diagram of a generating station, we have to create the symbols and store them as blocks.

<u>To draw a line:</u>

The common sequence is as follows

1. <u>Command:</u> Type ‘line’ and press enter.
2. Specify the starting point of the line.
3. Specify the next point of the line.

To create lightning Arrester:

1. Type’ rec’ in the command prompt.
2. Specify the first point p1.
3. Specify the second point p2.
4. Type ‘line’ in the command prompt.
5. Continue the same steps as for drawing a line.

To create the ground symbol:

1. Type trim command in the command prompt. Draw a polygon using the command polygon.
2. Select cutting edges.
3. Select the object that define the cutting edges or which we want to trim.
4. Press enter.

To create potential transformer (P.T) :

1. Type the command ARC.
2. Specify the starting and ending point.
3. Repeat the same procedure to get required number of turns.
4. The resultant will be

To create current transformer:

This is done using ARC command and the procedure as far as PT is repeated.

To create circuit breaker (CB):

1. Type command circle .specify center of circle.
2. Expand the circle as required.
3. Create 2 more circles within the bigger circle in the same method.

To create Bus tar:

1. Type the command rectangle.
2. Specify the starting and ending point.
3. To fill the required portion of the rectangle with solid use HATCHcommand.
4. Specify the boundary to be hatched.
5. Click Ok. The symbol will be filled with solid.

To create outgoing lines:

1. Form a line as before.
2. Type ‘polygon’ in the command prompt. Specify number of sides as 3.
3. Fill the solid in the triangle using hatch command.

To create TEXT:

1. Type text command.
2. Select the starting
3. Specify height of the text and press enter.
4. Then type the required text.

To store all the symbols in library:

1. Go to Pull down menu
2. Select block, select make.
3. Give the name for the symbol.
4. Click on insert, select the block. click ok, symbol will be stored in library.

To insert block from the library:

1. Click on insert, select the block.
2. Select the name box and type the name given to the required symbol.
3. Click ok.

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Begin by drawing the main layout of the substation. This includes positioning the transformers, circuit breakers, isolators, busbars, and other equipment. Use appropriate symbols or blocks for each component.
7. Use the line tool to draw the main incoming and outgoing lines for the substation. These lines represent the 33kV and 11kV power lines entering and leaving the substation.
8. Draw the busbars and connect them to the transformers, circuit breakers, and other equipment using lines or appropriate symbols.
12. Add labels to each component and line to identify them clearly. Include equipment numbers, ratings, and other necessary information.
13. Indicate the direction of power flow using arrows on the lines.
14. Save your work frequently using the Save command or the Ctrl + S shortcut.
15. Once you have completed the wiring diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:-

SINGLE LINE DIAGRAM OF 11kV/415V SUBSTATION

SINGLE LINE DIAGRAM OF 11kV/415V SUBSTATION

EXP NO: **DATE:**

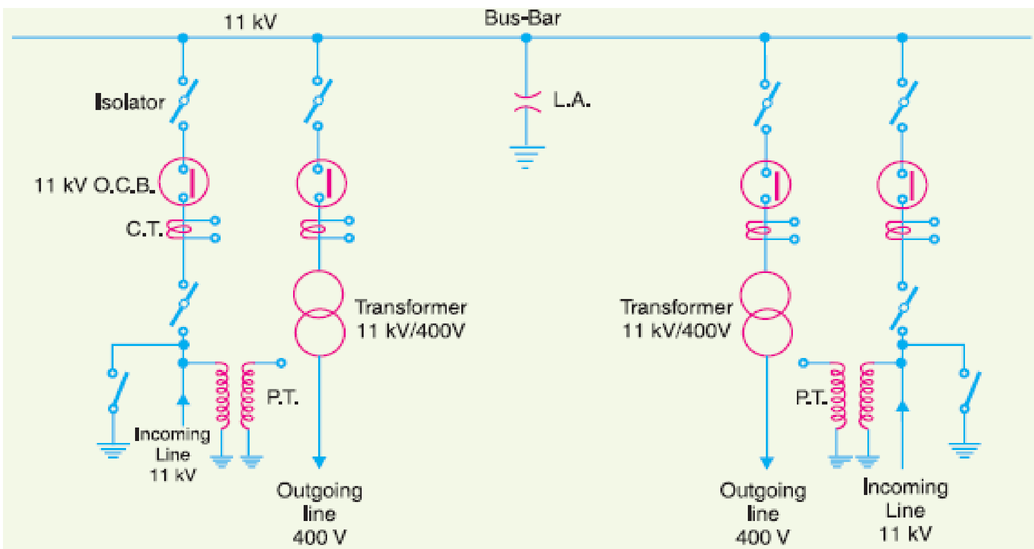
AIM:

Draw the single line diagram of a 11kV/415V substation.

APPARATUS:

1. PC.
2. CAD Software.

CIRCUIT DIAGRAM:



Theory:

Substation provides the energy supply for the local area in which the line is located. The main function of the substation is to collect the energy transmitted at high voltage from the generating station and then reduce the voltage to an appropriate value for local distribution and gives facilities for switching. The substation is of two types one is the simple switching type where the different connection between transmission line are made and the other is the converting stations which convert AC to DC or vice versa or convert frequency from higher to lower or lower to higher.

The substation has an additional function like they provide points where safety devices may be installed to disconnect equipment or circuit in the event of the fault. The synchronous condenser is placed at the end of the transmission line for improving the power factor and for measuring the operation at the various part of the power system. Street lighting, as well as the switching control for street lighting, can be installed in a substation.

The single line diagram of an 11 KV substation is shown in the figure above. The 11kv supply is received in an HT panel consisting of three 11kv OCBs, are incoming and two outgoing. The LT sides of the transformers are connected to M.V panel board through L.T ACBs. Sectionalising of the bus is done through the bus couplers. During power cut period, essential load can be supplied through a DG set and a changeover switch. The bus coupler is mechanically interlocked with two nos. 300A TPN fuse switch units so that the bus coupler can be switched ON only when both the fuse switch units are OFF.

Main Components of 11kV Substation

The working of the electrical equipment used in the substation is explained below in details.

1. **Isolator** – The isolator connects or disconnects the incoming circuit when the supply is already interrupted. It is also used for breaking the charging current of the transmission line. The isolator is placed on the supply side of the circuit breaker so that the circuit breaker isolated from the live parts of the maintenance.
2. **Lightning Arrester** – The lightning arrester is a protective device which protects the system from lightning effects. It has two terminals one is high voltage and the other is the ground voltage. The high voltage terminal is connected to the transmission line and the ground terminal passes the high voltage surges to earth.
3. **CT Metering** – The metering CT measure and records the current when their secondary terminal is connected to the metering equipment panel.
4. **Step-down Transformer** – The step-down transformer converts the high voltage current into the low voltage current.
5. **Capacitor Bank** – The capacitor bank consists series or parallel connection of the capacitor. The main function of the capacitor bank is to improve the power factor of the line. It draws the leading current to the line by reducing the reactive component of the circuit.
6. **Circuit Breaker** – The circuit breaker interrupts the abnormal or faults current to flow through the line. It is the type of electrical switch which open or closes the contacts when the fault occurs in the system.

Procedure:

1. Open **AutoCAD** from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT →UNITS [UN ↵]
5. Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Identify the main equipment in your substation, such as transformers, circuit breakers, disconnect switches, etc. Use AutoCAD's various drawing tools (lines, rectangles, circles, etc.) to represent these elements accurately. You can also use blocks or predefined symbols for better visualization.
7. Use lines or polylines to connect the different equipment in your substation. Draw lines to represent busbars, conductors, and cables, and connect them to the appropriate devices.
8. Add text labels to identify the equipment and components in your diagram. Use AutoCAD's text tool to insert labels such as "Transformer," "Circuit Breaker," etc. You can also include additional information such as ratings or identification numbers.
9. Use arrows to indicate the direction of current flow in the diagram. You can also include symbols or icons to represent specific elements, such as lightning arresters or surge protectors.
10. Draw lines to represent the interconnections between the substation and external sources, such as the power grid or other substations. Ensure that the connections are clearly depicted and labeled.
11. Include any necessary annotations or notes to provide additional information or clarify the diagram.
12. Review your single-line diagram to ensure accuracy and correctness. Verify that all equipment, connections, labels, and symbols are correctly represented.
13. Save your AutoCAD drawing file in the desired format. You can also export the diagram as a PDF or image file for easy sharing and printing.

RESULT:-

ARMATURE WINDING DIAGRAM OF A DC MACHINE

ARMATURE WINDING DIAGRAM OF A DC MACHINE

EXP NO: **DATE:**

AIM:

To develop a DC lap winding for a DC machine.

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:

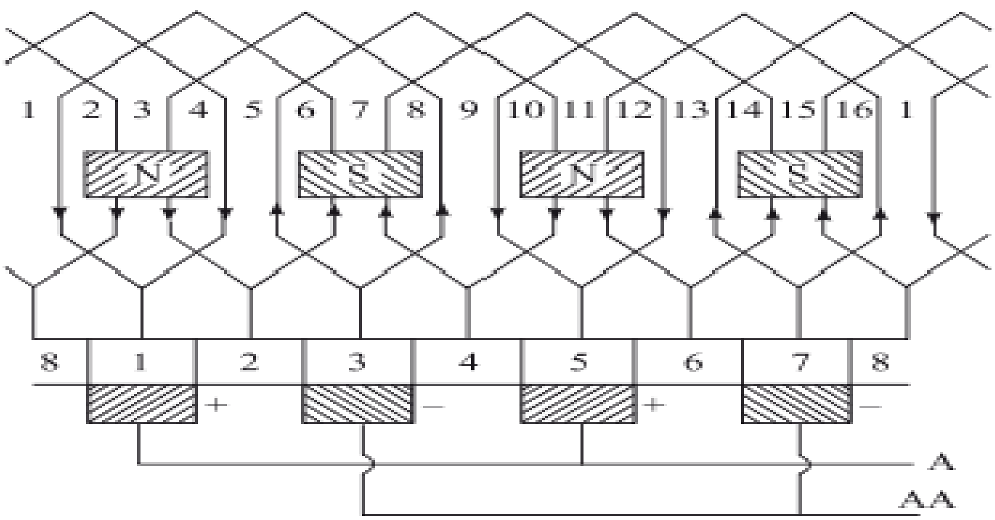
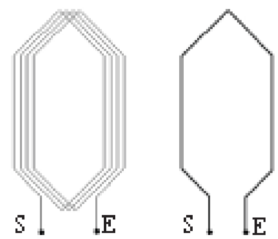


Fig 1.4: 16 Slots, 4 Pole, Single Layer, DC Lap Winding

Theory:

Any rotating electrical machine consists of stator, rotor, end shields, fan and ventilating system, bearing system and mounting system. In a DC machine, the stator consists of a yoke which houses poles attached to the yoke and the field windings. The rotor consists of armature with supports, commutators and bearings. The armature has slots in which the windings are placed. The winding terminals are connected to the commutator. The winding placement and the connections to the commutator follow a systematic procedure, so as to get the required formation and function as a generator or as a motor. The developed DC winding diagram furnishes the details of the coil end connections to the commutator segments. From this, position of poles, brushes and current directions are visualized. The following are some of the terminologies related to the winding.

i) Coil: A coil is made by winding over the 'formers' with the designed value of number of 'turns' of round copper conductor of suitable diameter / copper strips of suitable cross sectional area. The coil will have distinct 'start' and 'end' terminals with a span to cover the required number of slots in the armature. A multi-turn coil represented as a single turn coil is shown in the Fig.



ii) Pole Pitch or Full Pitch: The pitch is specified in terms of number of slots. If the machine is having 'P' number of poles and 'N1' number of armature slots, then the Pole Pitch or Full Pitch is given by 'N1/P'. This may be an integer or fraction, depending on the number of slots and the number of poles.

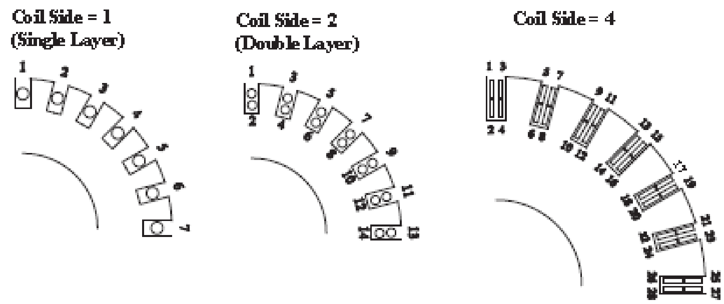
iii) Coil Pitch: The coil pitch denotes the number of slots the coil will cover, on insertion in to the slots. The coil pitch is usually selected to cover one pole pitch. If the coil pitch is less than the pole pitch, it said to be 'short chorded coil'. If the coil pitch is more than the pole pitch, it said to be 'over chorded coil'. If the pole pitch is a fraction, the coil pitch is usually selected closer to the next lower integer. The coil pitch is always an integer. It is to be noted that one side of the coil will be under the influence of the North Pole, whereas the other side of the coil will be under the influence of the South Pole.

iv) Coil Sides per Slot or Number of Layers per Slot: If one coil side is inserted in a slot, then it is known as 'Single Layer'. If two coil sides are inserted in one slot, then it is known as 'Double Layer' and so on. Depending on the design, the coil sides per slot may be 1,2,3,4 etc. The symbol for number of coil sides is denoted by 'm'.

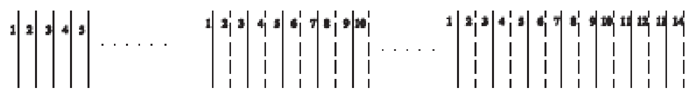
v) Numbering of conductors:

The total number of conductors, Z = Number of slots × Number of coil sides

The numbering of conductors is as shown in Fig.



Conductors Placed in Slots of Armature

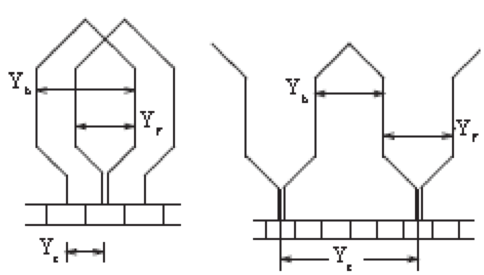


For DC winding various pitches are defined in terms of conductors and very rarely in electrical degrees.

vi) Back Pitch, Yb: The distance between two sides of a coil, measured in terms of conductors, at the back end of the commutator is known as the back pitch.

vii) Front Pitch, Yf: The distance between the two sides of coil connected to the commutator segment, measured in terms of conductors, at the front of the commutator, is known as the front pitch.

viii) Average Pitch, Yav: The average pitch is the average of the back pitch and front pitch. This will be nearer to the pole pitch measured in terms of conductors.



Commutator Segments: The commutator will have number of segments, related to the number of armature slots and the coil sides per slot is given below -

Number of commutator segments = $\frac{N_1 \times m}{2}$

x) Commutator Pitch, Yc: It is the distance, measured in commutator segments, between two ends of the coil.

xi) Lap Winding: In a lap winding the finish-end of one coil is connected via the commutator segment to the start-end of the adjacent coil situated under the same pole. As the sides of the adjacent coils overlap each other, it is known as lap winding.

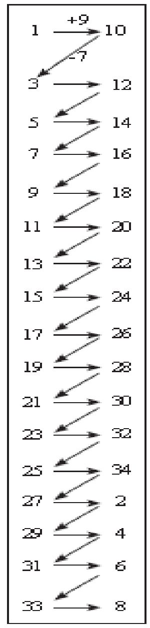
xii) Wave Winding: In a wave winding the finish-end of one coil under one pole- pair is connected to the start of a coil under the next pole- pair. The process is continued till all the armature coils are connected and the winding closes onto itself.

The back pitch Yb, front pitch Yf and commutator pitch Yc are marked in Fig. and in Fig. for Lap and Wave winding, respectively.

Pitch Calculation

Sequence of steps involved	Symbol	Remarks	Example
Number of slots in the armature	N_1		17
Number of coil sides per slot	m		2
Number of Poles	P		4
Total number of conductors	$Z = N_1 \times m$		34
Pole Pitch in terms of conductors	$Y_p = Z/P$		$8\frac{1}{2}$
Modified integer value of the Pole Pitch	Y_p	If the value is a fraction an integer lower than the obtained fractional number is selected	8
Commutator Pitch	$Y_c = X$	X — Type of Winding 1 — Simplex 2 — Duplex 3 — Triplex 4 — Quadraplex	1
Back Pitch (unmodified)	Y_b	The values are obtained by solving the two equations- $Y_b + Y_f = 2Y_p$, $Y_b - Y_f = \pm 2Y_c$ '+' for Progressive lap winding '-' for Retrogressive lap winding	9
Front Pitch (unmodified)	Y_f		7 (Progressive lap winding)
Final Back Pitch	Y_b	If the values of Y_b and Y_f are even, then the next lower values of odd integers for both Y_b and Y_f are selected	9
Final Front Pitch	Y_f		7

Winding Table

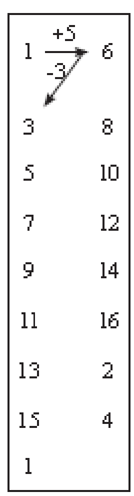


Draw the developed DC Lap Winding Diagram for the following data- Number of Slots = 16, Number of Poles = 4, Type: Single Layer Simplex Lap Winding

Solution

Total number of conductors, Z =16
Number of Poles, P = 4
Pole Pitch, Yp = Z/P = 16/4 = 4
Y_b = Back Pitch and Y_f = Front Pitch
$Y_b+Y_f = 2 \times Y_p = 2 \times 4 = 8$, $Y_b - Y_f = 2$
Solving for Y_b and Y_f , $Y_b = 5$ and $Y_f = 3$
Select Y_b and Y_f such that they are odd and differ by 2
Also to note that $(Y_b+Y_f)/2$ should be closer to Y_P

Winding Table



At the back Y_b=5 Coil side Connected coil side	At the front Y_f=3 Coil side Connected coil side
1+5=6	6-3=3
3+5=8	8-3=5
5+5=10	10-3=7
7+5=12	12-3=9
9+5=14	14-3=11
11+5=16	16-3=13
13+5=18(2)	18-3=15
15+5=20(4)	4-3=1

Steps for drawing the winding diagram:

Step 1:

- Start with a new file
- Set the limits. Type limits at the command prompt, keep the lower left corner at 0, 0 i.e.type 0,0 and enter, type 297,210 for the upper right corner
- Type zoom and enter, all and enter

Step 2:

Create a line:

- Type line and press enter at the command user interface
- Specify a start point of the line any where
- On the screen with ORTHO status bar in ON state as shown below.

- Similarly 16 conductors can be drawn or obtained by using ARRAY command. TypeArray in command line or click array icon
- Select the line to be arrayed by crossing method and press enter
- Specify opposite corner for no. of items or count: Type'c' in command line and pressenter
- Enter the no. of rows:1 and press enter
- Enter the no. of columns: 17 and press enter
- Specify opposite corner to space items or <spacing>:10
- Double click on the object and re-enter the spacing as 10
- The result is as shown

Step 3:

Creating the text:

- Type text at the command user interface or go to draw, select text, select single line text
- Select the starting point from where the text is to be started
- Specify the height of the text as 2.5mm
- Specify the rotation angle for the text as 0
- Type the text, which is to be displayed and enter twice or press Esc to come out of the text command

  Or

  Select the text icon and drag it over the conductors and type the conductor numbersproviding the spacing between the numbers and press ok

Step 4:

Winding table:

At the back Y_b=5 Coil side Connected coil side	At the front Y_f=3 Coil side Connected coil side
1+5=6	6-3=3
3+5=8	8-3=5
5+5=10	10-3=7
7+5=12	12-3=9
9+5=14	14-3=11
11+5=16	16-3=13
13+5=18(2)	18-3=15
15+5=20(4)	4-3=1

Form a loop:

- Use the data from winding table
- Keep ORTHO in off state and OSNAP in on state. Select end point and midpoint in theOSNAP property.
- Type line in command user interface and form a loop as shown in the diagram below

Step 5:

Copy the entire loop or array the entire loop:

- Type copy at the command user interface.
- Select the entire loop or a coil either by window or crossing method
- Specify the base point, base point of displacement multiple as m[for multiple copy]copy the coil or loop as shown
- To array: select rectangular array>> no of rows = 1>> no of columns = 8>> columnoffset = 20 >> select object >> OK

Step 6:

Creating the poles:

- Type rectangle or rec at the command user interface or select rectangle icon
- Specify first corner point, i.e. click at the desired location by referring the drawing
- Specify the other corner point, i.e. click at the diagonally opposite point
- Crate the text i.e. N & S in the same way as explained above

Step 7:

Creating the commutator segments

- Type line in the command user interface
- Draw the first one commutator segment
- Array the segments in the same way as explained above.(or) Copy and place the commutator segments keeping ortho mode 'ON' The result is as shown in the fig.

- Create the text, i.e. 1 to 8 in the same way as explained early

Step 8:

Creating a brush:

- Type rectangle or rec at the command user interface
- Move the rectangle below the commutator segment
- Type hatch pattern from the swatch button, select an appropriate scale and click insidethe area to be hatch and click ok

Step 9:

Crating the directional arrows:

- Type polyline at the command user interface
- Specify the starting point of the arrow
- Type hatch or h at the command user interface. Select the hatch pattern form the swatch button [i.e. select solid]. Select the object in which solid is to be filled and laterclick ok the result is as below.

- This arrow can be reverse by using rotate command
- Move the arrow and place on the conductor
- Using copy tool bar, copy the arrows as per the drawing.

Steps for drawing the diagram:

Command	Details
Units	Set units to mm
Limits	To set paper size as A4, Lower left corner : 0,0 Upper right corner : 297,210
Zoom, all	To view all objects in the window Select:Zoom option :all
Line	To draw one conductor of 40 units Specify first point: any where 30, 130 Specify next point or [undo]: @40<270 Specify next point: press enter key
Array	To draw multiple conductors Rows:1,Column: 17, Row offset:0, column offset:10 Select objects: Select the above conductor Enter key, ok
Text	➢ The conductors are numbered using the multi text command. ➢ Type text at the command user interface or go to draw, select text , select single line text ➢ Select the starting point from where the text is to be started ➢ Specify the height of the text as 3mm ➢ Specify the rotation angle for the text as ‘0’ ➢ Type the text, which is to be displayed and enter twice or press ‘Esc’ to come out of the text command ➢ Array the text i.e. 1 throughout the 16 conductors ➢ To change the text number from 1 to 16 ➢ Select the text number by double click you want to change and

	type the text number and click ok
Osnap Polar Tracking Line	Overhang is drawn using the Line command Draw a line from end point of conductor 1 at an angle 45^0 (Osnap and Polar tracking to be ON for better selection) Draw another line from end point of conductor 6 at an angle 135^o Similarly for the lower side
Trim	The extended lines are trimmed Select objects: upper and lower overhangs Enter key click on the object to be trimmed
Line Osnap on	To draw one extension line from the diamond line command is used, First point:Select tip of the lower diamond Next point: @15<270
Array	To complete overhang and extension line Rows: 1, Column: 8, Row offset; 0, Column offset: 20 Angle:0^0 Select objects: select above end connections 5 objects
Array	Repeat Array command to the remaining conductors Rows: 1, columns; 3, Row offset: 0, Column offset: -20 Angle:0^0 Select objects: select same 5 objects
Trim	Trim unnecessary connections at the beginning and end of the winding
Line	To draw commutator segments ➢ Type line in the command user interface ➢ Draw the first one commutator segment ➢ Array the segments in the same way as explained above ➢ Create the text i.e. 1 to 8 in the same way as explained early.
Rectangle, copy	Draw poles and brushes
Hatch	Fill poles and brushes with patterns using hatch command. Type predefined, pattern: ANS131, Scale:1, Angle:0 Add select objects: Select rectangle representing N poles and + brushes. Fill S pole and – brushes with same pattern and angle=90
Polyline, Array/Copy, Mirror/Rotate	Create one down arrow using polyline Start point: Select the start point of the arrow, Next point: w Starting width: 3, Ending width; 0 Next point: @5<270 Draw arrows to all conductors to show current directions
Line, Text	Make end connections and mark the terminals
Text	Give heading

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM →ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. For lap winding, the number of slots is usually equal to the number of coils. in lap winding, each coil overlaps the adjacent coil in a loop-like pattern. use the line tool to draw the coil sides.
7. Connect the coils in a continuous manner. the starting point of one coil is connected to the ending point of the previous coil. this connection forms a series circuit for the armature winding.
8. Add labels or numbers to identify each coil. you can use the text tool to add these labels near the coils.
9. Create the Poles, Commutator Segments and Brushes using line or polyline.
10. Save your AutoCAD drawing file in the desired format. You can also export the diagram as a PDF or image file for easy sharing and printing.

RESULT:-

GENERAL ASSEMBLY OF A DC MACHINE END VIEW

GENERAL ASSEMBLY OF A DC MACHINE END VIEW

EXP NO: **DATE:**

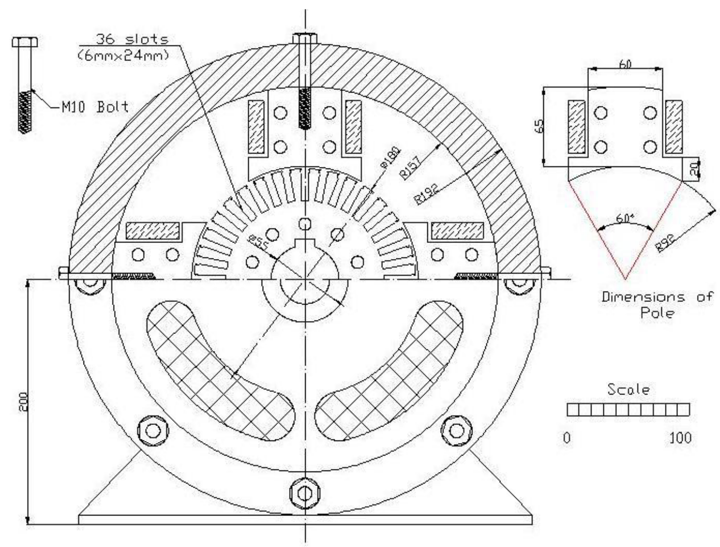
AIM:

Draw the General Assembly of a DC Machine in end view.

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:



18.5 kW, 4 Pole, 1500 rpm DC Motor
Half sectional Endview

Theory:

Construction of d.c. Generator

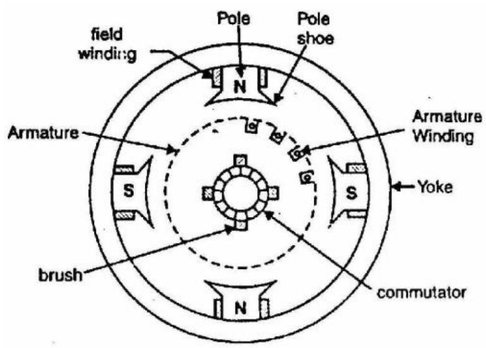
The d.c. generators and d.c. motors have the same general construction. In fact, when the machine is being assembled, the workmen usually do not know whether it is a d.c. generator or motor. Any d.c. generator can be run as a d.c. motor and vice-versa. All d.c. machines have five principal components viz., (i) field system

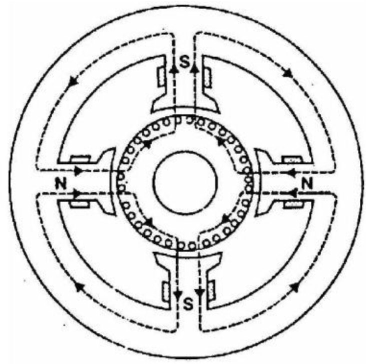
(ii) armature core

(iii) armature winding

(iv) commutator

(v) brushes



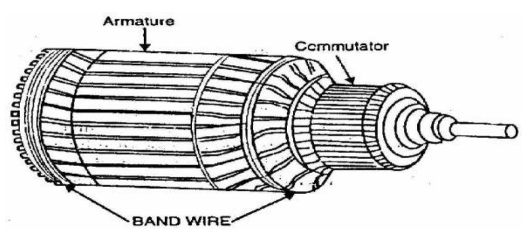


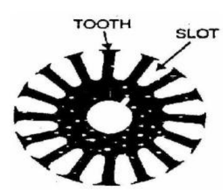
(i) Field system

The function of the field system is to produce uniform magnetic field within which the armature rotates. It consists of a number of salient poles (of course, even number) bolted to the inside of circular frame (generally called yoke). The yoke is usually made of solid cast steel whereas the pole pieces are composed of stacked laminations. Field coils are mounted on the poles and carry the d.c. exciting current. The field coils are connected in such a way that adjacent poles have opposite polarity.

(ii) Armature core

The armature core is keyed to the machine shaft and rotates between the field poles. It consists of slotted soft-iron laminations (about 0.4 to 0.6 mm thick) that are stacked to form a cylindrical core as shown in Fig. The laminations (See Fig.) are individually coated with a thin insulating film so that they do not come in electrical contact with each other. The purpose of laminating the core is to reduce the eddy current loss. The laminations are slotted to accommodate and provide mechanical security to the armature winding and to give shorter air gap for the flux to cross between the pole face and the armature "teeth".





(iii) Armature winding

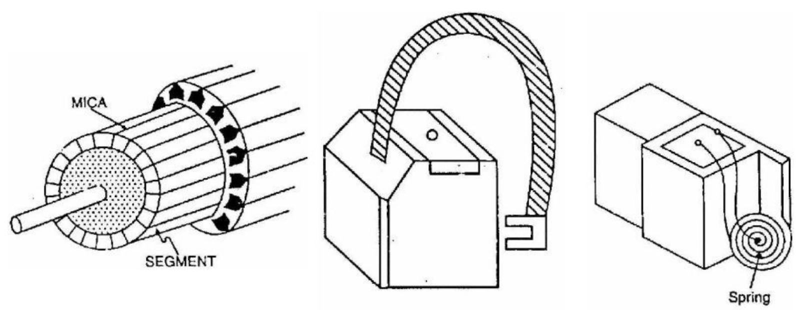
The slots of the armature core hold insulated conductors that are connected in a suitable manner. This is known as armature winding. This is the winding in which "working" e.m.f. is induced. The armature conductors are connected in series-parallel; the conductors being connected in series so as to increase the voltage and in parallel paths so as to increase the current. The armature winding of a d.c. machine is a closed-circuit winding; the conductors being connected in a symmetrical manner forming a closed loop or series of closed loops.

(iv) Commutator

A commutator is a mechanical rectifier which converts the alternating voltage generated in the armature winding into direct voltage across the brushes. The commutator is made of copper segments insulated from each other by mica sheets and mounted on the shaft of the machine (See Fig 1.11). The armature conductors are soldered to the commutator segments in a suitable manner to give rise to the armature winding. Depending upon the manner in which the armature conductors are connected to the commutator segments, there are two types of armature winding in a d.c. machine viz., (a) lap winding (b) wave winding.

(V) Brushes

The purpose of brushes is to ensure electrical connections between the rotating commutator and stationary external load circuit. The brushes are made of carbon and rest on the commutator. The brush pressure is adjusted by means of adjustable springs (See Fig). If the brush pressure is very large, the friction produces heating of the commutator and the brushes. On the other hand, if it is too weak, the imperfect contact with the commutator may produce sparking.



Multi pole machines have as many brushes as they have poles. For example, a 4-pole machine has 4 brushes. As we go round the commutator, the successive brushes have positive and negative polarities. Brushes having the same polarity are connected together so that we have two terminals viz., the +ve terminal and the –ve terminal.

Dimensions:

Rating: 18.5 kW, 4 Pole, 220 v, 1500 rpm

Armature diameter = 0.18 m

Core length = 0.2 m

36 slots of dimension 8mm x 24 mm

Shaft diameter = 55 mm

Pole arc/ Pole pitch = 0.6666

Pole height = 65 mm

Pole width = 60 mm

Yoke Thickness = 35 mm

Air gap between stator and rotor = 2 mm

i)The armature is directly resting on the shaft.

ii)10 Nos. of ventilating holes, on a PCD of 96mm

Design Calculations:

1. **Shaft:** Diameter of shaft = 55mm

   Radius of shaft=27.5mm

2. **Armature or Rotor:**

   1. Inside diameter of Armature stamping =
   2. Outside diameter of Armature stamping = 180mm
      Radius of the Armature=90mm
   3. No of slots = 36
   4. Size of slot = 6mm*24mm

3. **Main poles:**

   Given: - pole arc/pole pitch = 0.666

   Pole pitch = 360/No. of poles = 360/4 = 90

   Then pole arc =0.667*pole pitch= 0.667*90 = 60^{o}

   Pole height = 65 mm
   Pole width = 60 mm

4. **Stator:**

   Outer radius of stator stamping = outer radius of Armature stamping + air gap + height of the main pole.

   = 90mm + 2mm + 65m = 157mm

   Overall radius of the machine = Outer radius of stator + thickness of the yokestamping

   = 157+ 35mm= 192mm

   Overall diameter of the machine = 192*2=384mm

Steps for drawing the diagram:

Commands	**Details**
Units	mm
Limits	297, 210
Zoom, All	
Point	110, 110
Circle	centre 110, 110 Radius 27.5mm(Shaft) Radius 90mm(Armature) Radius 92mm (Stator Pole) Radius 157mm (Yoke inner) Radius 192mm (Yoke outer)
Line	Draw Horizontal and Vertical lines
Offset, Trim, Line	Draw 30^0 line to the vertical, select 20mm pole shoe height, pole width offset =30mm Complete one half of the Pole profile
Line, offset, Trim	Draw one half of the pole winding with suitable dimensions
Circle	Draw rivet holes of 4mm diameter, 2 numbers
Mirror	The complete pole with winding is obtained by using mirror Selecting the vertical line as the base line
Arc Line Offset Trim Mirror	Draw an arc of radius 90 and angle 10^0 Draw slot width=8mm, height=24mm Trim slot opening, retain the small arc Mirror on center line
Array	Polar array, Total number of items=4, angle=360 select main pole Polar array, total number of items =36, angle=360 Select slot
Trim Erase	For lower half remove poles and armature slots
Circle Array	Dra one circle of dia=96mm (Vent hole) Array to get 5 holes on the top
Circle Line Offset Trim	Draw a line of 200mm offset from the center line Show the foot with approximate dimensions Show the positions of bolts to fix poles to the yoke
Dimension Text	Show important dimensions Provide caption and scale

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS[UN ↵]
5. Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Draw pole with yoke sub-assembly. Also show the field winding with suitable depth and height.
7. Take polar array to show all the 4 poles. Delete the poles in the bottom half.
8. Use M10 bolts for fixing. Use zoom window and zoom all wherever necessary.
9. Take up armature stamping drawing. Draw the slot profile of 6x24 mm dimension, confining the details within an angular arc of 10^0 (i.e.360/ 36) on a radius of 180 mm.
10. Take polar array to show all 36 slots. Delete the slots in the bottom half.
11. On the shaft, show half key way, for a key of 16mmx10mm.
12. Concentrate on the un-sectioned bottom half of the drawing. Half of END SHIELD will be seen.
13. The wire mesh opening is for ventilation. End shield is attached to the yoke through bolts.
14. Show the FOOT and the bracket butting the housing.
15. Save your work frequently using the Save command or the Ctrl + S shortcut.
16. Once you have completed the diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

Result:

SINGLE PHASE CORE TYPE TRANSFORMER SECTIONAL ELEVATION AND END-VIEW

SINGLE PHASE CORE TYPE TRANSFORMER SECTIONAL ELEVATION AND END-VIEW

EXP NO: **DATE:**

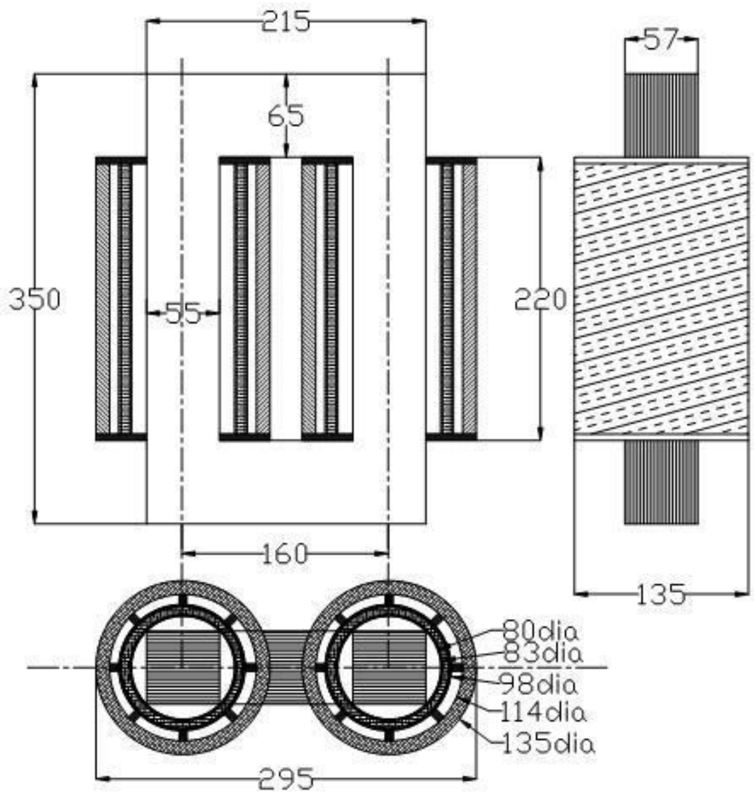
AIM:

Design the parameters of a single phase core type transformer and draw Sectional elevation and end-view for the given data

APPARATUS:

1. PC.
2. CAD Software

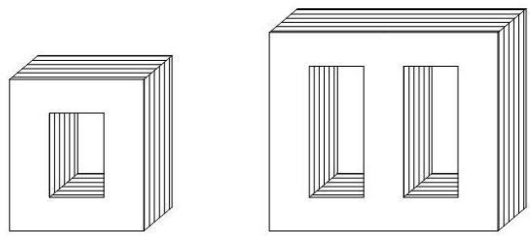
CIRCUIT DIAGRAM:



5 kVA SINGLE PHASE TRANSFORMER

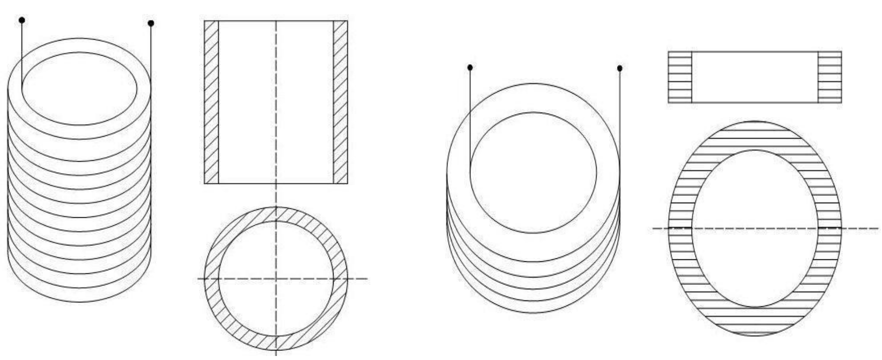
THEORY:

Single Phase and Three Phase Transformers (Core Type) The elevations of single phase core type transformer and three phase core type transformers are shown in Figure 1. The widths of cores on the two limbs are equal in single phase transformers. The widths of cores of all the three limbs are equal in three phase transformers. The height of yoke may be equal or greater than the width of core, in both cases. The depth of core will be confined to the dimension of circum circle diameter.



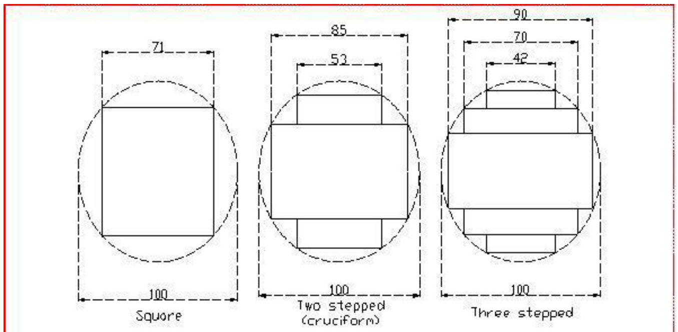
LV and HV windings

The transformer will have Low Voltage (LV) winding and High Voltage (HV) winding wound over the limbs. The LV winding is placed near the core. There will be a gap between LV and HV windings for oil circulation. The HV winding is placed away from the core. The finished windings are cylindrical in shape. The thickness and height of the cylinder will depend upon the number of turns and area of cross section of winding wire. The internal diameter will depend on the circum circle diameter, slack allowance and insulation layer. It may be noted that the sections of the cylinders so formed is confined to the window dimensions, viz, width of window and height of window. When the winding wires are thin or when the handling of finished winding is difficult because of heavy weight, the winding may be split into smaller discs. These discs may be stacked one above the other so that the required length may be formed. The views of such windings are shown in Figures.



Core section

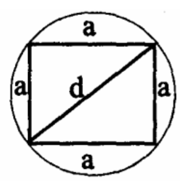
The core section of core type transformer may be – square type, two stepped or cruciform, three stepped, four stepped and so on. The imaginary circle passing through the corners of the core section is known as circumscribing circle or circum circle. The dimensions for obtaining the maximum area in the given circum circle, for various number of steps is given in Figure



Stepped Sections of Core for maximum Iron Area

Square Cores

- Let d = diameter of circumscribing circle
- Also, d = diagonal of the square core and a = side of square
- Diameter of circumscribing circle



$$d = \sqrt{2}a$$

- Therefore Side of square,

$$a = d/\sqrt{2}$$

- Gross core area, A_{gi} = area of square = a^2

$$a^2 = 0.5d^2$$

Overall Dimensions of Transformer

- The main dimensions of the transformer are Height of window (Hw) and Width of window (Ww).
- The other important dimensions of the transformer are width of largest stamping (a), diameter of circumscribing circle (d), and distance between core centres (D), height of yoke (Hy), depth of yoke (Dy), overall height of transformer frame (H) and overall width of transformer frame (W).

- These dimensions for various types of transformers are shown in figures.

- D-distance between the two core or leg central lines
- Width Ww is measured from one edge of the leg to the other of the adjacent leg in case of square or rectangular core with square or rectangular coil and between the two circumscribing circles of adjacent legs in case of stepped legs.

Depth or width of the core type transformer = b in case of rectangular core

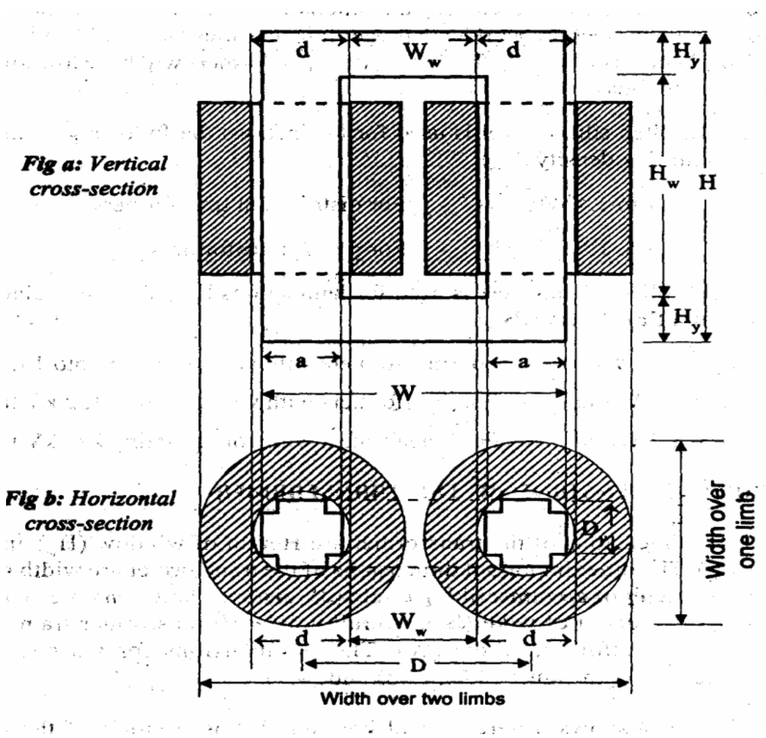
= a in case of square or stepped core

Overall length = (Ww + 2a) or (D+a) in case of single phase core type transformer with square or rectangular core

= (Ww+d+a) or (D+a) in case of single phase core type transformer with a Stepped leg

= (2Ww + 2d + a) or (2D+a) in case of three phase core type transformer with a stepped leg. No square or rectangular leg is used for high capacity three phase transformers.

Overall height = (Hw + 2Hy) for all core type transformers.



The above figure shows a vertical and horizontal cross-section of the core and winding assembly of a core type single phase transformer.

Design Dimensions:

Draw Sectional Elevation, Sectional Plan and End-view of a 5 kVA, core type, single phase transformer for the data given -

Circumscribing Circle = 80 mm diameter

Width of Core = 55 mm, Height of Yoke = 65 mm

LV –Internal diameter = 83mm

LV –External diameter = 98mm

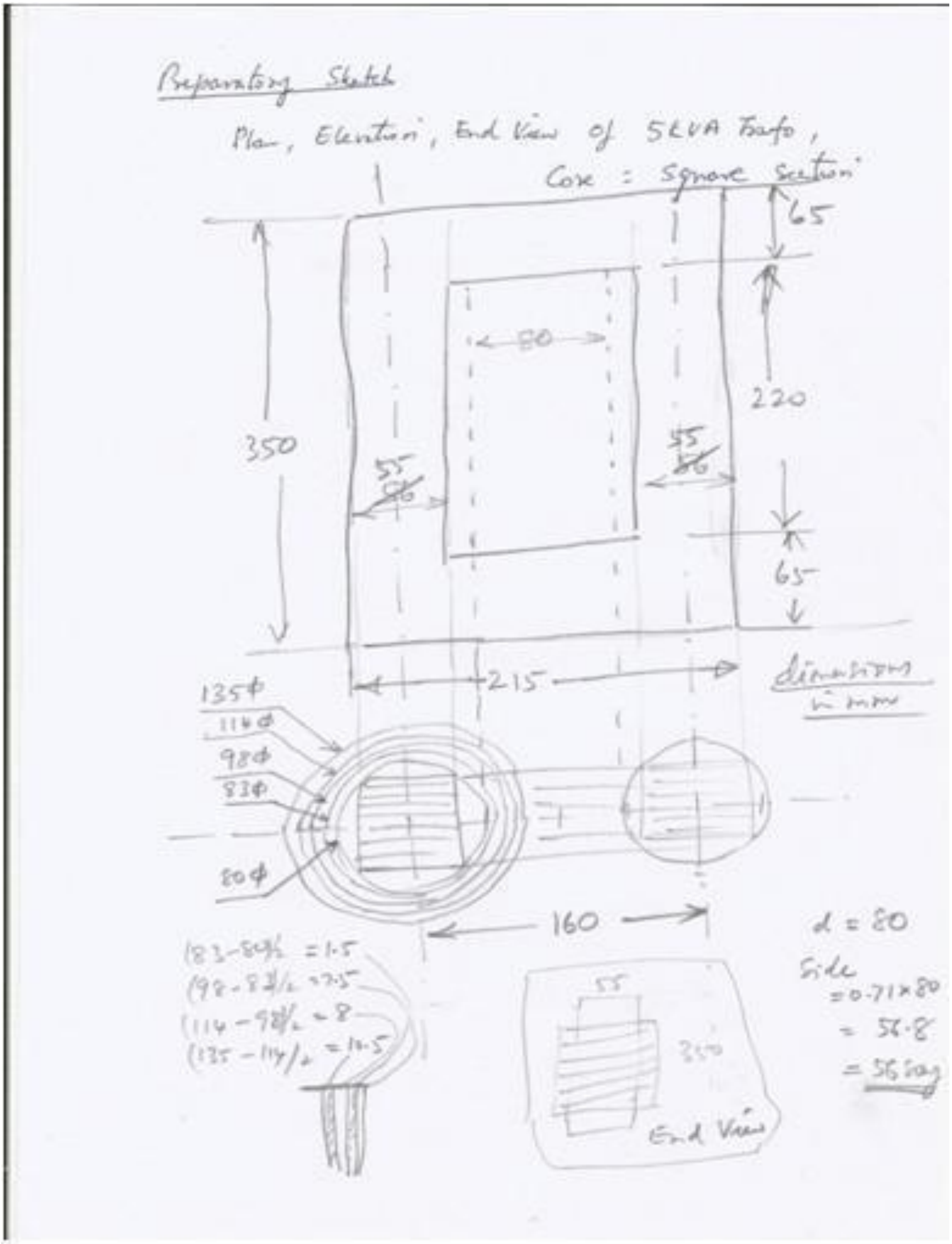
HV –Internal diameter = 114mm

HV –External diameter = 135mm

Over all width of the magnetic frame = 215mm

Over all height of the magnetic frame = 350mm

Center to center distance between limbs =160mm


Preparatory Sketch
Plan, Elevation, End View of 5KVA Trafo,
Core : Square section
65
80
220
350
55
55
65
215
dimensions in mm
135φ
114φ
98φ
83φ
80φ
160
d = 80
Side
= 0.71×80
= 56.8
= 56 say
(83-80)/2 = 1.5
(98-83)/2 = 7.5
(114-98)/2 = 8
(135-114)/2 = 10.5
55
350
End View

Steps for drawing the diagram:

Steps	Commands	Details
1	Units	mm
2	Limits	297, 210
3	Zoom, All	
4	Point	100, 100
5	Circle	Center :100, 100 Dia:100
6	Line	To draw center line- Select: ByLayer Select: Load Select: CENTER Select: Global scale 30 Draw horizontal and vertical center lines
7	Offset	Use offsets 56.8/2 with respect to vertical line Use offsets 56.8/2 with respect to horizontal line
8	Trim	Trim to get one quarter of square core
9	Mirror	Mirror twice and get the full square core
10	Hatch	Hatch the core-section with horizontal lines Angle:45^0 Global scale:20
11	Circle	Center: 100, 100 Draw circles with following diameters 83,98, 114 and 135
12	Line	Draw one wooden piece in the gap between HV and LV
13	Array	Select: Polar array, Center point: center of circle, Total number of items:8, Angle to fill 360^0 Select object: Select: one wooden piece
14	Hatch	Hatch Wooden piece, HV and LV windings with different patterns
15	Array	Rows:1, Columns:2 Row offset:0, Column offset:160 Select objects: Select complete core and winding Two limbs of the transformer have been obtained in plan view
16	Line	Extend the center lines horizontally and vertically
17	Line, Trim, Offset	Complete the elevation of the core Draw a horizontal line as a reference for elevation Offset 130/2 (i.e 350-220=130), 220, 130/2 with reference to horizontal line Extend the core vertically Offset 56.8, 103, 56.8 with reference to vertical line
18	Line, Trim	Extend line Project HV and LV winding ends to elevation Use Offset:6, both vertical heights of window (winding height=208)
19	Hatch	Hatch HV and LV windings with different patterns on elevation
20	Line, Trim, Offset	Complete the end view, by extending elevation and trim to get proper end view as shown in fig.
21	Dimension	Use Arrowhead:4, Text Height:6, for all diameters and linear dimensions
22	Text	Give the heading

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. With reference to center to distance marking, the core in plan is constructed. The plan of windings is drawn.
7. The magnetic frame is completed. The windings in elevation are constructed.
8. End view is constructed.
9. Use the Text tool to add labels, annotations, and other information to your drawing.
10. Save your drawing: Save your work frequently using the Save command or the Ctrl + S shortcut.
11. Once you have completed the wiring diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

Result:

THREE PHASE CORE TYPE TRANSFORMER SECTIONAL ELEVATION AND END-VIEW

THREE PHASE CORE TYPE TRANSFORMER SECTIONAL ELEVATION AND END-VIEW

EXP NO: **DATE:**

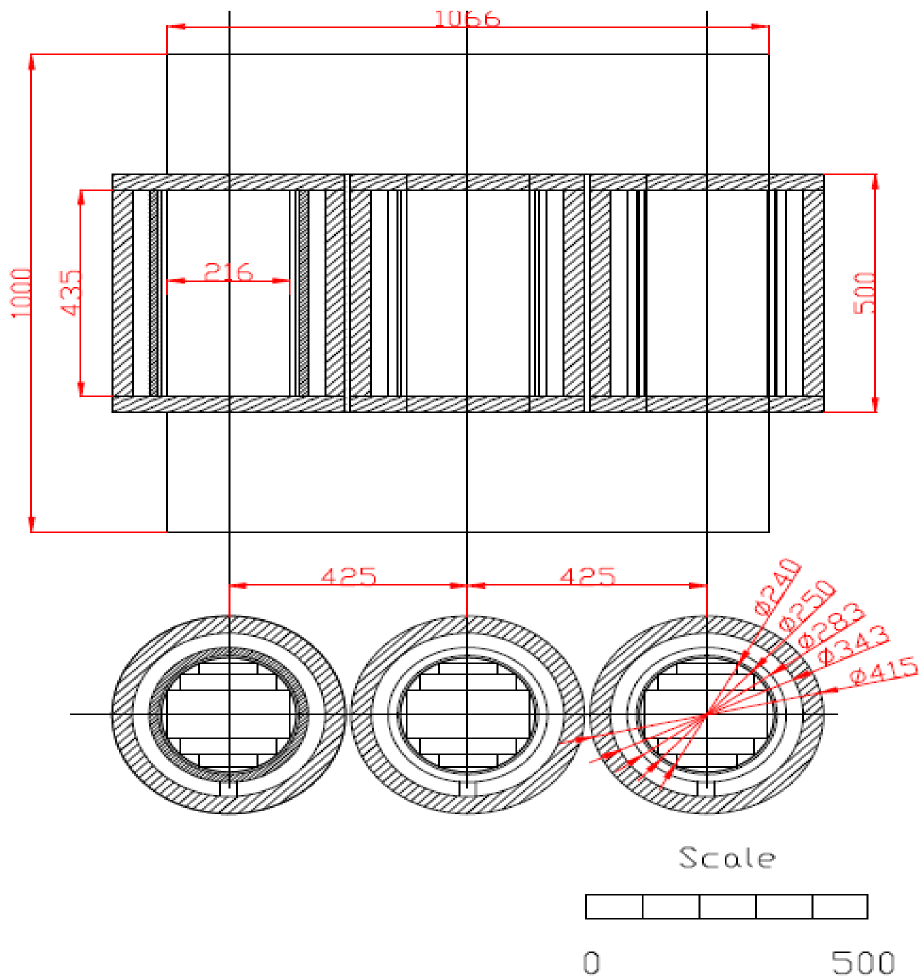
AIM:

Design the parameters of a single phase core type transformer and draw Sectional elevation and end-view for the given data

APPARATUS:

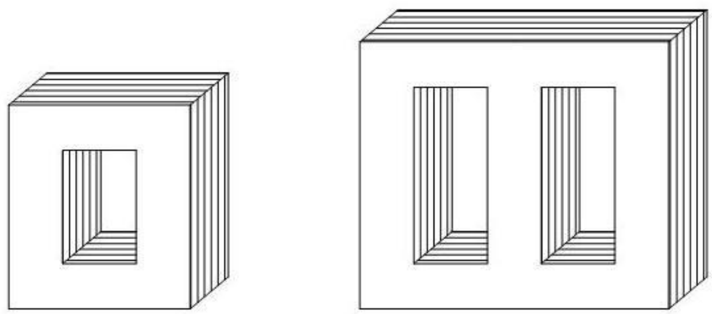
1. PC.
2. CAD Software

CIRCUIT DIAGRAM:



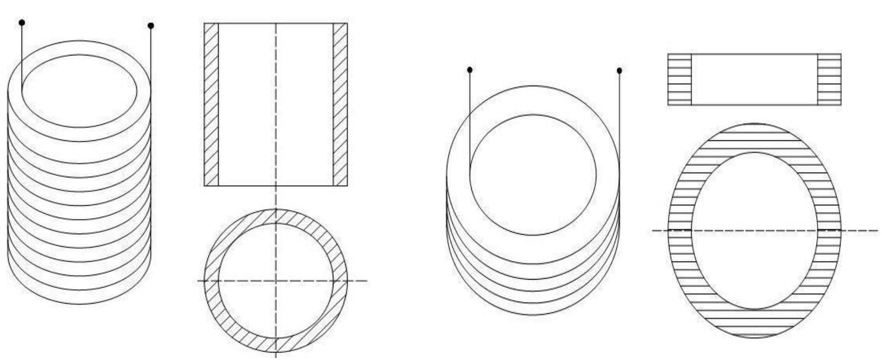
THEORY:

Single Phase and Three Phase Transformers (Core Type) The elevations of single phase core type transformer and three phase core type transformers are shown in Figure 1. The widths of cores on the two limbs are equal in single phase transformers. The widths of cores of all the three limbs are equal in three phase transformers. The height of yoke may be equal or greater than the width of core, in both cases. The depth of core will be confined to the dimension of circumcircle diameter.



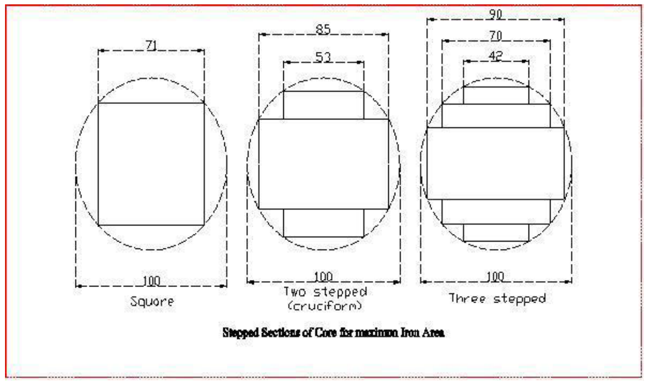
LV and HV windings

The transformer will have Low Voltage (LV) winding and High Voltage (HV) winding wound over the limbs. The LV winding is placed near the core. There will be a gap between LV and HV windings for oil circulation. The HV winding is placed away from the core. The finished windings are cylindrical in shape. The thickness and height of the cylinder will depend upon the number of turns and area of cross section of winding wire. The internal diameter will depend on the circum circle diameter, slack allowance and insulation layer. It may be noted that the sections of the cylinders so formed is confined to the window dimensions, viz, width of window and height of window. When the winding wires are thin or when the handling of finished winding is difficult because of heavy weight, the winding may be split into smaller discs. These discs may be stacked one above the other so that the required length may be formed. The views of such windings are shown in Figures.



Core section

The core section of core type transformer may be – square type, two stepped or cruciform, three stepped, four stepped and so on. The imaginary circle passing through the corners of the core section is known as circumscribing circle or circum circle. The dimensions for obtaining the maximum area in the given circum circle, for various number of steps is given in Figure



Stepped Sections of Core for maximum Iron Area

Stepped Core For Cruciform Core

- In stepped cores the dimensions of the steps should be chosen, such as to occupy maximum area within a circle. The dimensions of the two step to give maximum area for the core in the given area of circle are determined as follows.

- Let, a = Length of the rectangle
  b = Breadth of the rectangle
  d = Diameter of the circumscribing circle
  Also, d= Diagonal of the rectangle
  ϴ = Angle between the diagonal and length of the rectangle.

  The cross-section of two stepped core is shown in figure.

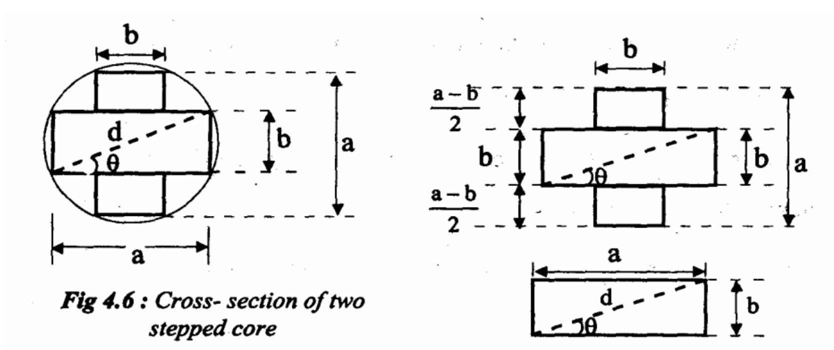


Fig 4.6 : Cross- section of two stepped core

The maximum core area for a given d is obtained when ϴ is maximum value.

- Hence differentiate Agi with respect to Θ and equate to zero to solve for maximum value of Θ.

From figure we get,

$$a = d\cos\theta$$
$$b = d\sin\theta$$

The two stepped core can be divided into three rectangles. The area of three rectangles gives the gross core area. With reference to figure, we can write,

$$Agi = 2ab - b^2$$

On substituting for a and b in above equation we get

$$Agi = d^2 \sin 2\theta - d^2 \sin^2\theta$$

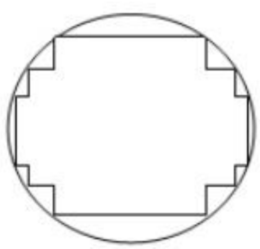
To get maximum value of Θ, differentiate Agi with respect to Θ, and equate to zero,

$$\Theta = 31.72$$

When Θ =31 .72° the dimensions of the core (a & b) will give the maximum area for core for a specified ‘ d’ .

a=0.85d, b=0.53d

Three stepped core:



Width of the largest stamping a = 0.9d
Width of the middle stamping b = 0.7d
Width of the smallest stamping c = 0.42d
$A_i = 0.6d^2$

As the number of steps increases, the diameter of the circumscribing circle reduces. Though the cost of the core increases, cost of copper and size of the coil or transformer reduces.

Overall Dimensions of Transformer

- The main dimensions of the transformer are Height of window (Hw) and Width of window (Ww).
- The other important dimensions of the transformer are width of largest stamping (a), diameter of circumscribing circle (d), and distance between core centres (D), height of yoke (Hy), depth of yoke (Dy), overall height of transformer frame (H) and overall width of transformer frame (W).
- These dimensions for various types of transformers are shown in figures.

1. D-distance between the two core or leg central lines

2. Width Ww is measured from one edge of the leg to the other of the adjacent leg in case of square or rectangular core with square or rectangular coil and between the two circumscribing circles of adjacent legs in case of stepped legs.
3. Depth or width of the core type transformer = b in case of rectangular core

    = a in case of square or stepped core

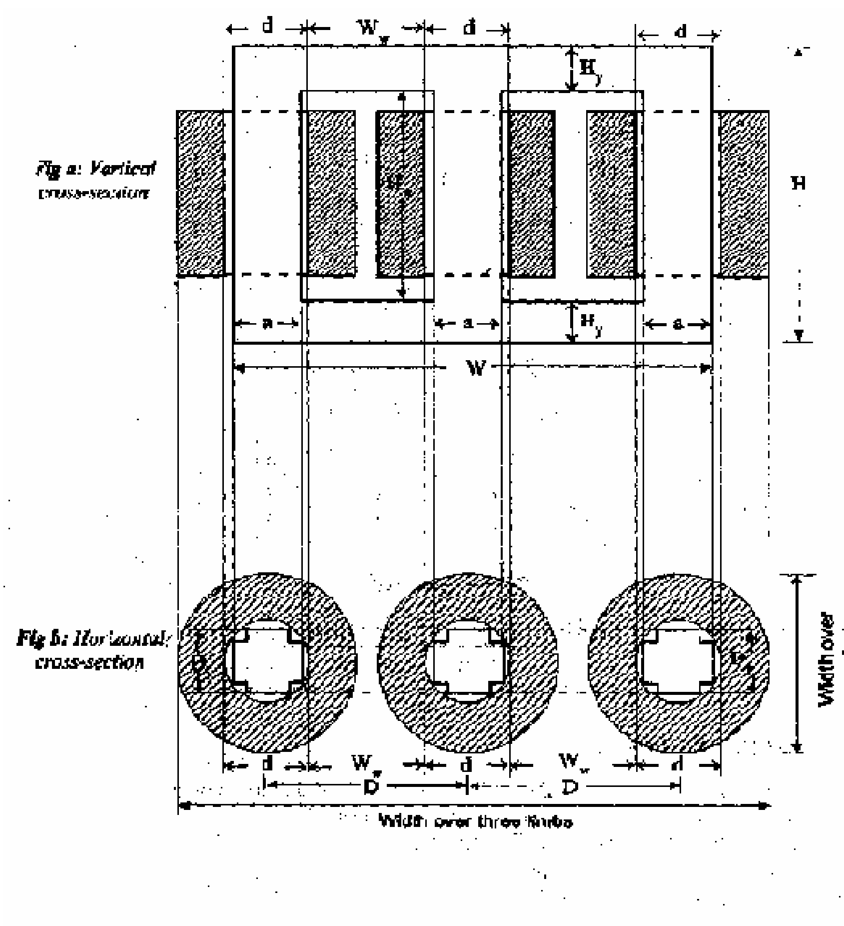
Overall length = (Ww + 2a) or (D+a) in case of single phase core type transformer with square or rectangular core

= (Ww+d+a) or (D+a) in case of single phase core type transformer with a Stepped leg

= (2Ww + 2d + a) or (2D+a) in case of three phase core type transformer with a stepped leg. No square or rectangular leg is used for high capacity three phase transformers.

Overall height = (Hw + 2Hy) for all core type transformers.

The following figure shows a vertical and horizontal cross-section of the core and winding assembly of a core type three phase transformer.



Draw the following views of a 3phase, core type, 250kVA, 11kV/400V transformer-

i) Front elevation in full section and ii)Plan in full section

Cross section of the core: 3Stepped

Diameter of the circum circle =24cm

Centre to centre distance between adjacent limbs =42.5cm

Yoke height=25cm

Details of LV Winding: Outer diameter of LV Coil = 28.3 cm; Inner diameter of LV coil = 25 cm; Height of LV winding = 43.5 cm.

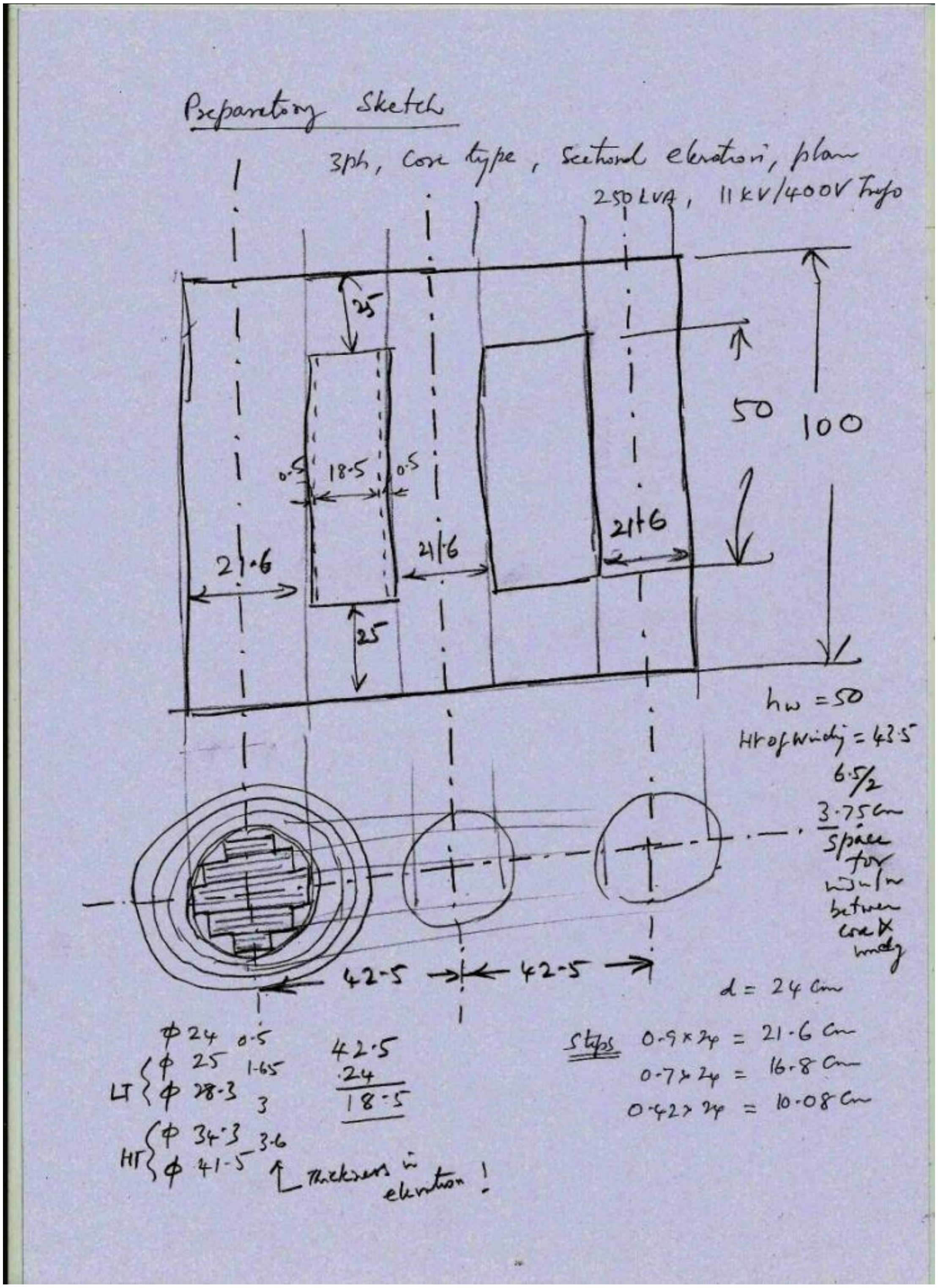
Details of HV Winding: Outer diameter of HV Coil = 41.5 cm; Inner Diameter of HV coil = 34.3 cm; Height of HV winding = 43.5 cm;

Total height of transformer=100cm

Calculations

Preparatory sketch – Three Phase Core Type Transformer

- Circum circle,d=24cm
- Core is three stepped
- Calculate the values of three steps, viz.,
- 0.9x24=21.6cm
- 0.7x24=16.8cm
- 0.42x24=10.08cm


Preparatory Sketch
3ph, Core type, Sectional elevation, plan
250 kVA, 11kV/400V Trafo
25
0·5
18·5
0·5
21·6
21·6
21·6
25
50
100
hw = 50
Ht of Windg = 43·5
6·5/2
3·75 cm
space for winding between core & windg
42·5
42·5
d = 24 cm
φ 24 0·5
φ 25 1·65
LT φ 28·3 3
HT φ 34·3 3·6
φ 41·5
Thickness in elevation!
42·5
24
18·5
Steps 0·9 × 24 = 21·6 cm
0·7 × 24 = 16·8 cm
0·42 × 24 = 10·08 cm

Prodedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Draw center lines, 425mm apart. Draw another center line at the bottom of the monitor.
7. Draw the left hand side core section with three steps.
8. Draw the LV and HV winding profile with dia =250, 283, 343, 415mm respectively.
9. Complete the magnetic frame in elevation with the given dimensions.
10. Draw the projection of the windings from the plan view. Hatch the core section in the plan.
11. Hatch the LV and HV windings in the plan. Hatch the LV & HV windings in the elevation. Copy the views to the other two limbs.
12. Mark the dimensions and title.
13. Use the Text tool to add labels, annotations, and other information to your drawing.
14. Save your work frequently using the Save command or the Ctrl + S shortcut.
15. Once you have completed the diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:

HALF SECTIONAL END VIEW AND ELEVATION OF SLIP RING INDUCTION MOTOR

HALF SECTIONAL END VIEW AND ELEVATION OF SLIP RING INDUCTION MOTOR

EXP NO: **DATE:**

AIM:

Draw the half sectional end view and elevation of slip ring Induction motor with the given dimensions.

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:

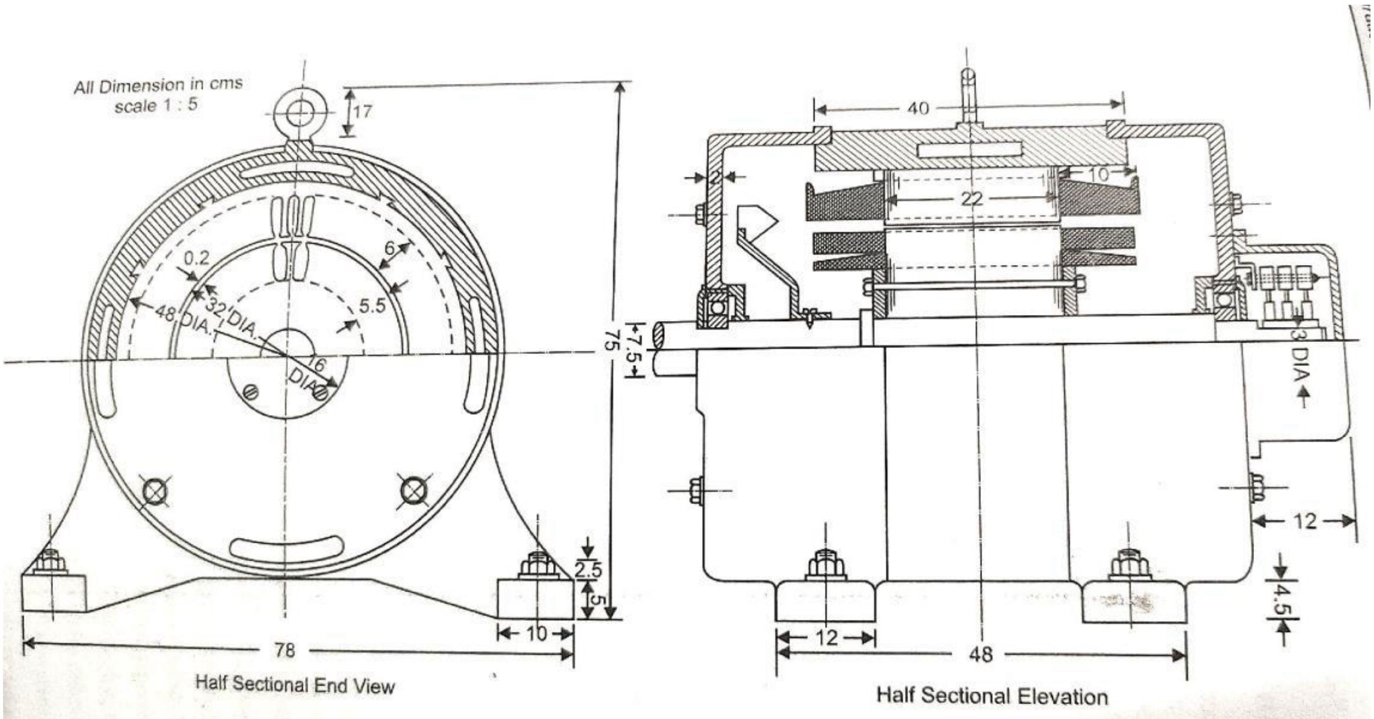


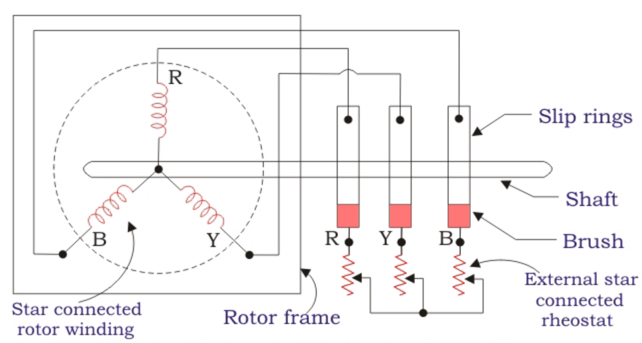
Fig. 9.24. Three phase slipring induction motor

THEORY:

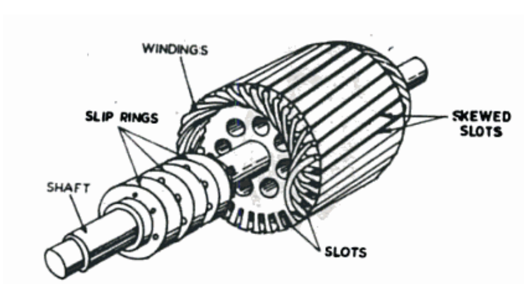
A three phase induction motor is of slip ring type. The slip rings which are mounted on a projection of the shaft at right hand end are connected to the winding by insulated conductor passing through a hole in the shaft, and a slip ring cover with the movable lid is supported from the end shield. The left hand of the shaft supports the fan inside the casing and projects through the ball bearing to carry the driving pulley. The ventilation is of mixed flow type being partly axial and partly radial. Under the action of the fan air enters at the slip ring and flows through the duct in the rotor and over the stator plates. Some of the rotor air flows through the two radial ducts. All the air is exhausted from the machine at the pulley end.

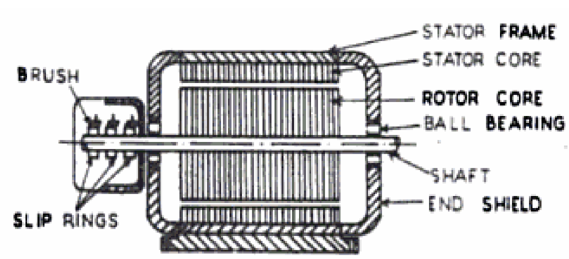
In this type of three phase induction motor the rotor is wound for the same number of poles as that of stator but it has less number of slots and has less turns per phase of a heavier conductor. The rotor also carries star or delta winding similar to that of stator winding. The rotor consists of numbers of slots and rotor winding are placed inside these slots. The three end terminals are connected together to form star connection. As its name indicates three phase slip ring induction motor consists of slip rings connected on same shaft as that of rotor. The three ends of three phase windings are permanently connected to these slip rings. The external resistance can be easily connected through the brushes and slip rings and hence used for speed control and improving the starting torque of three phase induction motor.

The brushes are used to carry current to and from the rotor winding. These brushes are further connected to three phase star connected resistances. At starting, the resistance is connected in rotor circuit and is gradually cut out as the rotor pick up its speed. When the motor is running the slip ring are shorted by connecting a metal collar, which connect all slip ring together and the brushes are also removed. This reduces wear and tear of the brushes. Due to presence of slip rings and brushes the rotor construction becomes somewhat complicated therefore it is less used as compared to squirrel cage induction motor.



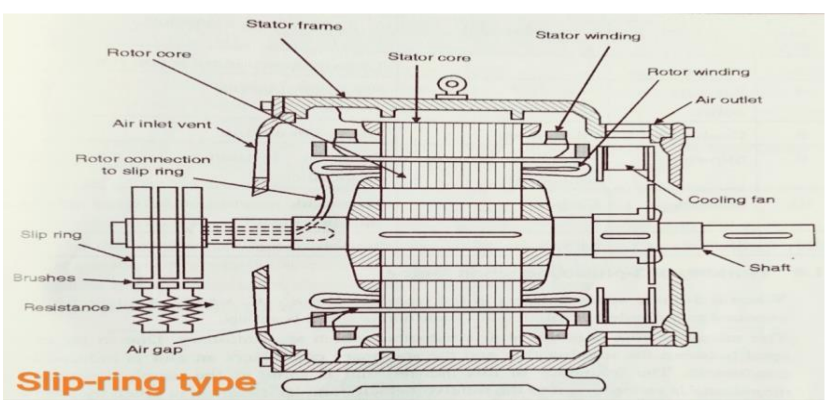
Slip Ring Three Phase Induction Motor



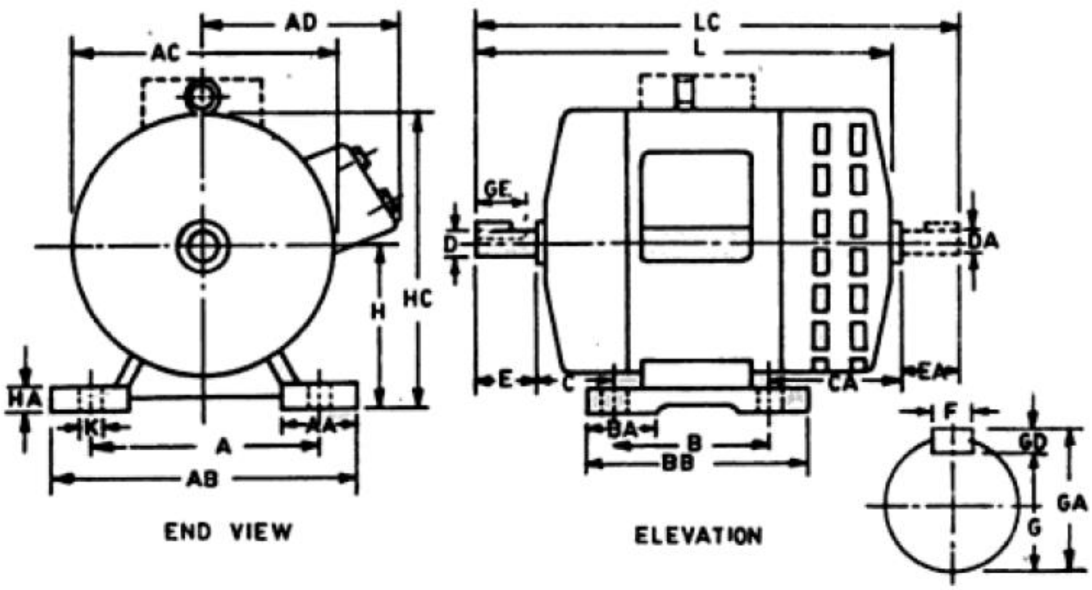


Difference between Squirrel Cage Induction Motor and Slip Ring Induction Motors.

Squirrel Cage Induction Motor	Slip Ring Induction Motor
The construction of squirrel cage induction simple and rugged.	Construction of slip ring induction motors needs slip rings, brushes, short-circuiting device, etc.
This type of motor has less overhang and better space factor in slots.	These motors have the highest overhang and poor space factor in slots.
Cost and maintenance are less.	The cost is more.
Higher efficiency (in case of machines, not designed for high starting torque)	Low efficiency and more copper losses.
Small copper losses and better power factor.	Poor power factor and can be improved at the start.
The cooling factor is better because of its bare end rings and the availability of more space for rotor fans.	The cooling factor is not quite efficient.
These motors have better speed regulation, simple starting and low staring torque with high starting current	Poor speed regulation when operated with external resistances in the rotor circuit. The motor needs slip rings, brush gear, short-circuiting device and starting resistors, etc. Possibility of increasing starting torque due to external resistances in the rotor circuit.
Power factor is poor at starting	The power factor can be improved.
There is no possibility of speed control.	Speed control is possible by the insertion of external resistors in the rotor circuit.
Explosion-proof against protection.	Explosion-proof against protection.



Outside Dimensional Drawings of 3-phase Induction Motor



List of letter symbols

A	Distance between centre-lines of counting holes (end view)
AA	Width of end foot (end view)
AB	Over-all dimensions across feet (end view)
AC	Diameter of machine
AD	Distance from centre-line of machine to extreme outside of terminal box
B	Distance between centre-lines of fixing holes (elevation)
BA	Length of foot (elevation)
BB	Overall dimension across feet (elevation)
C	Distance from shoulder of shaft to centre-line of mounting holes in the nearest feet
CA	Distance from shoulder of second shaft to centre-line of mounting holes in the nearest feet
D	Diameter of shaft extension
DA	Diameter of second shaft extension
E	Length of shaft extension from shoulder
EA	Length of the second shaft extension from shoulder
F	Width of keyway
G	Distance of bottom from keyway to the opposite surface of the shaft extension
GA	Distance from the top of the key to the opposite surface of the shaft extension
GD	Thickness of key
GE	Length of keyway at the crown of shaft
H	Distance from centre-line of shaft to bottom of feet
HA	Thickness of feet
HC	Top of horizontal machine to bottom of feet
K	Diameter of holes for width of slots in the feet of machine
L	Overall length of the machine with single shaft extension
LC	Overall length of the machine when there is a double shaft extension

Dimensions :

Draw the half sectional elevation and half sectional end view of a three phase slip-ring induction motor with the following dimensions.

Inside dia of stator =32 cm

External dia of stator = 48 cm

Stator length=22 cm

Stator overhang of each side =10 cm

Length of stator frame = 40 cm

Air gap length = 0.2 cm

No. of slots in stator = 45

Size of stator slot=12 cm x 6 cm, open type

No. of slots in rotor = 36

Size of rotor slot=0.85 cm x 5.5 cm, open type, shaft dia=7.5 cm

Total length of motor at foot step = 48 cm

Height of base up to eye bolt=72 cm

Width of foot step=78 cm

Foot thickness= 5 cm

Length of Foot= 10 cm

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Begin by drawing the outline of the motor frame in the end view. Use lines, arcs, and other drawing tools to create the shape of the motor frame.
7. Draw a line or a reference plane to indicate where the section cut will be made. This line should pass through the center of the motor.
8. Delete the portion of the motor that is hidden by the section cut. Use the "Trim" command to remove the unnecessary lines and arcs.
9. Add hatching or shading to the sectioned areas of the half sectional view. Use the "Hatch" command to apply a hatch pattern to the cutaway portion of the motor.
10. Create a copy of the half sectional view and move it to the side. This will be used as a reference for creating the elevation view.
11. Begin by drawing the outline of the motor frame in the elevation view. Use lines, arcs, and other drawing tools to create the shape of the motor frame.
12. Add any necessary details to the elevation view, such as mounting brackets, terminal boxes, cooling fins, or shafts. These details may vary depending on the specific motor design. Use additional lines, arcs, and circles to create these components.
13. Draw a line or a reference plane to indicate where the section cut will be made. This line should pass through the center of the motor.
14. Add dimension lines, annotations, and any other necessary details to the half sectional view.
15. Check your drawing for accuracy, making sure all dimensions and annotations are correctly placed.
16. Save your drawing in the desired format (e.g., DWG or DXF) and make any final adjustments or refinements as needed.

Result:

HALF SECTIONAL END VIEW AND ELEVATION OF SQUIRREL CAGE INDUCTION MOTOR

HALF SECTIONAL END VIEW AND ELEVATION OF SQUIRREL CAGE INDUCTION MOTOR

EXP NO: **DATE***:*

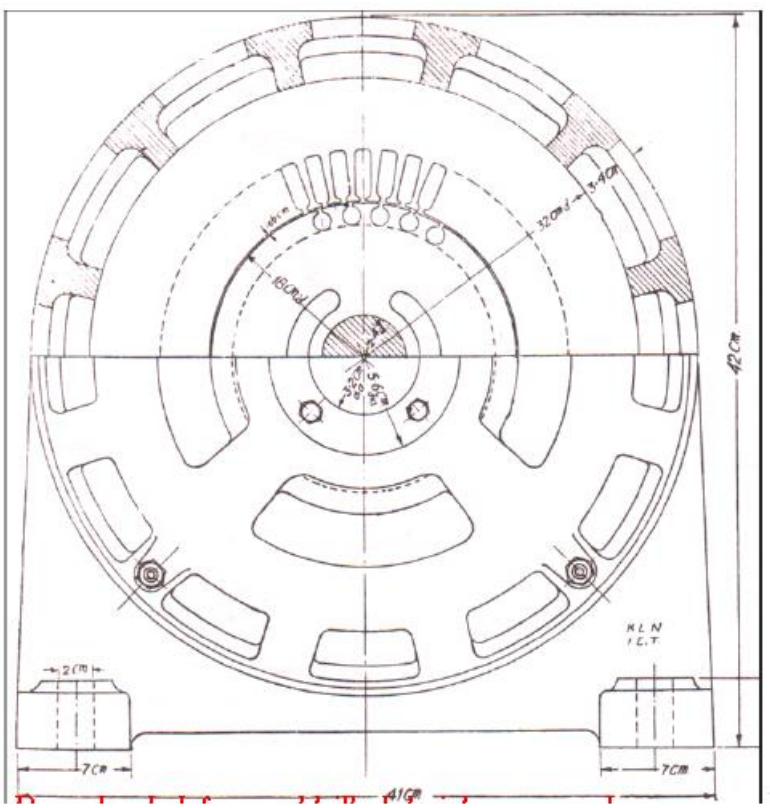
AIM:

Draw the half sectional end view and elevation of squirrel cage Induction motor with the given dimensions.

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:



Theory :

A typical motor consists of two parts namely stator and rotor like other type of motors.

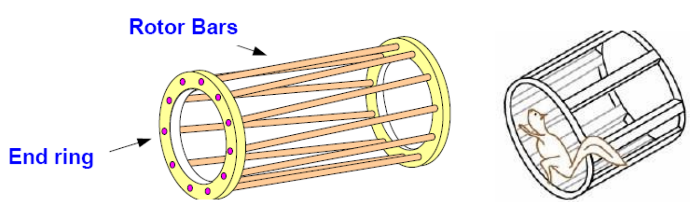
1. An outside stationary stator having coils supplied with AC current to produce a rotating magnetic field,
2. An inside rotor attached to the output shaft that is given a torque by the rotating field.

Stator:

Stator of an Induction Machine

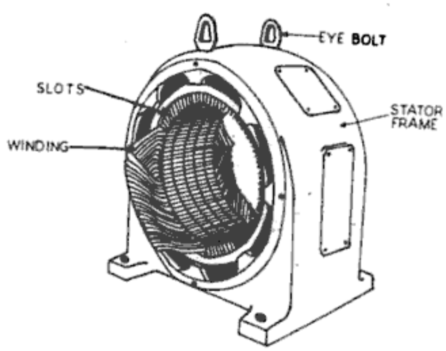
The stator of an induction motor is ,in principle ,the same as that of synchronous motor or generator. It is made up of a number of stampings, which are slotted to receive the windings. The stator carries 3-phase winding and is fed from a 3 phase supply. It is wound for a definite number of poles, the exact numbers of poles being determined by the requirements of speed. Greater the number of poles ,lesser the speed and vice-versa. The stator windings, when supplied with 3-phase currents ,produce a magnetic flux, which is of constant magnitude but which at a speed of synchronous speed. This revolving magnetic flux induces an e.m.f in the rotor by mutual induction.

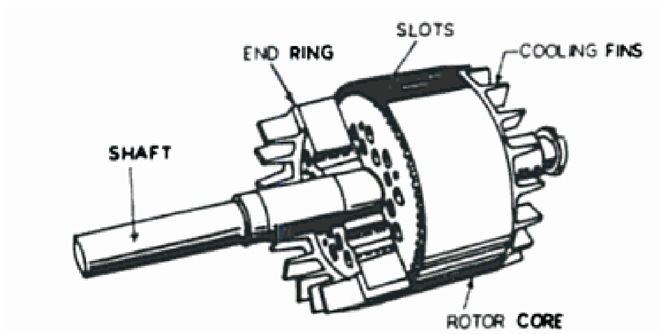
Squirrel-Cage Rotor

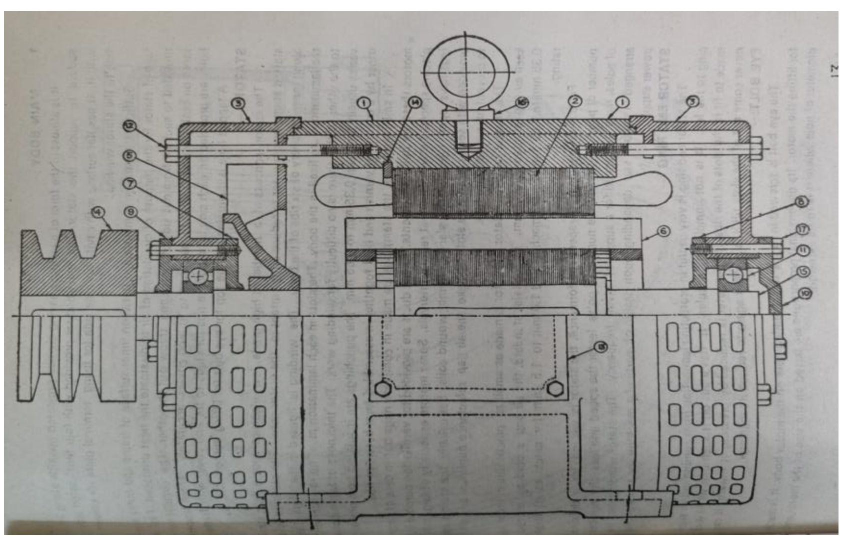


The rotor of the squirrel cage three phase induction motor is cylindrical in shape and have slots on its periphery. The slots are not made parallel to each other but are bit skewed (skewing is not shown in the figure of squirrel cadge rotor beside) as the skewing prevents magnetic locking of stator and rotor teeth and makes the working of motor more smooth and quieter. The squirrel cage rotor consists of aluminum, brass or copper bars (copper bras rotor is shown in the figure beside).

These aluminum, brass or copper bars are called rotor conductors and are placed in the slots on the periphery of the rotor. The rotor conductors are permanently shorted by the copper or aluminum rings called the end rings. In order to provide mechanical strength these rotor conductor are braced to the end ring and hence form a complete closed circuit resembling like a cage and hence got its name as "squirrel cage induction motor". The squirrel cage rotor winding is made symmetrical. As the bars are permanently shorted by end rings, the rotor resistance is very small and it is not possible to add external resistance as the bars are permanently shorted.The absence of slip ring and brushes make the construction of Squirrel cage three phase induction motor very simple and robust and hence widely used three phase induction motor. These motors have the advantage of adapting any number of pole pairs.



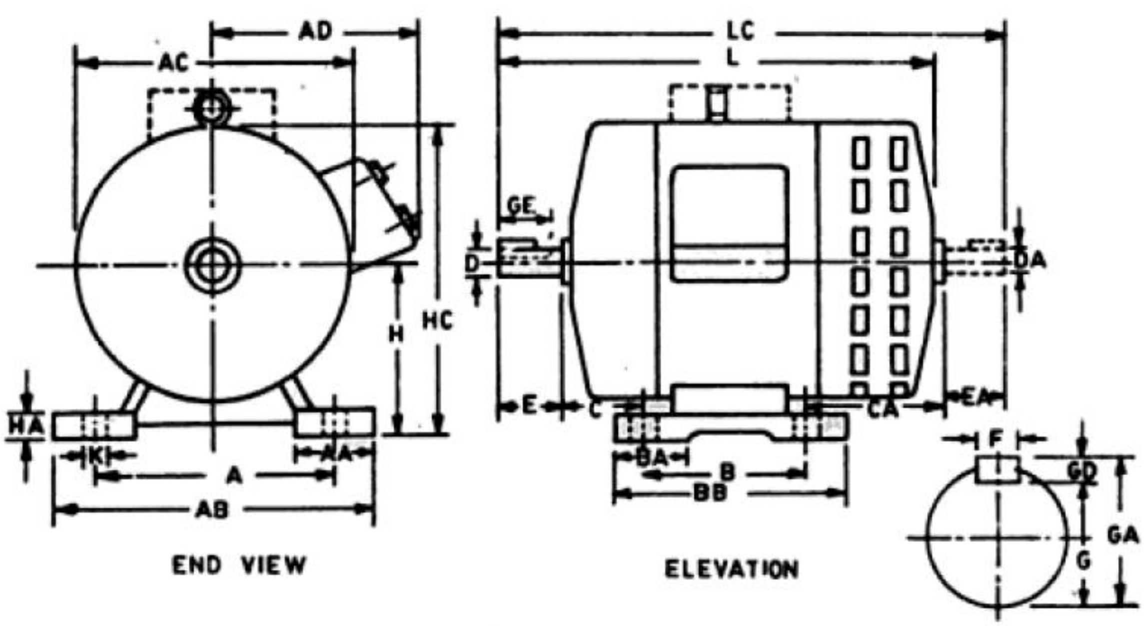




The induction motor de... ing parts as also shown in the assembly on opposite ...

Sl.No.	Part No.	Name of Part	Meterial
1	1	Main Body	Cast iron
2	3	End Cove. (End S. ield)	Cast iron
3	6	Rotor	Silicon Steel Lamination
4	5	Fan	Aluminium
5	—	Terminal Plate (with studs & nuts)	Bakelite
6	13	Terminal Box Cover	Cast iron
7	4	Pulley	Cast iron
8	7.8	Inside Bearing Cover	Cast iron
9	9	Outside Bearing Cover (Driving end side)	Cast iron
10	10	Outside Bearing Cover (Non driving end side)	Cast iron
11	11	Ball Bearing	Steel
12	15	Shaft	Mild Steel
13	14	Stator End Ring	Mild steel
14	2	Stator	Silicon Steel Lamination
15	16	Eye Bolt	Mild Steel
16	12	Bolt for fixing end cover with body	Mild Steel
17	17	Bolt for Bearing Covers	Mild Steel

Outside Dimensional Drawings of 3-phase Induction Motor



List of letter symbols

A	Distance between centre-lines of counting holes (end view)
AA	Width of end foot (end view)
AB	Over-all dimensions across feet (end view)
AC	Diameter of machine
AD	Distance from centre-line of machine to extreme outside of terminal box
B	Distance between centre-lines of fixing holes (elevation)
BA	Length of foot (elevation)
BB	Overall dimension across feet (elevation)
C	Distance from shoulder of shaft to centre-line of mounting holes in the nearest feet
CA	Distance from shoulder of second shaft to centre-line of mounting holes in the nearest feet
D	Diameter of shaft extension
DA	Diameter of second shaft extension
E	Length of shaft extension from shoulder
EA	Length of the second shaft extension from shoulder
F	Width of keyway
G	Distance of bottom from keyway to the opposite surface of the shaft extension
GA	Distance from the top of the key to the opposite surface of the shaft extension
GD	Thickness of key
GE	Length of keyway at the crown of shaft
H	Distance from centre-line of shaft to bottom of feet
HA	Thickness of feet
HC	Top of horizontal machine to bottom of feet
K	Diameter of holes for width of slots in the feet of machine
L	Overall length of the machine with single shaft extension
LC	Overall length of the machine when there is a double shaft extension

Dimensions:

Inside dia. Of stator =18cm

Length of stator=13.5cm

On radial cooling duct in stator and rotor = lcmwide

Stator slotsize =0.95cm*2.9cm

Outside dia. Of stator =32cm

Airgap length=0.06cm

Rotor has 31 slots of size lcm dia. And is directly mounted over the shaft.

Dia. Of shaft below rotor =2.4cm

The rotor shaft is supported in the end cover by means of ball bearings.

Other missing data may be assumed.

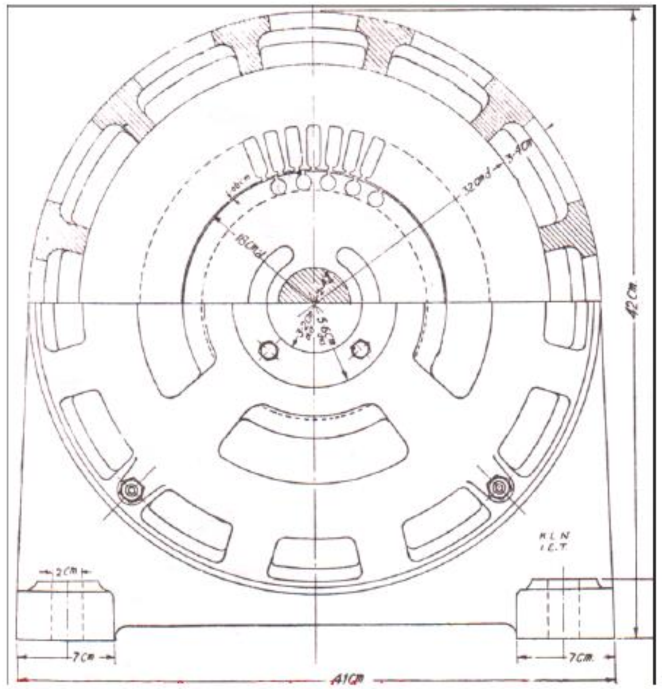


Fig. Half - Sectional End view

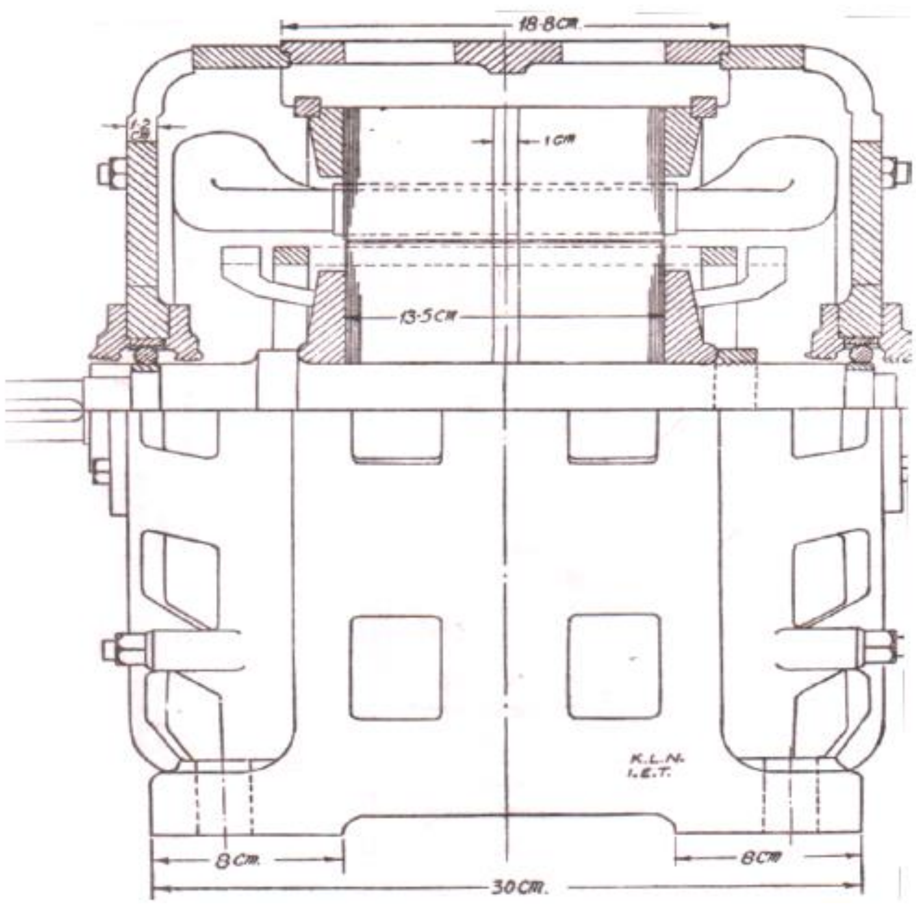


Fig. Half - Sectional Longitudinal view

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Begin by drawing the outline of the motor frame in the end view. Use lines, arcs, and other drawing tools to create the shape of the motor frame.
7. Draw a line or a reference plane to indicate where the section cut will be made. This line should pass through the center of the motor.
8. Delete the portion of the motor that is hidden by the section cut. Use the "Trim" command to remove the unnecessary lines and arcs.
9. Add hatching or shading to the sectioned areas of the half sectional view. Use the "Hatch" command to apply a hatch pattern to the cutaway portion of the motor.
10. Create a copy of the half sectional view and move it to the side. This will be used as a reference for creating the elevation view.
11. Begin by drawing the outline of the motor frame in the elevation view. Use lines, arcs, and other drawing tools to create the shape of the motor frame.
12. Add any necessary details to the elevation view, such as mounting brackets, terminal boxes, cooling fins, or shafts. These details may vary depending on the specific motor design. Use additional lines, arcs, and circles to create these components.
13. Draw a line or a reference plane to indicate where the section cut will be made. This line should pass through the center of the motor.
14. Add dimension lines, annotations, and any other necessary details to the half sectional view.
15. Check your drawing for accuracy, making sure all dimensions and annotations are correctly placed.
16. Save your drawing in the desired format (e.g., DWG or DXF) and make any final adjustments or refinements as needed.

Result:

THREE-PHASE INDUCTION MOTOR WITH DOL STARTER

THREE-PHASE INDUCTION MOTOR WITH DOL STARTER

EXP NO: **DATE**:

AIM:

Draw the diagram of Three-phase motor with DOL starter

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:

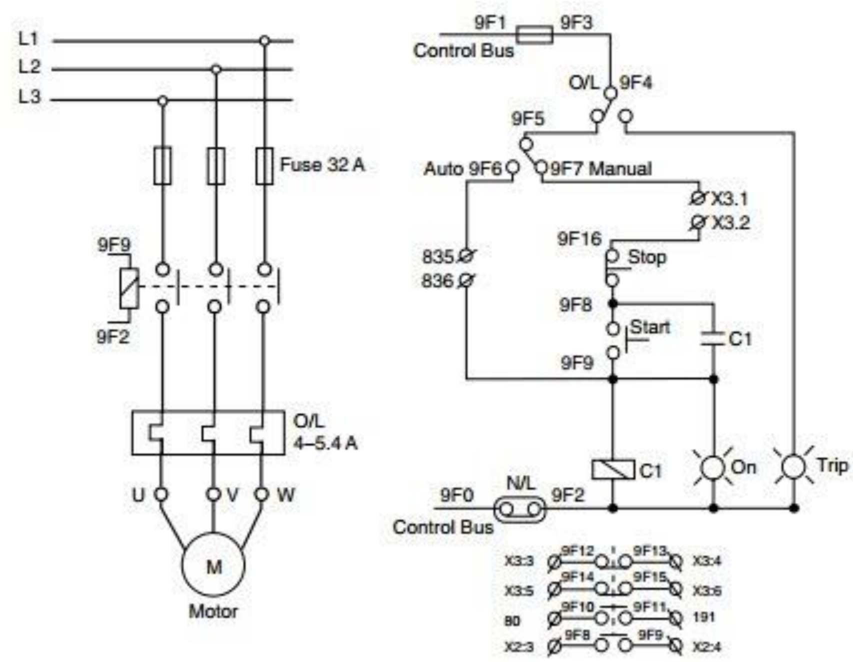


Figure 2.5
Typical electrical drawing of power and control circuits for a three-phase motor with DOL starter

Theory:

Different starting methods are employed for starting induction motors because Induction Motor draws more starting current during starting. To prevent damage to the windings due to the high starting current flow, we employ different types of starters.

The simplest form of motor starter for the induction motor is the **Direct on Line starter**. The Direct On Line Motor Starter (DOL) consist a MCCB or Circuit Breaker, Contactor and an overload relay for protection. Electromagnetic contactor which can be opened by the thermal overload relay under fault conditions.

Typically, the contactor will be controlled by separate start and stop buttons, and an auxiliary contact on the contactor is used, across the start button, as a hold in contact. I.e. the contactor is electrically latched closed while the motor is operating.

Principle of DOL starter

To start, the contactor is closed, applying full line voltage to the motor windings. The motor will draw a very high inrush current for a very short time, the magnetic field in the iron, and then the current will be limited to the Locked Rotor Current of the motor. The motor will develop Locked Rotor Torque and begin to accelerate towards full speed.

As the motor accelerates, the current will begin to drop, but will not drop significantly until the motor is at a high speed, typically about 85% of synchronous speed. The actual starting current curve is a function of the motor design, and the terminal voltage, and is totally independent of the motor load.

The motor load will affect the time taken for the motor to accelerate to full speed and therefore the duration of the high starting current, but not the magnitude of the starting current.

Provided the torque developed by the motor exceeds the load torque at all speeds during the start cycle, the motor will reach full speed. If the torque delivered by the motor is less than the torque of the load at any speed during the start cycle, the motor will stops accelerating. If the starting torque with a DOL starter is insufficient for the load, the motor must be replaced with a motor which can develop a higher starting torque.

The acceleration torque is the torque developed by the motor minus the load torque, and will change as the motor accelerates due to the motor speed torque curve and the load speed torque curve. The start time is dependent on the acceleration torque and the load inertia.

DOL starting have a maximum starting current and maximum start torque

This may cause an electrical problem with the supply, or it may cause a mechanical problem with the driven load. So this will be inconvenient for the users of the supply line, always experience a voltage drop when starting a motor. But if this motor is not a high power one it does not affect much.

Operation

The power circuit consists of a three-phase main supply with a fuse unit for protection purposes. The other side of the fuse unit is connected to a power contactor. The output terminals of the contactor are connected to an overload relay. Finally, the overload relay output terminals are connected to motor terminals.

The control circuit for the motor works on a 110 V AC single-phase supply. The phase of the control supply is connected to a NC contact of the overload relay (O/L).

The wire from the O/L relay contact is connected to an auto/manual mode selector switch.

In the auto mode, the motor gets a start/run command through a potential-free contact (Terminals 835–836) of a relay, which in turn is energized with a Programmable Logic Controller (PLC) output.

In the manual mode, the motor can be started with the help of a start pushbutton. When the start pushbutton is pressed, the control circuit is completed and the auxiliary control contactor (C1) coil is energized. A potential-free NO contact of the contactor (C1) is closed and keeps the contactor C1 latched when the start pushbutton is released. When the auxiliary contactor (C1) is on, the motor power circuit is completed and the motor starts and remains on until the contactor C1 is de-energized and the power circuit to the motor terminals is broken.

For the manual mode, additional interlocks to trip the motor are connected between terminals X3.1 and X3.2. The motor can be stopped with a stop pushbutton. The NC contact of a stop pushbutton breaks the control supply to the auxiliary control contactor (C1) and the motor is stopped. The neutral for the control circuit is connected with a neutral link (N/L).To indicate that the motor is ON or running, an indication lamp is connected in parallel to the contactor, which goes ON whenever the auxiliary contactor is turned on. Another indication lamp to indicate a motor trip is connected to a NO contact of the overload relay.

When the motor is overloaded, the NO contact is closed and the TRIP indication lamp is turned ON, until the overload relay is reset. In the control circuit, potential-free contacts, 2 NO and 2 NC, of the auxiliary contactor (C1) are connected to various pairs of terminals such as X3:3 – X3:4 (NC), X3:5 – X3:6 (NC), 80 – 191 (NO), and X2:3 – X2:4 (NO).The NO contact of the auxiliary control contactor is terminated at the terminals X2:3 and X2:4, and is used in parallel to the start pushbutton NO contact for latching purposes. In addition, the contact letters 9F8-9F9 are mentioned. This shows the location of the contact in the drawing.

Advantages of DOL Starter:

1. Most Economical and Cheapest Starter
2. Simple to Establish, operate and maintain
3. Simple control circuitry
4. It provides 100% torque at the time of starting

Disadvantages of DOL Starter:

1. It does not reduce the starting current of the motor
2. High starting current
3. There is a big voltage dip in the electrical installation because of high inrush current affecting other customers connected to the same lines and therefore not suitable for higher size squirrel cage motors.
4. Unnecessary high starting torque even when not required by the load, thereby increased mechanical stress on the mechanical systems such as rotor shaft, bearings, gearbox etc.

Applications of direct online Starter

DOL starters are used to start the small rating motor like water pumps, compressors, conveyors etc. The compressor motor starts at no load therefore it is suitable for compressor motor. The Squirrel cage induction motor coupled through **fluid coupling** can also be started with DOL starter.

Prodedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Use AutoCAD's drawing tools, such as lines, arcs, and circles, to create the outline of the motor. Refer to technical specifications or motor drawings for accurate dimensions and proportions. Typically, a three-phase induction motor has a cylindrical shape with mounting brackets.
7. Draw the motor details such as cooling fans, terminal boxes, shaft, rotor, and stator windings. These details may vary depending on the specific motor design.
8. Position the DOL starter near the motor and draw its components. A DOL starter usually consists of contactors, overload relays, start and stop buttons, and connection terminals. Use AutoCAD's drawing tools to create these components with accurate proportions.
9. Add text labels and annotations to identify various components and provide necessary information. Label the motor terminals, starter components, and any relevant specifications or ratings.
10. Save your work frequently using the Save command or the Ctrl + S shortcut.
11. Once you have completed the diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:-

THREE-PHASE INDUCTION MOTOR WITH STAR–DELTA STARTER

THREE-PHASE INDUCTION MOTOR WITH STAR–DELTA STARTER

EXP NO: **DATE:**

AIM:

Draw the line diagram of Three-phase induction motor with star–delta starter.

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:

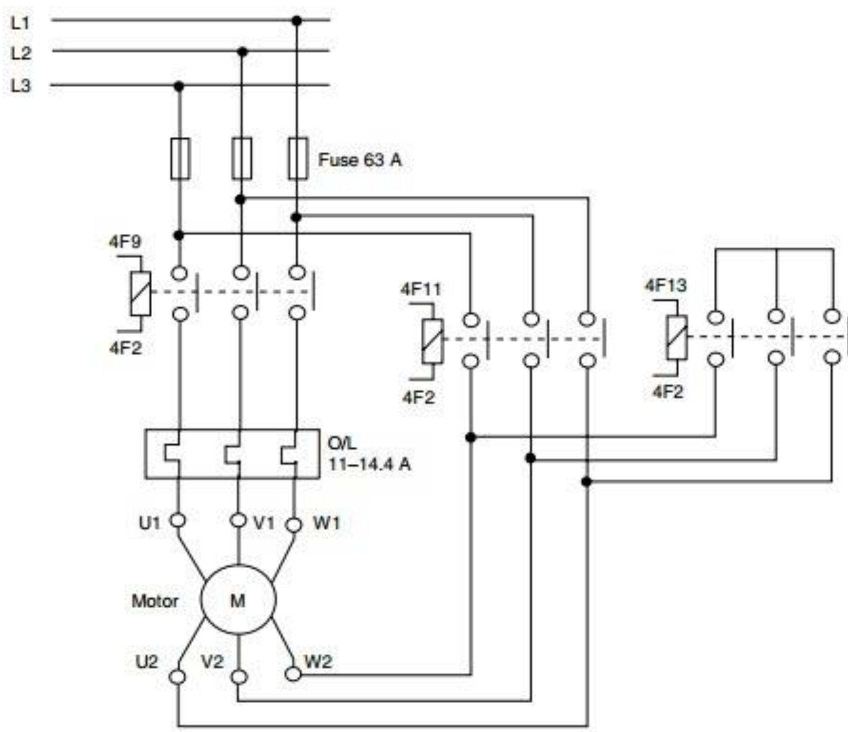


Figure 2.6
Typical electrical drawing of power circuit for a three-phase motor with star–delta starter

Theory:

Star-Delta Starter:

An induction motor is similar to a poly-phase transformer whose secondary is short circuited. Thus, at normal supply voltage, like in transformers, the initial current taken by the primary is very large for a short while. Unlike in DC motors, large current at starting is due to the absence of back emf. If an induction motor is directly switched on from the supply, it takes 5 to 7 times its full load current and develops a torque which is only 1.5 to 2.5 times the full load torque. This large starting current produces a large voltage drop in the line, which may affect the operation of other devices connected to the same line. Hence, it is not advisable to start induction motors of higher ratings (generally above 25kW) directly from the mains supply.

Most induction motors are started directly on line, but when very large motors are started that way, they cause a disturbance of voltage on the supply lines due to large starting current surges. To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run up to near rotated speed.

Working Principle

This is the reduced voltage starting method. Voltage reduction during star-delta starting is achieved by physically reconfiguring the motor windings as illustrated in the figure below. During starting the motor windings are connected in star configuration and this reduces the voltage across each winding 3. This also reduces the torque by a factor of three.
After a period of time the winding are reconfigured as delta and the motor runs normally. Star/Delta starters are probably the most common reduced voltage starters. They are used in an attempt to reduce the start current applied to the motor during start as a means of reducing the disturbances and interference on the electrical supply.

The stator phase windings are first connected in the star manner and full voltage is connected across its free terminals. As the motor picks up speed, the windings are connected through a switch and they are re-connected in delta across the supply terminals. The current drawn by the motor from the lines is reduced to $1/\sqrt{3}$ as compared to the current it would have drawn if connected in delta.

Comparison between Various Starters:

Direct Online Starting	Auto Transformer Starting	Star-delta Starting
Full voltage is applied to the motor at the time of starting requirement.	The starting voltage can be adjusted according to the starting.	Each winding gets 58% (1/√3) of the rated line voltage at the time of starting.
The starting current is 5-6 times the full-load current.	The starting current can be reduced as desired.	The starting current is reduced to 1/3 rd that of direct online starting.
Only three wires are to be brought out from the motor.	Only three wires are to be brought out from the motor.	Six wires are to be brought out from the motor.
Low cost.	High cost.	Low cost.
Very easy operation.	Not so easy to operate, a skilled operator is needed.	Not so easy to operate, since the connections are first to be made in star and then in delta either manually or automatically.
Used for motors up to 5 HP.	Used for large motor ratings.	Used up to 10 HP motors.

<u>Operation:</u>

The power circuit consists of a three-phase mains supply with a fuse unit, three contactors – line contactor, star contactor, and delta contactor. The line contactor gets its three-phase power supply from the fuse unit and the output terminals of the line contactor are connected to the overload relay.Overload relay output terminals are connected to the motor terminals – U1, V1, W1. Motor terminals U2, V2, W2 are connected through either star or delta contactors.

The star contactor and delta contactor are mutually interlocked in the control circuit to ensure only one contactor is on at a time. When the delta timer is on, the motor-winding terminals – U2, V2, W2 – get a three-phase supply and the motor is delta-connected. When the star contactor is on, the motor terminals – U1, V1, W1 – are shorted and the motor is star-connected. The control circuit as shown in Figure 2.7, for the motor, works on a 110 V AC single- phase supply. The phase of the control supply is connected to a NC contact of the overload relay (O/L). The wire from the O/L relay contact is connected to an auto/manual mode selector switch.

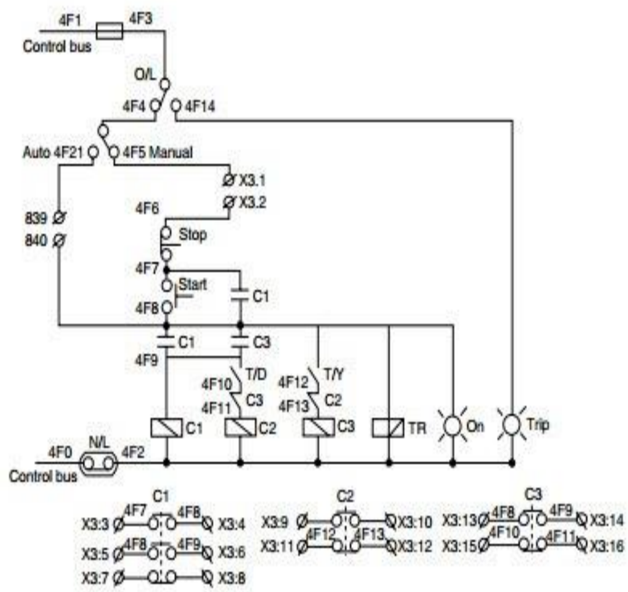


Figure 2.7
Typical electrical drawing of control circuit for a three-phase motor with star–delta starter

In an auto mode, the motor gets a start/run command through a potential-free contact of a relay, which in turn is energized with a PLC output.In the manual mode, the motor can be started with the help of a start pushbutton. When the start pushbutton is pressed momentarily, the control circuit is completed and the line contactor is energized. A potential-free NO contact of the line contactor is closed and keeps the control complete when the start pushbutton is released. When the motor is started, the star contactor is closed and the motor is started with a star connection.

As the motor runs for a few seconds, the delta timer picks up, which energizes the delta contactor and de-energizes the star contactor. The motor continues to run, connected in the delta configuration, until it is stopped with the stop pushbutton or trips due to an overload or an external interlock.As can be viewed in Figure 2.7, each contactor used contacts that are given at the end of the drawing. For example, NO contact used is shown with letters 4F7-4F8 and 4F8-4F9 specify their locations in the drawing. Similarly, contact details of contactor C2 and C3 are shown.

Note: The overload relay in this circuit is actually connected in series with the phase winding of the motor in the normal running mode (i.e., delta connection). The motor rated current is normally indicated in terms of the line current which is greater than the phase current by a factor of 3. Selection and setting of the overload relay must take this into consideration.

Advantages and Disadvantages of Star Delta Starter

The advantages are

- The method of starting reduces the inrush current to almost 2 to 3 times the FLC. while in case of direct online starting in the delta the inrush current is almost 6-8 times of FLC.
- This is a comparatively cheaper method of reduced voltage starting of the motor.
- These are also used in industry as the power-saving device. The change over from star to delta and vice versa is done as per the torque requirement of the motor. If a large motor is installed and the load requirement is one-third of the motor capacity than the motor can be run in star reducing the magnetizing current of the motor, thus saving power.

The disadvantages are

- Due to low starting torque sometimes, the motor may fail to pick up speed. The torque is about 33% of the full load torque.
- The transition from star to delta will give rise to a current transient which neither good for motor nor for the supply system.
- For conversion from star to delta, start and finish of each winding is to be brought out to the motor terminal otherwise only three terminals are sufficient.
- As the transition from star to delta takes place in the starter, two separate cables are required from the motor terminal to the starter.
- It requires higher maintenance compared to direct online starting.

Applications of Star Delta Starter

The applications are

- For very limited applications like small pumps of 7.5 hp small grinding mills, etc where the supply system does not allow heavy inrush of current due to poor regulation.
- It may be added that the industry is finding a new use of this starter as a power-saving device by choosing between star and delta as per the torque requirement.

Prodedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS ↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view.[Z ↵ A]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Use AutoCAD's drawing tools to create the outline of the slip ring induction motor. Refer to technical specifications or motor drawings for accurate dimensions and proportions. Typically, a slip ring induction motor has a cylindrical shape with mounting brackets.
7. Position the star-delta starter near the motor and draw its components. A star-delta starter generally consists of contactors, overload relays, timer, and connection terminals. Use AutoCAD's drawing tools to create these components with accurate proportions.
8. Draw lines or polylines to depict the electrical connections between the motor and the star-delta starter. Typically, there are six connection points from the motor to the starter for the three phases of the stator windings and the three phases of the rotor windings.
9. Add text labels and annotations to identify various components and provide necessary information. Use AutoCAD's dimensioning tools to add dimensions to your drawing.
10. Once you have completed the diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:

TRANSMISSION TOWER DIAGRAM

TRANSMISSION TOWER DIAGRAM

EXP NO: **DATE:**

AIM:

Draw the transmission tower diagram for the given dimensions

APPARATUS:

1. PC.
2. CAD Software

CIRCUIT DIAGRAM:

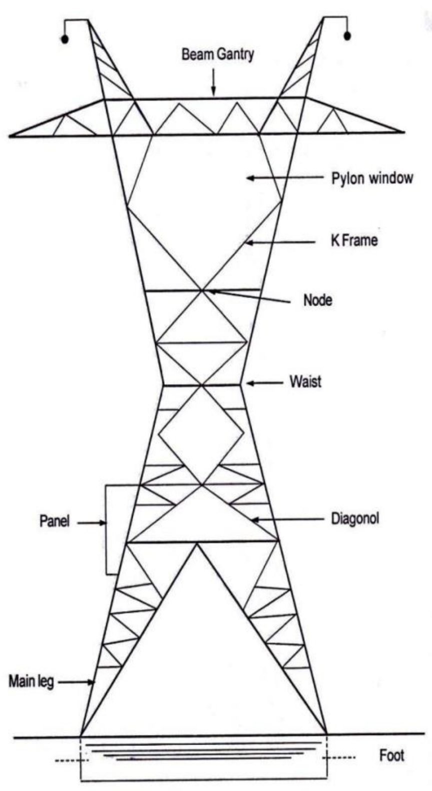
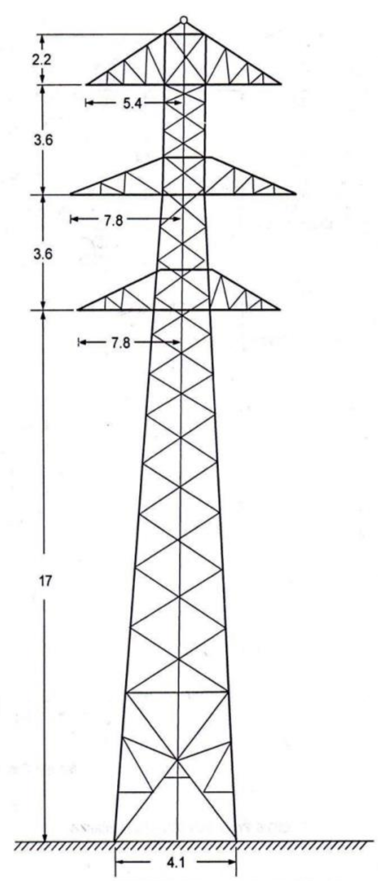


Fig. Pylon tower



66 KV Steel Tower for Double Circuit

Fig. A 66KV steel tower for double circuit with all the dimensions is given in figure.

THEORY:

The supporting structures for overhead line conductors are various types of poles and towers called *line supports*. In general, the line supports should have the following properties :

(*i*) High mechanical strength to withstand the weight of conductors and wind loads etc.

(*ii*) Light in weight without the loss of mechanical strength.

(*iii*) Cheap in cost and economical to maintain.

(*iv*) Longer life.

(*v*) Easy accessibility of conductors for maintenance.

The line supports used for transmission and distribution of electric power are of various types including *wooden poles, steel poles, R.C.C. poles* and *lattice steel towers*. The choice of supporting structure for a particular case depends upon the line span, X-sectional area, line voltage, cost and local conditions.

1. Wooden poles. These are made of seasoned wood (sal or chir) and are suitable for lines of moderate X-sectional area and of relatively shorter spans, say upto 50 metres. Such supports are cheap, easily available, provide insulating properties and, therefore, are widely used for distribution purposes in rural areas as an economical proposition. The wooden poles generally tend to rot below the ground level, causing foundation failure. In order to prevent this, the portion of the pole below the ground level is impregnated with preservative compounds like *creosote oil*. Double pole structures of the '*A*' or '*H*' type are often used to obtain a higher transverse strength than could be economically provided by means of single poles.

The main objections to wooden supports are : **(*i*)** tendency to rot below the ground level
(*ii*) comparatively smaller life (20-25 years) **(*iii*)** cannot be used for voltages higher than 20 kV
(*iv*) less mechanical strength and **(*v*)** require periodical inspection.

2. Steel poles. The steel poles are often used as a substitute for wooden poles. They possess greater mechanical strength, longer life and permit longer spans to be used. Such poles are generally used for distribution purposes in the cities. This type of supports need to be galvanised or painted in order to prolong its life. The steel poles are of three types *viz.,* **(*i*)** rail poles **(*ii*)** tubular poles and **(*iii*)** rolled steel joints.

3. RCC poles. The reinforced concrete poles have become very popular as line supports in recent years. They have greater mechanical strength, longer life and permit longer spans than steel poles. Moreover, they give good outlook, require little maintenance and have good insulating properties. R.C.C. poles for single and double circuit. The holes in the poles facilitate the climbing of poles and at the same time reduce the weight of line supports. The main difficulty with the use of these poles is the high cost of transport owing to their heavy weight. Therefore, such poles are often manufactured at the site in order to avoid heavy cost of transportation.

4. Steel towers. In practice, wooden, steel and reinforced concrete poles are used for distribution purposes at low voltages, say upto 11 kV. However, for long distance transmission at higher voltage, steel towers are invariably employed. Steel towers have greater mechanical strength, longer life, can withstand most severe climatic conditions and permit the use of longer spans. The risk of interrupted serivce due to broken or punctured insulation is considerably reduced owing to longer spans. Tower footings are usually grounded by driving rods into the earth. This minimises the lightning troubles as each tower acts as a lightning conductor. However, at a moderate additional cost, double circuit tower can be provided .The double circuit has the advantage that it ensures continuity of supply. It case there is breakdown of one circuit, the continuity of supply can be maintained by the other circuit.

Procedure:

1. Open AutoCAD from desktop
2. Set the drawing limits by clicking, FORMAT → DRAWING LIMITS [LIMITS↵] from menu bar and set the required values for both lower and upper limits.
3. Then click on VIEW MENU → ZOOM → ZOOM ALL to get enlarged view. [Z ↵ A ↵]
4. Set the units and precision from the format menu by clicking FORMAT → UNITS [UN ↵]
5. Set up the drawing space: Arrange the drawing space according to your preference. You can adjust the zoom level, pan the view, and use other tools to make the drawing area suitable for your needs.
6. Draw the outline of the tower's foundation or base. use basic drawing tools such as lines, rectangles, and circles to create the structure. consider the size and shape of the tower's foundation as per the design requirements.
7. Draw the tower structure: start drawing the tower structure using basic shapes and lines. typically, transmission towers have a lattice-like structure. use the line, polyline, and circle tools to create the tower's legs, crossbeams, and other supporting elements.
8. Use the Text tool to add labels, annotations, and other information to your drawing.
9. Save your drawing: Save your work frequently using the Save command or the Ctrl + S shortcut.
10. Once you have completed the diagram, save the AutoCAD drawing file to a location on your computer and you can print it or export it to a suitable file format, such as PDF or DWG.

RESULT:

Commonly used 2D tools in AutoCAD:

About – Brings the **About AutoCAD** bitmap on screen

Align (al) – Aligns objects between chosen points

Arc (a) – Creates an arc

Area – States in square units the area selected from a number of points

Array (ar) – Creates **Rectangular** or **Polar** arrays in 2D

Break (br) – Breaks an object into parts

Chamfer (cha) – Creates a chamfer between two entities

Circle (c) – Creates a circle

Copy (co) – Creates a single or multiple copies of selected entities

Del – Allows a file (or any file) to be deleted

Dim – Starts a session of dimensioning

Ellipse (el) Creates an ellipse

Erase (e) – Erases selected entities from a drawing

Extend (ex) – To extend an entity to another

Fillet (f) – Creates a fillet between two entities

Gradient – Brings the **Hatch and Gradient** dialog on screen

Hatch – Allows hatching by the *entry* responses to prompts

Hatchedit (he) – Allows editing of associative hatching

Help – Brings the **AutoCAD 2007 Help: User Documentation** dialog on screen

Join (j) – Joins lines which are in line with each other or arcs which are from the same centre point

Limits – Sets the drawing limits in coordinate units

Line (l) – Creates a line

Mirror (mi) – Creates an identical mirror image to selected entities

Offset (o) – Offsets selected entity by a stated distance

Options – Brings the **Options** dialog to screen

Osnap (os) – Brings the **Drafting Settings** dialog to screen

Ortho – Allows ortho to be set ON/OFF

Plot (Ctrl_P) – Brings the **Plot** dialog to screen **Point** (po)– Allows a point to be placed on screen **Polygon** (pol) – Creates a polygon

Polyline (pl) – Creates a polyline

Properties – Brings the **Properties** palette on screen

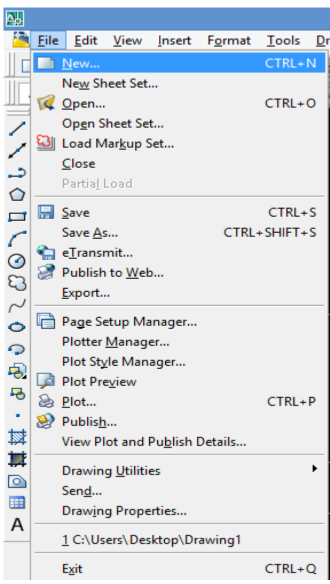
Style (st) – Brings the **Text Style** dialog on screen

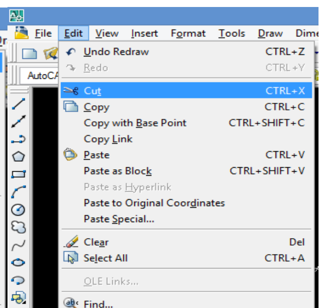
Trim (tr) – Allows entities to be trimmed up to other entities

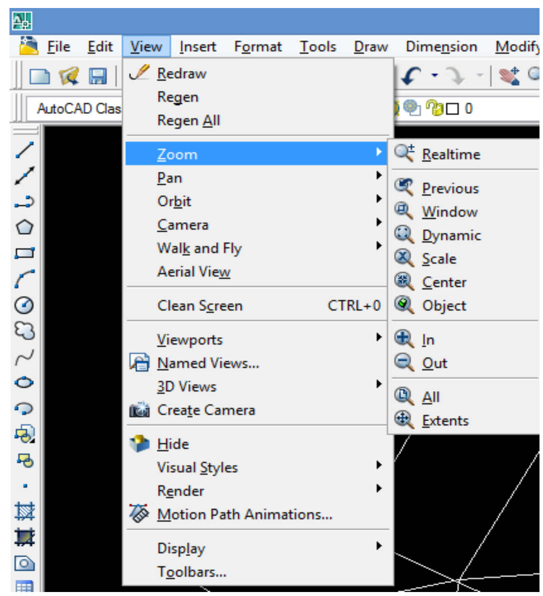
Type – Types the contents of a named file to screen

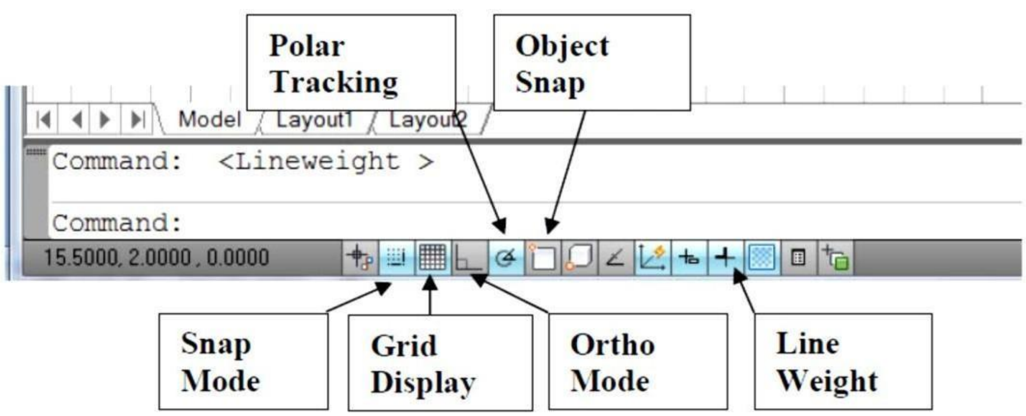
UCS – Allows selection of **UCS** (User Coordinate System) facilities

Zoom (z) – Brings the zoom tool into action.









(i) New,Open, Save, Close

From File menu we can draw a new drawing, open a selected drawing, save and close the drawings.

(ii) Cut , Copy, Paste

From edit menu, we can cut, copy and paste the selecting the drawings.

(iii) Zoom

From view menu, we can zoom the selected part of the drawings.

Command : z [space]

[All/Center/Dynamic/Extents/Previous/ Scale/Window/ Object]<real time>: eFits the diagram to screen

Function Keys

F1	Help	Explanations of Commands.
F2	Flipscreen	Toggles from Text Screen to Graphics Screen.
F3	Osnap	Toggles Osnap On and Off.
F4	Tablet	Toggles the Tablet On and Off.
F5	Isoplane	Changes the Isoplane from Top to Right to Left.
F6	Coordinate Display	Changes the display from ON / Off /.
F7	Grid	Toggles the Grid On or Off.
F8	Ortho	Toggles Ortho On or Off.
F9	Snap	Toggles Increment Snap on or off.
F10	Polar	Toggles Polar Tracking On or Off.
F11	Otrack	Toggles Object Snap Tracking On and Off

Special Key Functions

Escape Key	Cancels the current command, menu or Dialog Box.
Enter Key	Ends a command, or will repeat the previous command if the command lineis blank.
Space Bar	Same as the Enter Key, except when entering text.

Methods Of Entering Commands

AutoCAD has 3 different methods of entering commands. All 3 methods will accomplish the same end result. AutoCAD allows you to use the method you prefer. The following are descriptions of all 3 methods and an example of how each one would be used to start a command such as the Line command.

1. Pull down Menu 2. Tool Bars 3. Keyboard

SHORTCUT Menu

In addition to the methods listed above, AutoCAD has shortcut menus. Shortcut Menus give you quick access to command options. Shortcut Menus are only available when brackets [ ] enclose the options, on the command line. (Example below) To activate a Shortcut Menu, press the right mouse button.

Saving a Drawing

To save a drawing, click Save on the Standard toolbar. If you are saving a drawing for the first time, the Save Drawing As dialog box appears To save a file, type a file name in the File Name text box and click Save to save the file.

Closing a Drawing and Exiting from ProgeCAD

You can close your drawing and keep ProgeCAD open. The simplest way is to use the drawing Close button just under the application Close button. You can also choose File -> Close.

Opening an Existing Drawing

Choose Open from the Standard toolbar. The Select File dialog box appears, shown in Figure 2-3. In the Look in drop-down list box, choose the drive where your drawing resides. In the main box, double-click the folder you need. Then choose your drawing. The Preview box enables you to quickly look at the drawing to see if it’s the one you want. Click Open. ProgeCAD opens the drawing.

Responding to command options

Many commands have a number of options from which you need to choose. The format for command options is as follows:

current instruction or [options] <current value>:

- To choose an option on the command line, type the one or two letters that are capitalized in the option name—usually (but not always) the first letter(s) ofthe option. You can type the letter(s) in lowercase. Press Enter.
- To choose a default option or current value on the command line, which appears in angled brackets, as in <Real time>, simply press Enter or provide the point or value required.
- To choose an option without going to the command line, right-click in the drawing area and choose one of the options from the shortcut menu. This works best for options that won’t need any numerical input on the command line.

Repeating commands

The most common way to repeat a command you have just used is to press Enter at the Command: prompt. The most recent command appears again. You can also press the Spacebar at the Command: prompt to repeat a command you just used.

If you know in advance that you will be using a command several times, you can use another technique—type **multiple** At the Enter command name to repeat: prompt, type the command name on the command line. The command automatically reappears on the command line until you press the Esc key.

Canceling commands

Sometimes you start a command and then realize you don't need it. In this situati n, you can cancel the command and then choose a different command. Press Esc to cancel a command that you have already started.The Command: prompt reappears.

Undoing a command

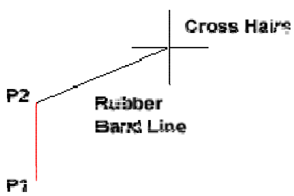
The Undo button on the Standard toolbar now lists the commands you have executed so that you can quickly seehow many commands you want to undo.

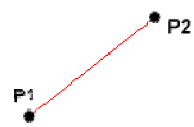
Getting help on a command

The easiest way to get help on a command is to start the command and press F1. The help screen for thatcommand opens up

DESCRIPTION OF COMMANDS

LINE:





With the Line command you can draw a simple line from one point to another. When you *pick* the first point and move the *cross-hairs* to the location of the second point you will see a *rubber band line* which shows you where the line will be drawn when the second point is picked. Line *objects* have two ends (the first point and the last point). You can continue picking points and PROGECAD will draw a straight line between each picked point and the previous point. Each line segment drawn is a separate *object* and can be moved or erased as required. To end this command, just hit the ↵ key on the keyboard.

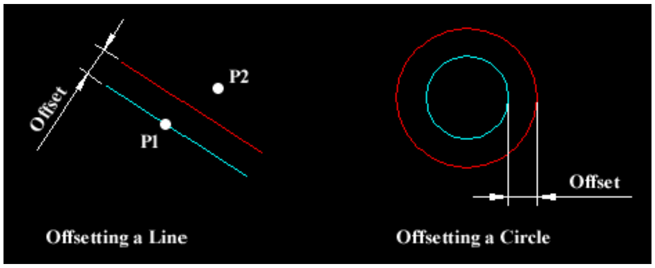
CONSTRUCTION LINE:

The Construction Line command creates a line of infinite length which passes through two picked points. Construction lines are very useful for creating construction frameworks or grids within which to design.

Construction lines are not normally used as objects in finished drawings, it is usual, therefore, to draw all your construction lines on a separate *layer* which will be turned off or frozen prior to printing

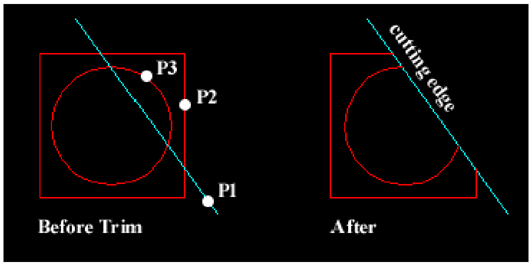
OFFSET:

Offset is probably one of the most useful commands for constructing drawings. The Offset command creates a new object parallel to or concentric with a selected object. The new object is drawn at a user defined distance (the offset) from the original and in a direction chosen by the user with a pick point. You can offset lines, arcs, circles, ellipses, 2D polylines, xlines, rays and planar splines.

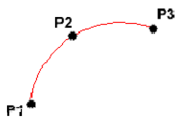


TRIM:

The Trim command can be used to trim a part of an object. In order to trim an object you must draw a second object which forms the "cutting edge". The illustration on the right shows the Trim command in action. The cutting edges are selected first (there can be one or more) and then the objects to be trimmed are selected. In the example above, the line is selected first because it forms the cutting edge and then the square and circle are selected.

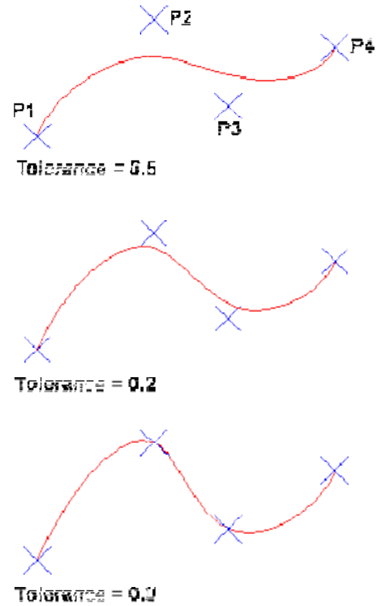


ARC:



The Arc command allows you to draw an arc of a circle. There are numerous ways to define an arc, the default method uses three pick points, a start point, a second point and an end point. Using this method, the drawn arc will start at the first pick point, pass through the second point and end at the third point. Once you have mastered the default method try some of the others. You may, for example need to draw an arc with a specific radius. All of the Arc command options are available from the pull-down menu.

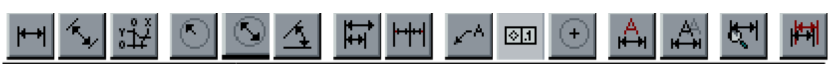
SPLINE:



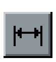
The Spline command creates a type of spline known as a nonuniform rational B-spline, NURBS for short. A spline is a smooth curve that is fitted along a number of control points. The Fit Tolerance option can be used to control how closely the spline conforms to the control points. A low tolerance value causes the spline to form close to the control points. A tolerance of 0 (zero) forces the spline to pass through the control points. The illustration on the right shows the effect of different tolerance values on a spline that is defined using the same four control points, P1, P2, P3 and P4.

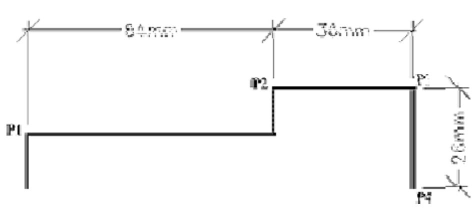
DIMENSIONING:

The correct use of ProgeCADs dimension tools is the key to producing clear and concise measured drawings. If you just need to quickly find a description of the various dimension commands, click on the appropriate button on the QuickFind toolbar below.



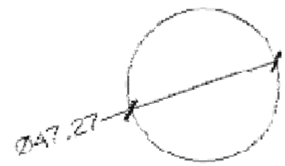
The Linear Dimension Command

Toolbar  Pull-down *Dimension* ▶*Linear* Keyboard *DIMLINEAR*



You can use this command to generate horizontal and verticaldimensions.

The Diameter Dimension Command



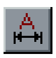
Toolbar 

Pull-down Dimension ▸Diameter

Keyboard DIMDIAMETER

You can use the Diameter command to annotate a circle or an arc with a diameter dimension.

The Dimension Edit Command

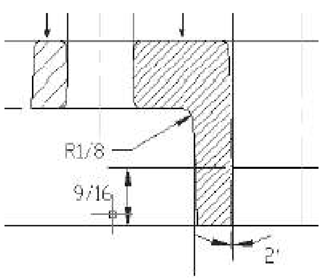
Toolbar 

Pull-down Dimension Oblique (other options are duplicated in DIMTEDIT so don't appear)

Keyboard DIMEDIT

The Dimension Edit command can be used to modify and change the text of any number of dimensions. The command could, for example, be used to add a standard prefix or suffix to a number of dimensions.

Creating Hatches



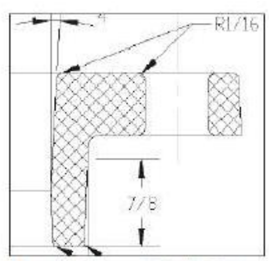


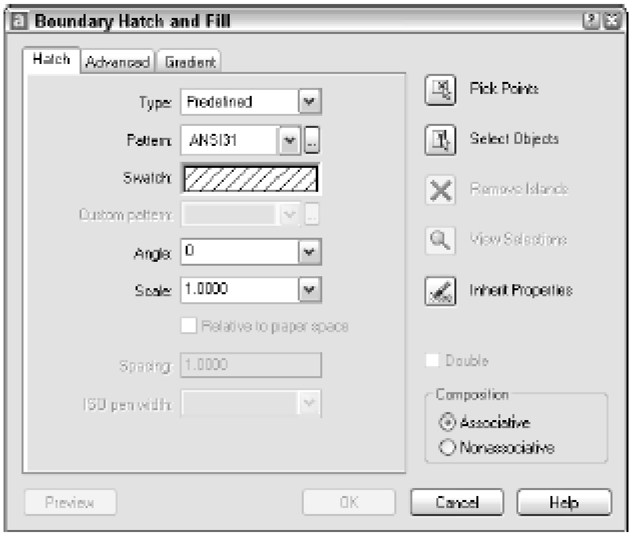
Figure 16-23: A user-defined hatch

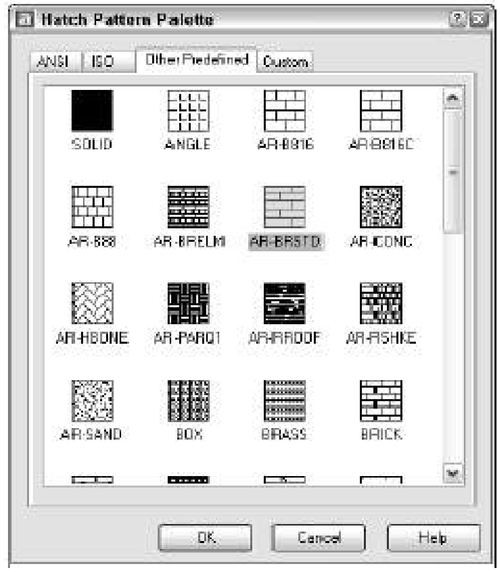
Hatches are patterns that fill in an area. Most types of drafting make use of hatching. To hatch an area, choose Hatch from the Draw toolbar. This starts the BHATCH command. ProgeCAD opens the Boundary Hatch and Fill dialog box From the Type drop-down box, choose one of the three options:

✦ **Predefined:** Enables you to select one of ProgeCAD's hatch patterns.

✦ **User-defined:** Enables you to define your own hatch pattern by specifying the angle and spacing,using the current line type.

✦ **Custom:** Enables you to choose a pattern you have created in your own .pat file.





Use the Angle text box to rotate the angle of the hatch pattern.

The Scale box determines the scale of the hatch pattern. You can choose from the drop-down list ortype a scale.

The Spacing box and the Double check box are available if you choose a user-defined hatch pattern. A user-defined hatch uses the current line type and creates a hatch based on the spacing and angle you specify.

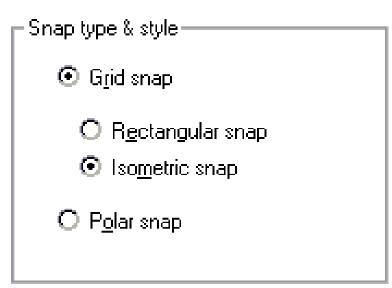
Determining the hatch boundary

The hardest part of hatching is placing the hatch, not defining it. Hatching an entire object is the simplest way to place a hatch. But often the area you want to hatch is fairly complex, and ProgeCAD needs to do some calculations to determine it. The Boundary Hatch and Fill dialog box offers two ways to specify the hatch boundary— you can pick points inside an area and let ProgeCAD try to find an enclosed boundary, or you can select objects. If you want to hatch an entire object:

1. Choose Select Objects. ProgeCAD returns you temporarily to your drawing.

2. Select all the objects you want to hatch. You can use all the standard object selection options to select objects. Remove and Add are especially helpful.

3. Press Enter to end object selection and return to the dialog box.



If the area you want to hatch does not neatly fit into one or moreobjects, choose Pick Points.

Isometric Drawing:

One can use any point entry method to construct an isometric drawing. Polar coordinates and dynamic input or dimensional input are common basic point entry options for isometric construction because they allow you to specify angles. Polar tracking set to 30° increment angles is also an effective method. One of the most useful aids for isometric drawing is the Isometric snap option of Snap and Grid modes. Use the Snap and Grid tab of the Drafting Settings dialog box to set Isometric snap. A quick way to access the Snap and Grid tab is to right-click on the Grid Display or Snap Mode button on the status bar and select Settings…. Pick the Isometric snap radiobutton in the Snap type area to activate Isometric snap.

Then specify the snap increment using the Snap Y spacing: text box of the Snap spacing area, and the grid spacing using the Grid Y spacing: text box of the Grid spacing area. You can only set the Y snap and grid spacing. The X spacing is not applicable because the X axis relates to horizontal measurements. For this same reason, you must also check 2D model space in the Grid style area to display the grid as a pattern of dots. Activate Grid and Snap modes and you are ready to begin drawing.

Specifying the Isometric Plane:

Isometric grid and snap modes orient the grid and snap to isometric angles. You can align the crosshairs with the left, right, or top *isoplane*, depending on the plane on which you plan to draw. See Figure 3B-Changing the isoplane is not required when drawing isometric lines, but doing so can be helpful for visualization and drawing ease. You must change the isoplane orientation to construct isometric circles and arcs using the Isocircle option of the ELLIPSE tool, described in Chapter 4. Press [F5] repeatedly to cycle through the isoplanes, or access the ISOPLANE tool and specify the Left, Top, or Right option, depending on the isoplane orientation appropriate for the isometric plane on which you plan to draw

To draw Isometric Dimensions:

To create isometric dimensions in AutoCAD, you need to first use DDIM to create a dimension style for ISO1 and ISO2 (or ISORight and ISOLeft, etc). Assign these two dimension styles the text styles you created earlier (ISO30 and ISO-30). See "Draw Isometric Text" above.

The two styles ISO1 and ISO2 will alternate around the box, and the text should be aligned 30 degrees to the right then 30 degrees to the left.