ATME COLLEGE OF ENGINEERING

13th KM Stone, Bannur Road, Mysore - 570 028

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

NOTES

Course: Computer Aided Electric Drawing

Course Code: 21EE741

Semester: VII

Prepared by

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Department of EEE,

ATME College of Engineering

INSTITUTIONAL VISION AND MISSION

VISION:

- Development of academically excellent, culturally vibrant, socially responsible and globally competent human resources.

MISSION:

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional and moral foundations and shine as torchbearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence.

Department Vision and Mission

Vision:

To produce Electrical & Electronics Engineers through greatest quality of technical education, technical skill training and intellectual capacity building of individuals.

Mission:

- To provide knowledge to students that builds a strong foundation in the basic principles of electrical engineering, problem solving abilities, analytical skills, soft skills and communication skills for their overall development.
- To offer outcome based technical education.
- To encourage faculty in training & development and to offer consultancy through research & industry interaction.

Program Educational Objectives (PEOs)

PEO1:

To produce Electrical and Electronics Engineers who will exhibit the technical and managerial skills with professional ethics for the societal progress.

PEO2:

To make students continuously acquire, enhance their technical and socio-economic skills and also to be globally competent.

PEO3:

To impart the experience of research and development to students so that they develop abilities in offering solutions to relevant diverse career path.

PEO4:

To produce quality engineers with a team leading capabilities, also show good coordination to contribute towards real time application of projects

Program Outcomes (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design / Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: 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.

PO5: 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.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: 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.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering 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.

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

Graduates will develop the abilities to:

PSO1: Apply the concepts of Electrical & Electronics Engineering to evaluate the performance of power systems and also to control industrial drives using power electronics.

PSO2: Demonstrate the concepts of process control for Industrial Automation, design models for environmental and social concerns and also exhibit continuous self- learning.

Department of Electrical and Electronics Engineering

Computer Aided Electrical Drawing

Module-1
Winding Diagrams:
(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
(b) Developed Winding Diagrams of A.C. Machines:
(c)Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings2. Single line diagrams of generating stations and substations.

Module-2:

Single Line Diagrams: Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main),Power Transformers, Circuit Breakers, Isolators,Earthing Switches,Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power-Line Carrier) and Line Trap

Module-3:

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers .

Module-4:

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
D.C. Machine - Sectional Views of Yoke with Poles, Armature and Commutator dealt separately.

Module-5:
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
Alternator – Sectional Views of Stator and Rotor dealt separately

Department of Electrical and Electronics Engineering

Module-4

DC MACHINES

Objective :To draw the sectional views of yoke, field system, armature and commutator dealt Separately

Problem 1 :
Draw the sectional end and front elevation of the pole for the given below dimensions.
Width of the pole = 14cm
Pole Arc = 20cm
Height of the pole with shoe = 19cm
Radius of the pole = 28cm
Thickness of yoke = 9.5cm.
Show clearly the method of fixing the pole core lamination and the pole core with the yoke.

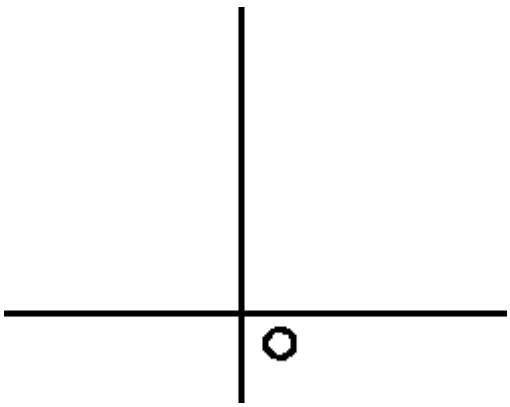
Solution:

Step1:

- Limits
- Lower corner 0,0
- Upper corner (3000,3000)
- Zoom
- All

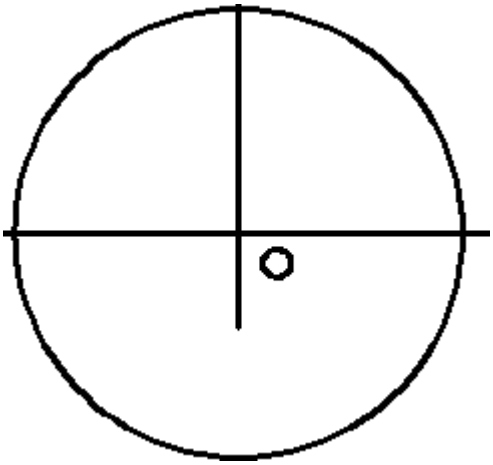
Step2:

Using “LINE” command draw horizontal & vertical line

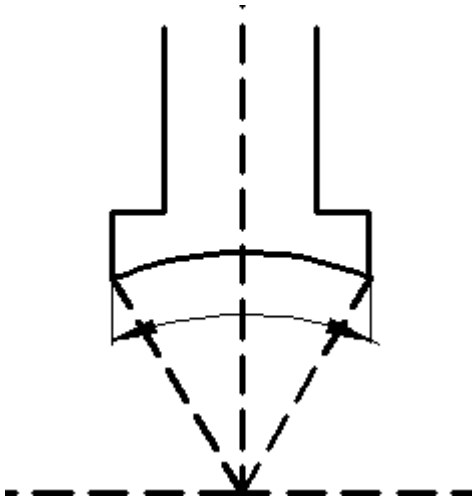


Step3:

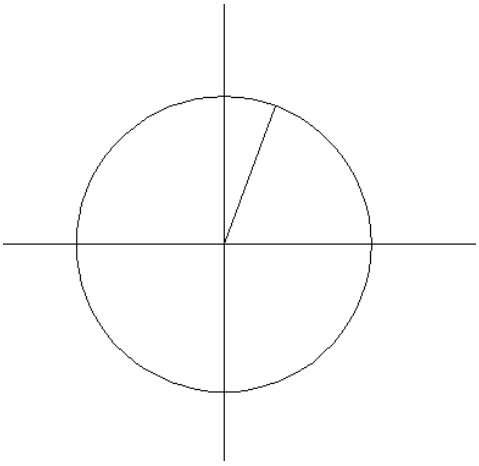
With “O” as centre draw a circle of radius 28cm



Step4:



Wkt: Pole arc =RΘ
Given: pole arc = 20
R=28
Θ in radians=180/π*pole arc/R
Θ=180/ π*20/28=41˚
Using line command draw a line of radius 28cm at 20.5˚
Since Autocad take angle always wrt x-axis but we need 20.5˚ wrt y-axis
Type 28cm @69.5˚

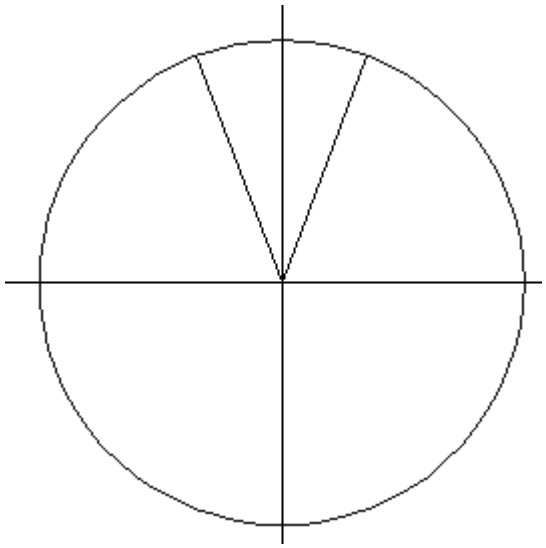


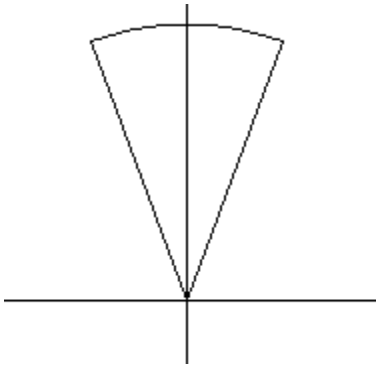
Step5:

Mirror it we get & Trim

Note:

- @280<69.5
- 280,69.5
- 280<69.5



After Trim 

Step 6:

Let

1. r=R=radius of pole =28cms

Given:
Height of the pole with shoe=19cms=Hp
Note: usually thickness of ploe shoe=3cms
Pole body =Hp-thickness of pole shoe

= 19-3=16cms

2. r1=r + thickness of pole shoe

r1=28+3=31cms

r2=r1+height or thickness of pole body

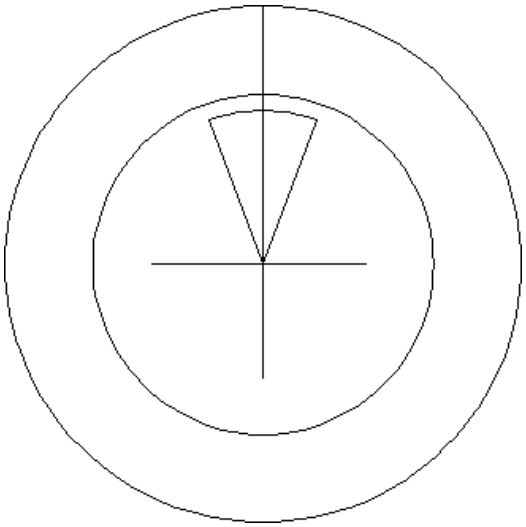
= 31+16=47cms

Draw two circles of radius

r1=31cms

r2=47cms with 'O' as center

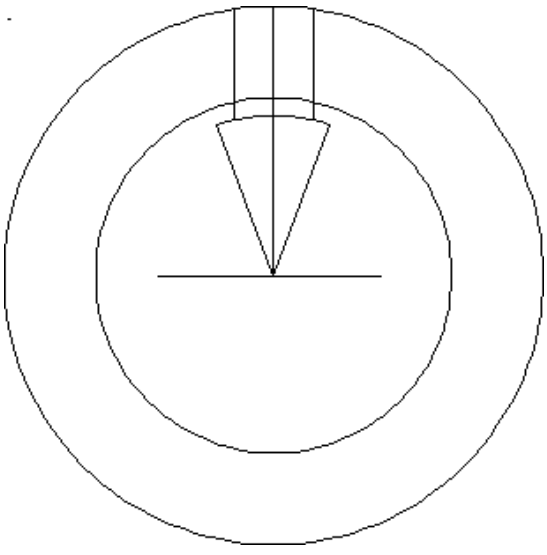
we get



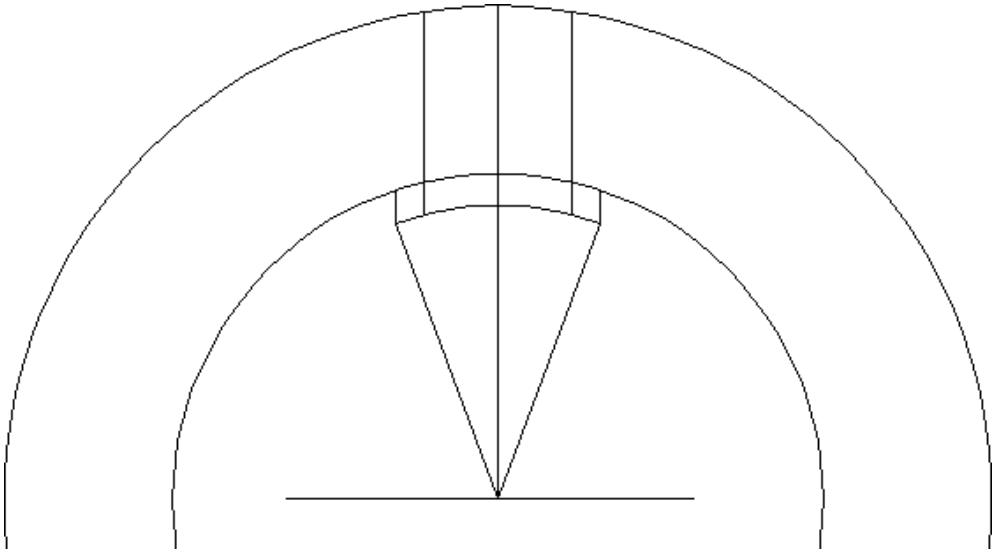
Step 7:

Given width of pole (Wp)=14cms

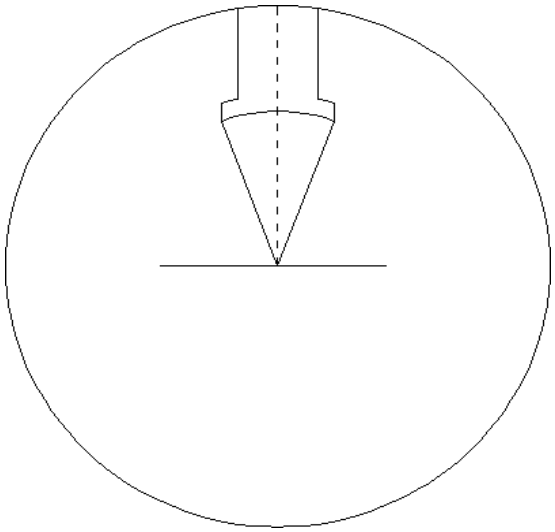
Offset vertically by 7cms we get



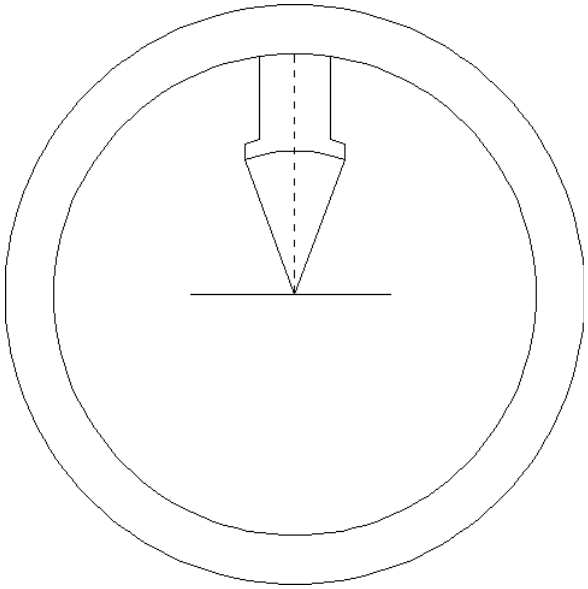
Note: Extend a line from point (a) &(b) to touch r1



Trim r1, we get

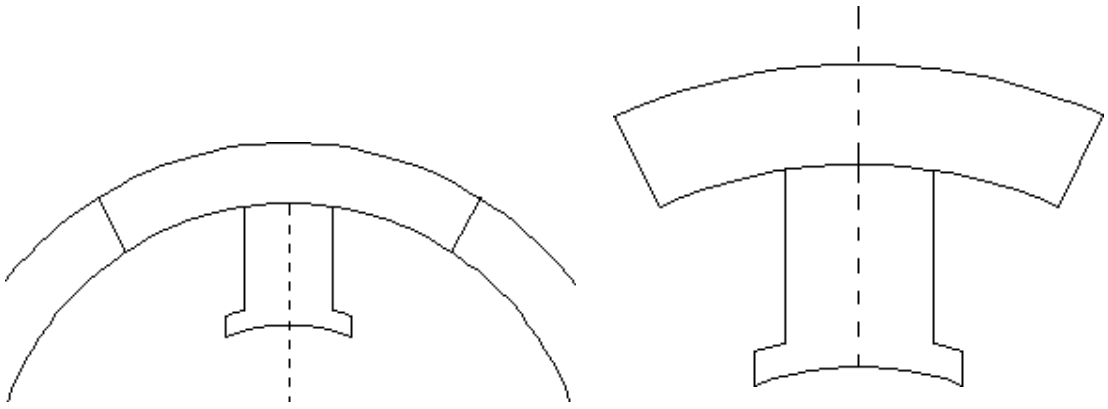


Step 8:
Given thickness of yoke =9.5cms
r3=r2+thickness of yoke
r3=47+9.5=56.5cms

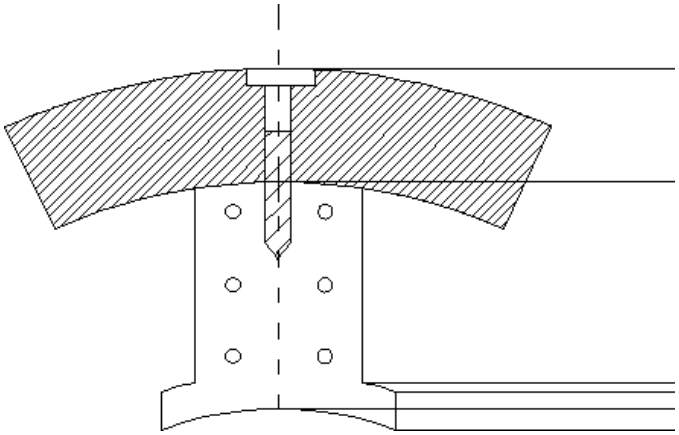


Step 9:

Draw inclined line and mirror it

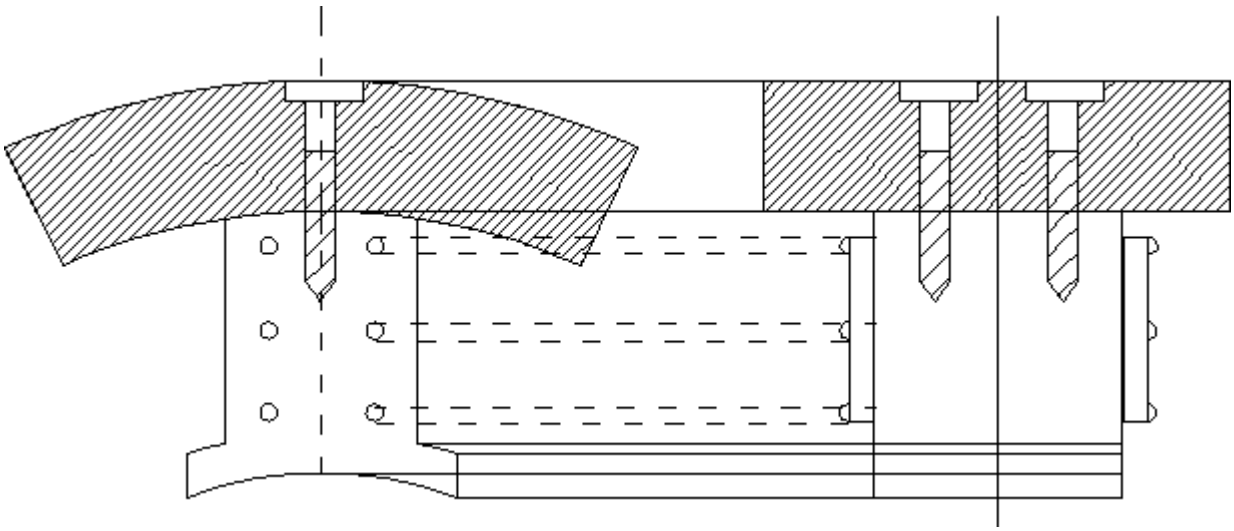


Step 10: Hatch , draw bolt and holes we get



Step 11: Length of pole body is not given so assume as 18cms

project the line as shown above, then we get



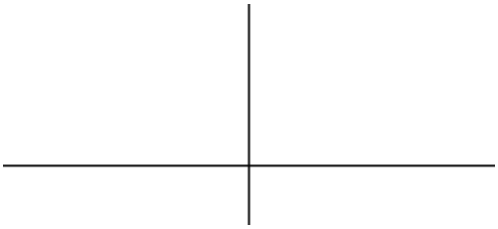
Problem 2:

Draw the sectional end sectional elevation of the pole core made of laminated sheet steel with a pole shoe. The pole core is fixed with the yoke by means of hexagonal headed set screws.
Width of the pole =19.6cm
Height of the pole = 27.54cm including the thickness of pole shoe
Length of the pole=35.6cm
Thickness of yoke=8cm
Air gap length =0.5cm
Radius of armature=38.25cm

Solution:
Step1:

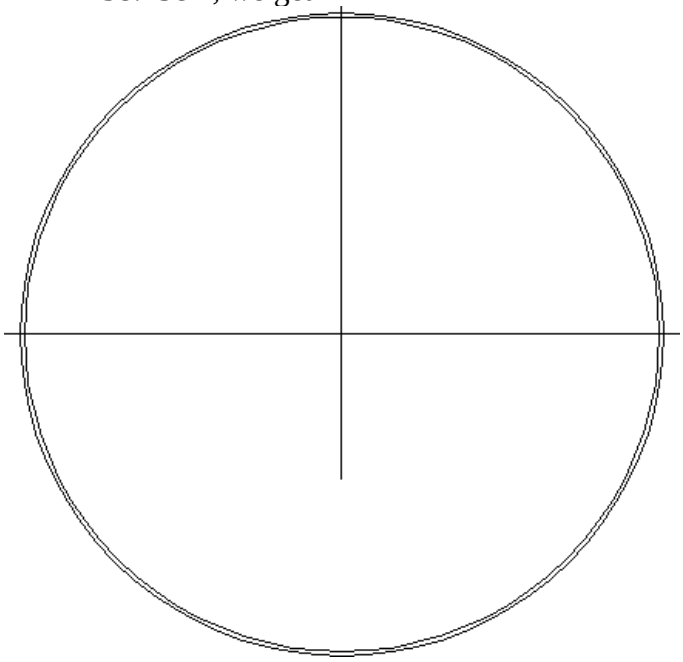
- Limits
- Lower left corner(0,0)
- Upper corner (3000,3000)
- Zoom
- All

Step2:
Using 'LINE' command draw horizontal & vertical line

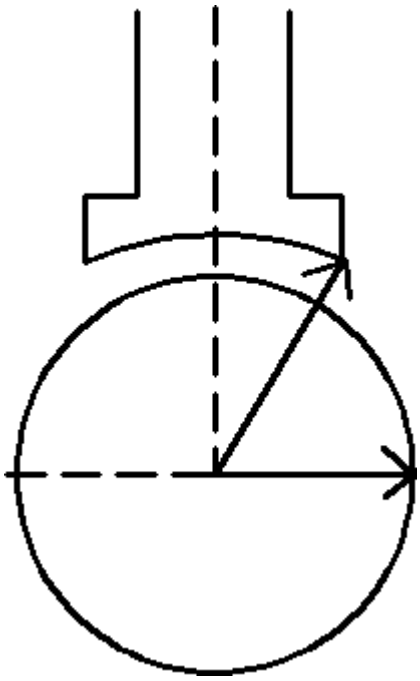


Step3:

1. With 'O' as centre draw circle of radius =38.25cm i,e radius of armature (r)
2. Given air gap =0.5
   Radius r1 = r + 0.5
   = 38.25 + 0.5 = 38.75cms
   Again draw one more circle with radius
   r1=38.75cm, we get



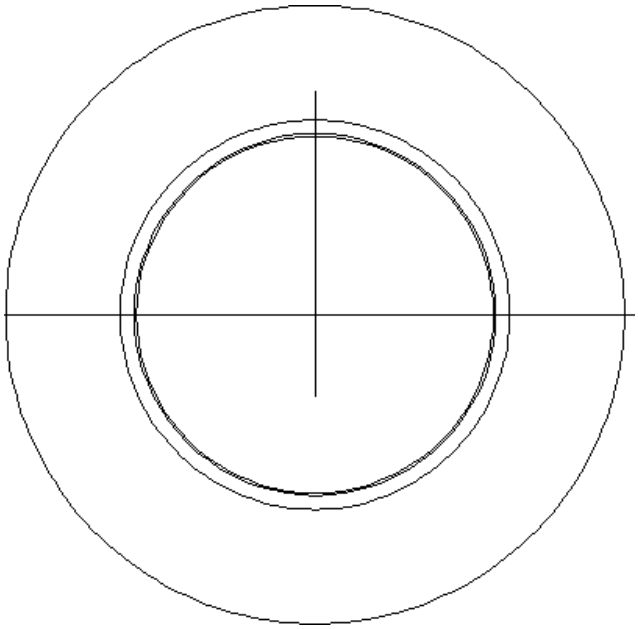
Step4:



Note: In the present problem pole arc is not specified. So follow below steps

Step5:

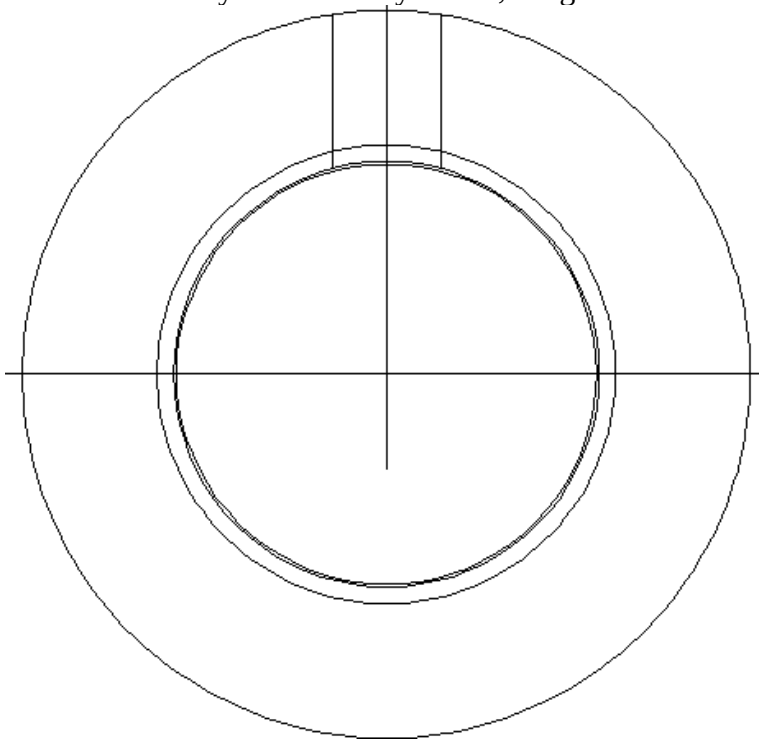
1. r1= radius of pole=38.75cms
2. height of pole with shoe = 27.54cm
   Assume pole shoe = 3cm
   Pole height =27.54 – 3 =24.54cm
   r2 = r1 + thickness of shoe
   =38.75 + 3 = 41.75cm
   r3 = r2 + height of pole body only
   = 41.75 + 24.54 = 66.29cm
   Draw 2 circles of radius
   r2 = 41.75cm
   r3 = 66.29cm



Step 6:

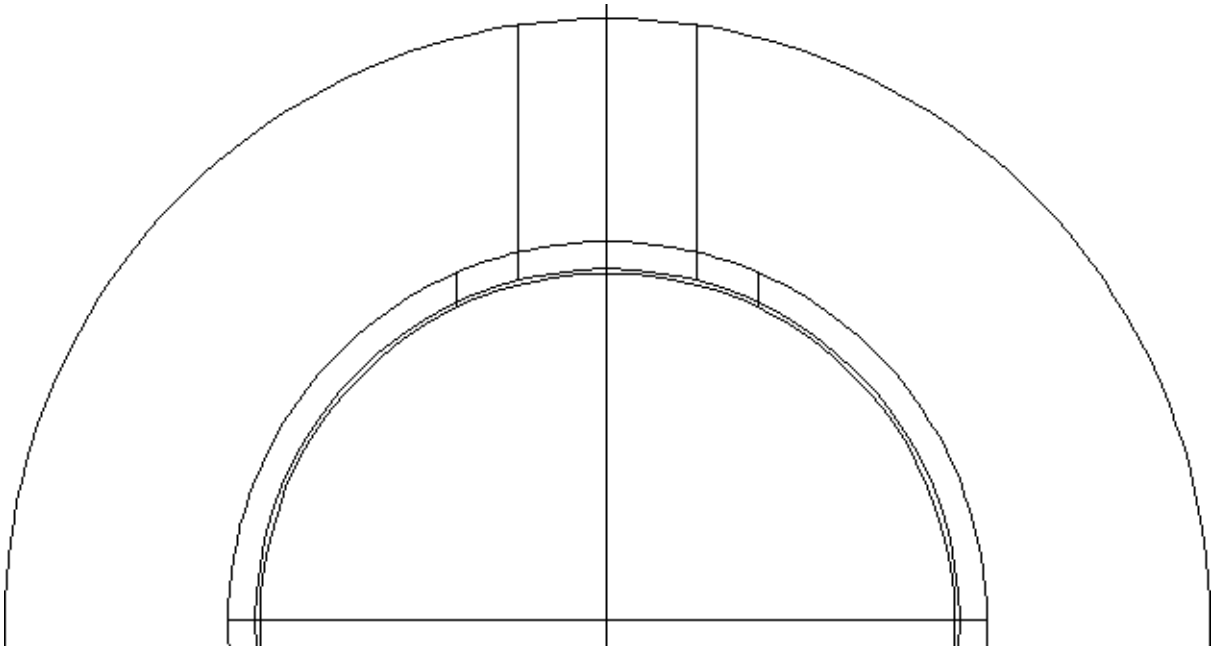
Given width of pole (wp) = 19.6cm

Offset vertically both sides by 9.8cm, we get



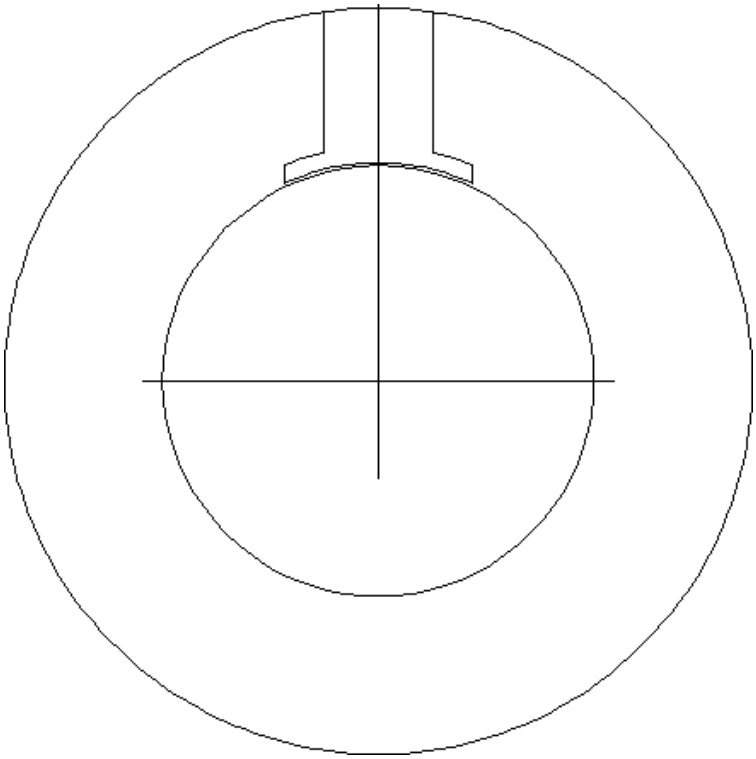
Step 7:

Draw a arbitrary line parallel to “ab” and mirror we get



Step 8:

After trim, we get

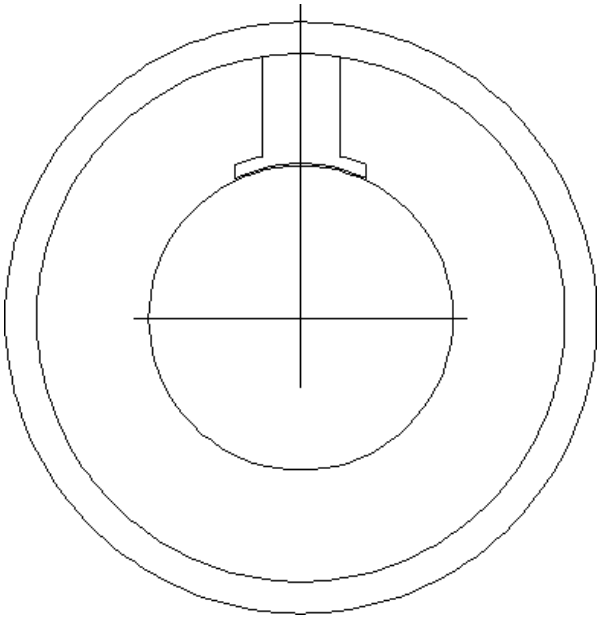


Step 9:

Given thickness of yoke = 8cm

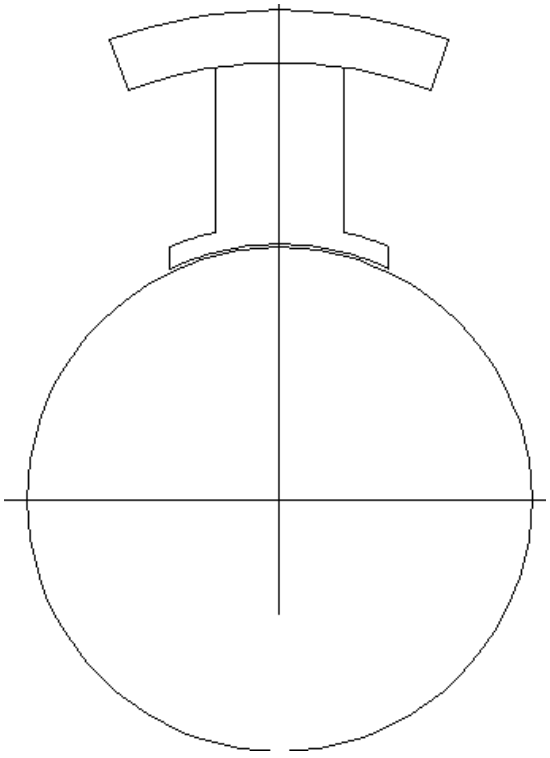
r4 = r3 + thickness of yoke

= 66.29 + 8 = 74.29 cm



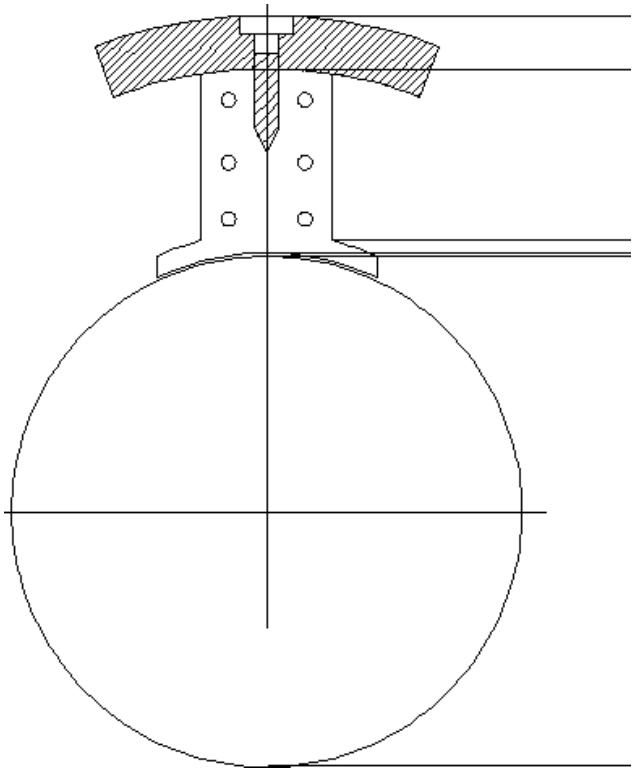
Step 10:

Draw a inclined line and mirror it

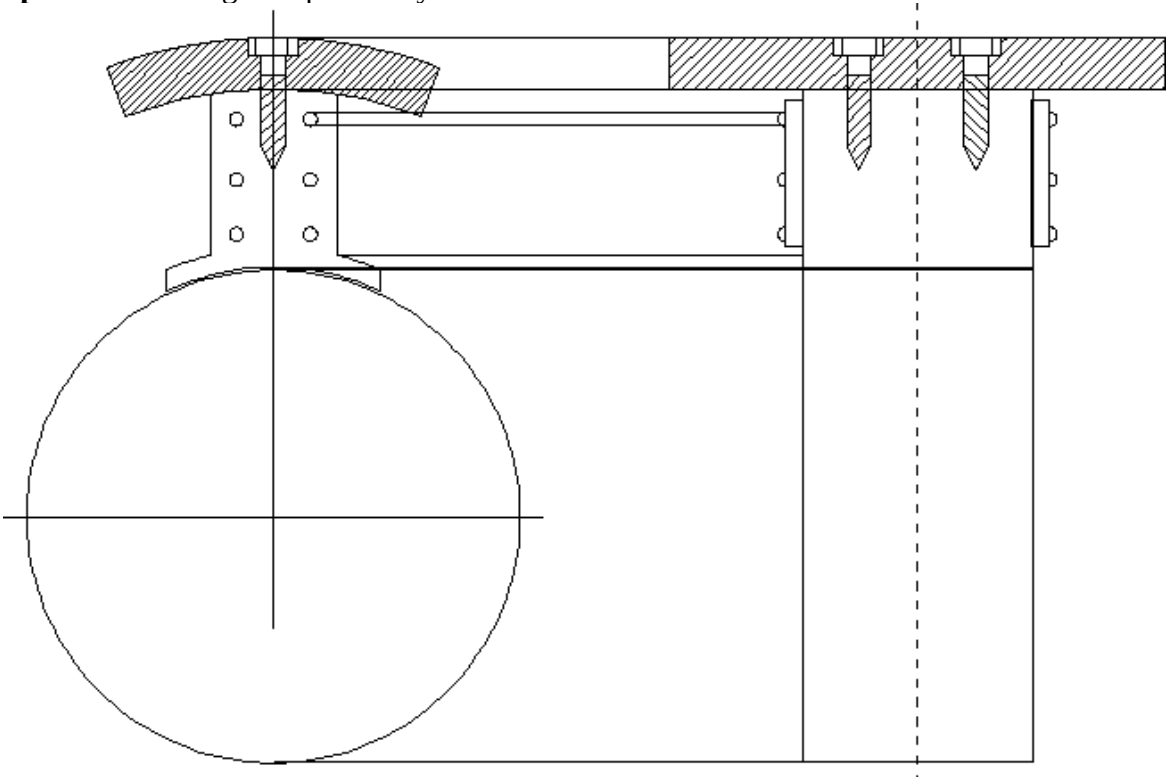


Step 11:

Hatch , draw bolts and holes we get



Step 12: Given length of pole body = 35.6cm



Problem 3:

Draw the two views of the commutator assembly.

1. **The front elevation to be half in section.**
2. **The end elevation half in section for the given dimension, use any suitable scale.**
   Given: Diameter of commutator = 13cm
   Length of the commutator = 11.8cm
   Diameter of shaft = 4cm
   Segment pitch with mica = 0.6cm
   Mica thickness = 0.1cm

Solution:

1. Assume copper riser = 1cm(standard value)

Formula:

L = 0.4r, where r = radius of the commutator

N = ½*L

M = ¼*k or ¼*length of commutator

Calculation:

Copper riser:

Given : dia of commutator D = 13cm, then r = D/2 = 13/2 = 6.5cm

Then L = 0.4*6.5 = 2.6cm

N = ½*L = ½*2.6 = 1.3cm

M = ¼*length of commutator = ¼*11.8cm = 2.95cm.

4. Segment pitch with mica =06cm [l]
Commutator segment length (or) segment pitch with mica[l] = RΘ
Θ=l/R=0.6/6.5*180/ π = 5˚

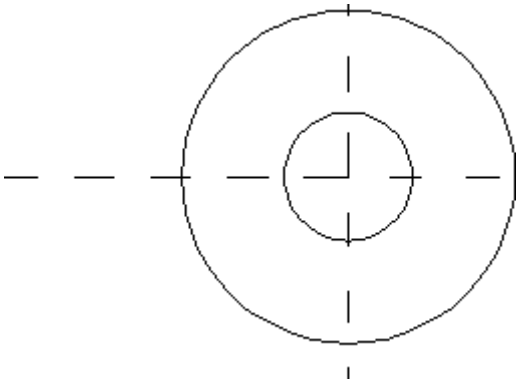
Step1:

- Limits
- Lower left corner 0,0
- Upper right corner (1000,1000)
- Zoom
- All

Step 2:

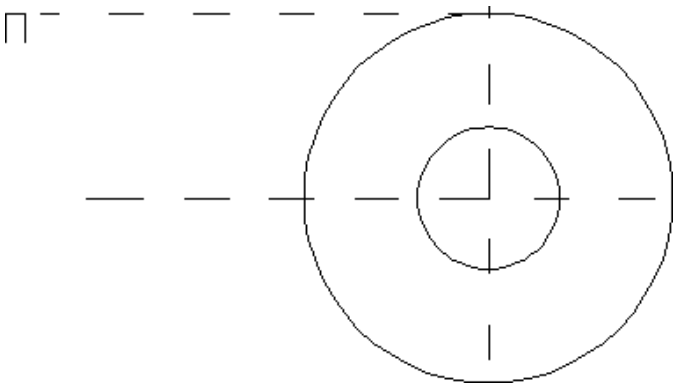
Draw commutator dia (D=130mm, hence radius r = 65mm)

Draw shaft dia (dia =50mm, r =25mm)



Step 3:

- Draw copper riser

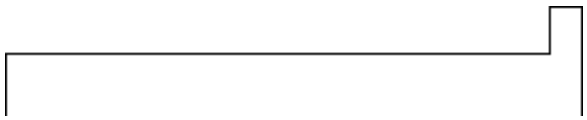


- Project the circumference of commutator
- Draw copper riser :
  - @10mm< - 90(i,e at point a)
  - 7mm<180(i,e at point a)
  - Offset 7mm to left

Step 4:

Draw length of commutator

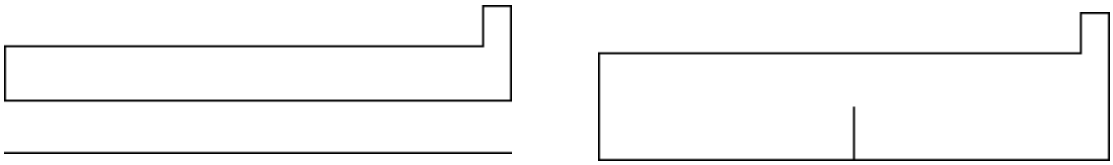
- At point **'c'**, draw a line i,e k=11.8cm or 118mm …..@118<180
- At point **'e'**, draw a perpendicular line of distance 'N'= 13mm or 1.3cm…..@130<-90
- Repeat the same at point 'd'.



Step 5:

- Join **'fg'** by a line

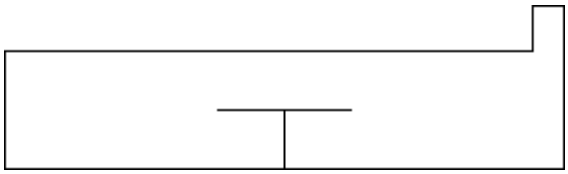
- Offset **'fg'** by 13mm, we get L=26mm 0r L=2N
- With Osnap ON get a midpoint 'o' & delete **'fg'** we get



Calculated M = 2.95cm =3cm or 30mm

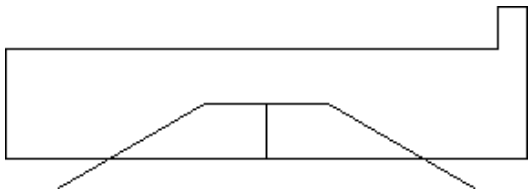
With 'o' as center a line i,e

- @15mm<0 with **'o'** as centre
- @15<180 again with **'o'** as center

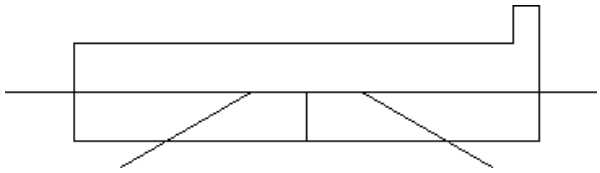


Step6:

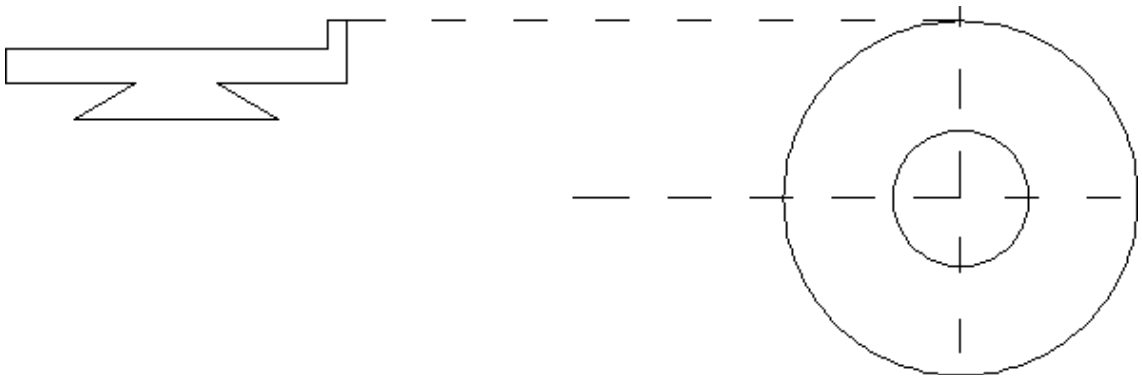
At 'H' draw line @40<210 , where 40 is arbitrary value, At I draw a line i,e @40<-30



Extend a line from H & I

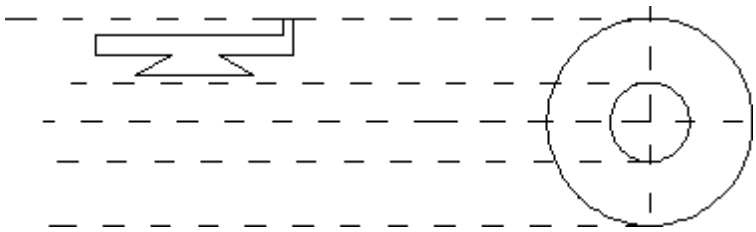


After trim and delete we get



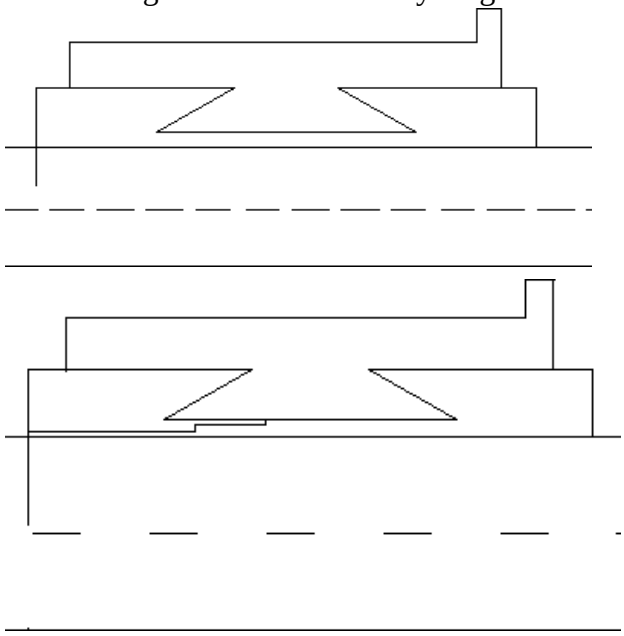
Step7:

Project shaft dia to LHS



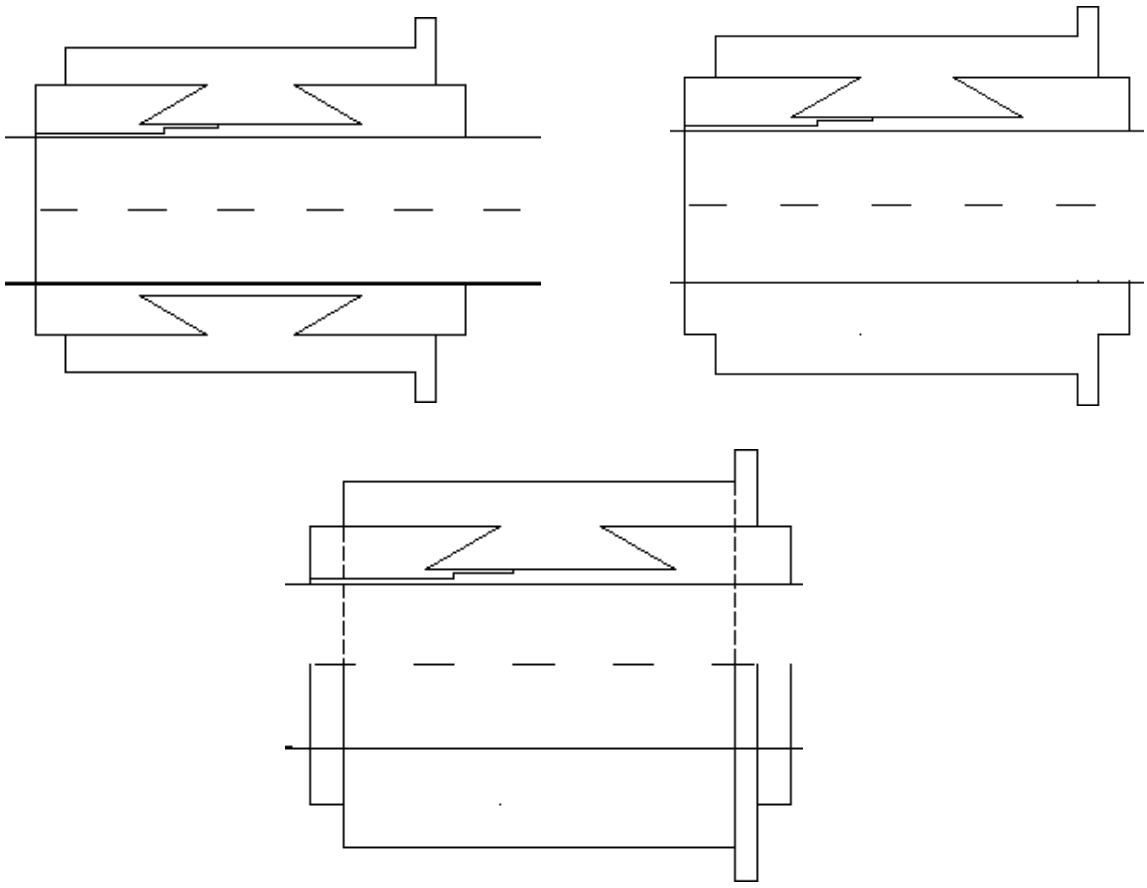
Step 8:

Draw v-ring on either of arbitrary length

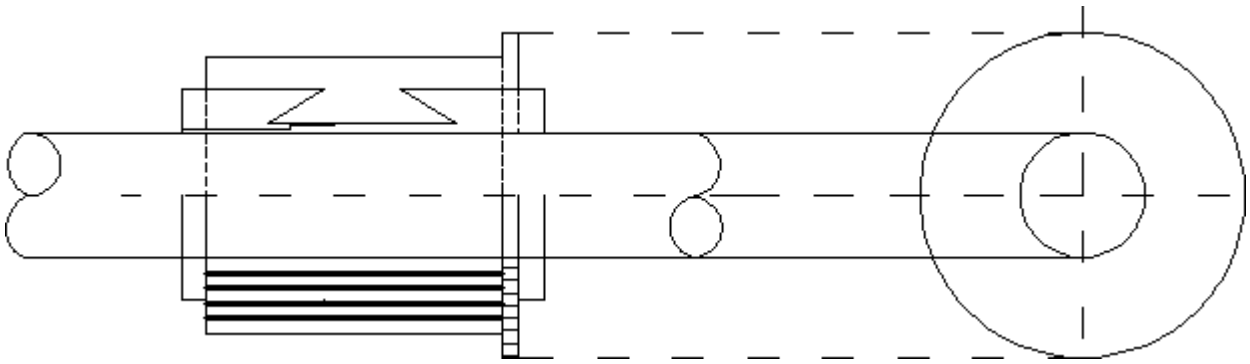


Step 9:

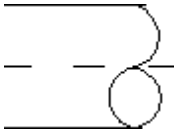
Mirror we get



Offset the line by 6mm(mica segment) and hatch

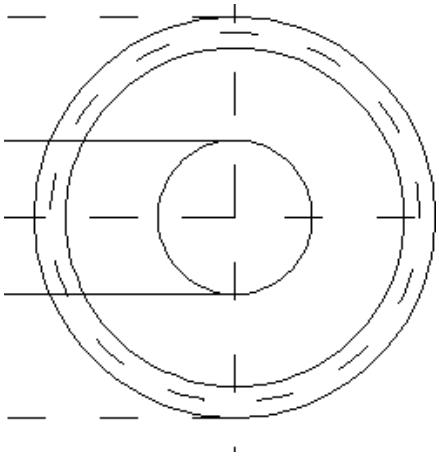


Use 3 point arc and mirror



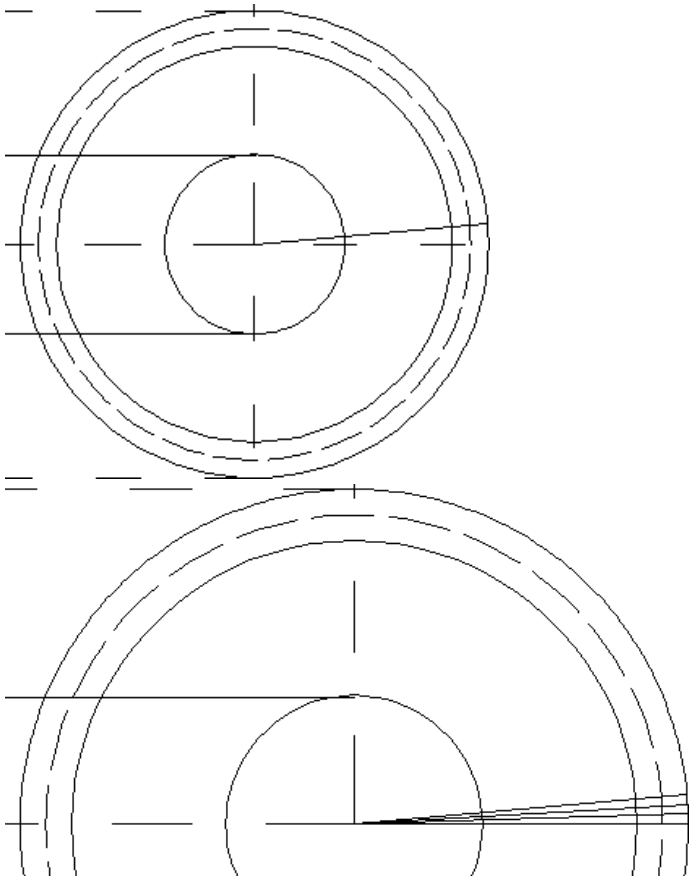
Step 10:

- Offset the circle by height of copper riser, 10mm
- Again 50% height of copper riser i,e 5mm



Step 11:

Draw inclined line @6 5<5, then we get



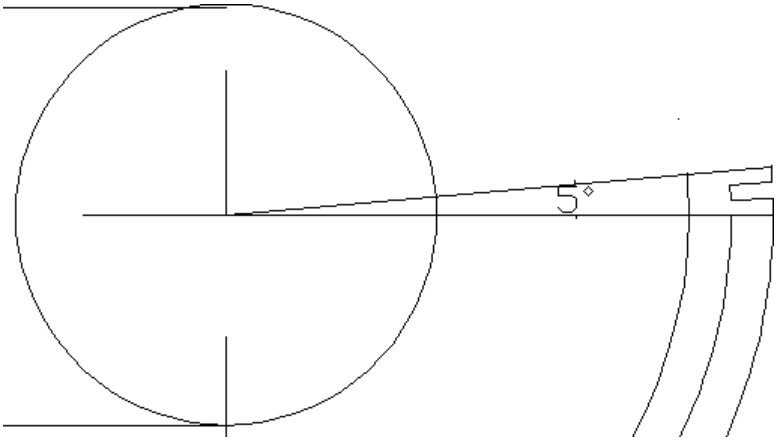
Again draw 2 inclined line within 5˚ shown

i,e 5/3=1.667

- @65<1.667
- @65<3.334 ; where angle 3.334 is 1.667*2=3.334

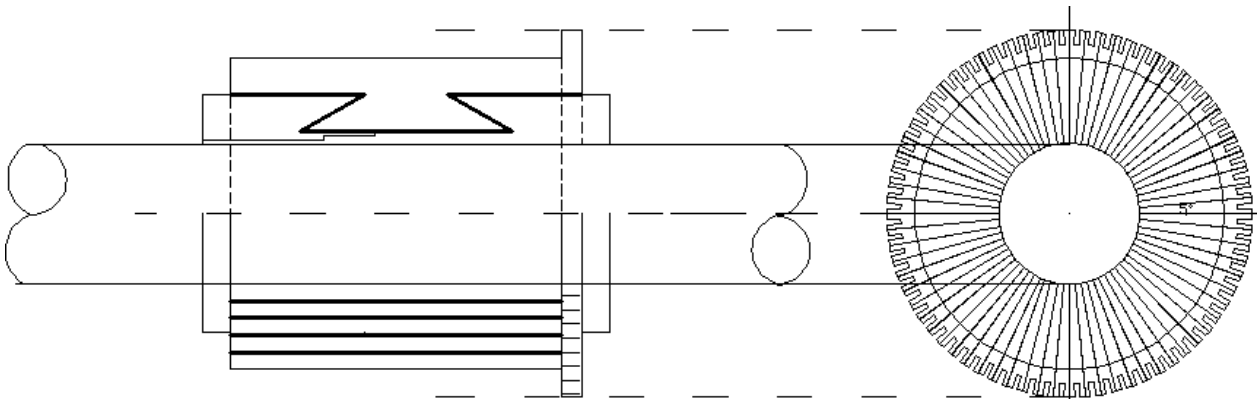
Step 12:

Trim we get



Array :

1. Polar
2. Center point (select)
3. Total no. of item: 72
4. Angle to fill : 360
5. Select object
6. OK



Problem 4:

Draw to quarter scale a half – sectional end elevation looking from the shaft end of a 100kW D.C. Generator with the main dimensions as given below
No. of poles = 4

External Diameter of arm stamping = 41.5cm
Inside diameter of armature stamping = 21cm
No of slots = 39
Size of slot = 3.5cm*1.2cm
Main poles:
Height = 16cm
Width = 12cm
Pole arc/pole pitch = 62%
Inter poles = 4.4cm*15cm
Air gap at main pole = 0.5cm
Thickness of yoke = 60cm
Shaft diameter at coupling end = 8cm
The machine has end shield bearing. The armature stampings are mounted on a cast iron spider keyed to the shaft and clamped between the plates.

Solution:

1. **Shaft:** Diameter of shaft = 8cm

2. Armature or Rotor:

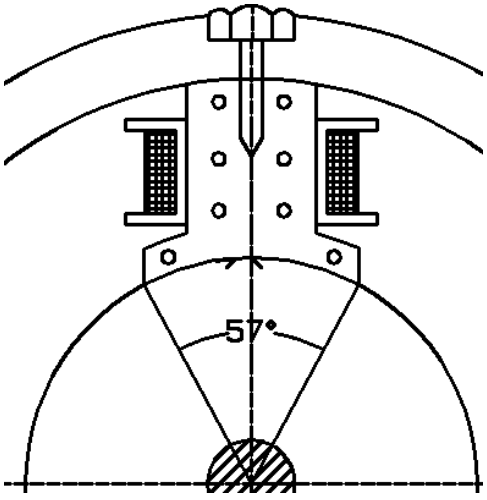
1. Inside diameter of Armature stamping = 21cm
2. Outside diameter of Armature stamping = 41.5cm
3. No of slots = 39
4. Size of slot = 3.5cm*1.2cm

3. Main poles:

Given: - pole arc/pole pitch = 62%

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

Then pole arc =0.62*pole pitch= 0.62*90 = 56.7^{o} = 57 ^{o}



4. Stator:

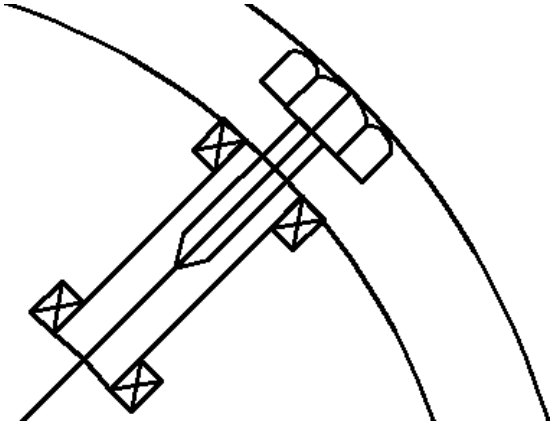
Outer diameter of stator stamping = outer diameter of Armature stamping + 2*air gap + 2*height of the main pole.

= 41.5cm + 2*0.5cm + 2*16cm = 74.5cm=75cm

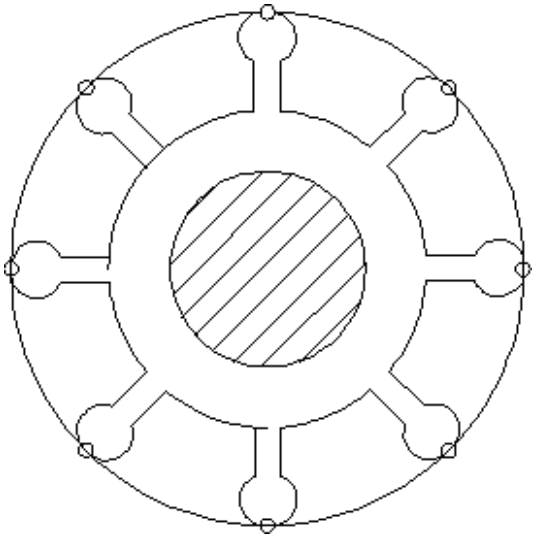
5.Overall diameter of the machine = Outer diameter of stator + 2*thickness of the yoke stamping

= 75.5cm + 2*6 = 86.5cm

5. **Interpole**:



Spider:



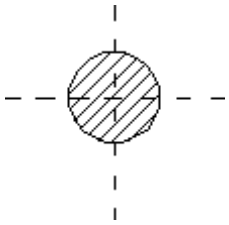
Step1:

- Limits
- Lower left corner 0,0
- Upper right corner (1000,1000)

- Zoom
- All

Step2: (shaft detail)

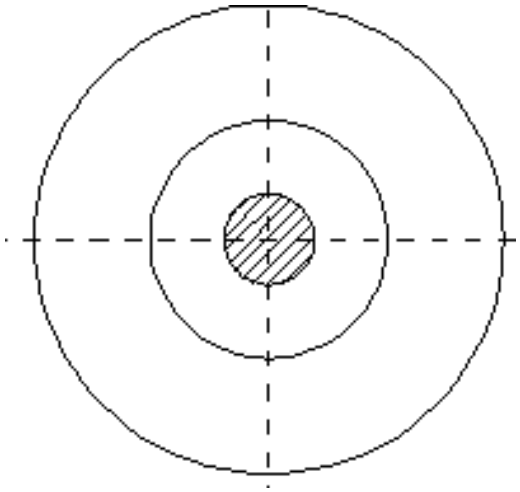
Draw a circle of dia 80mm, hatch the shaft



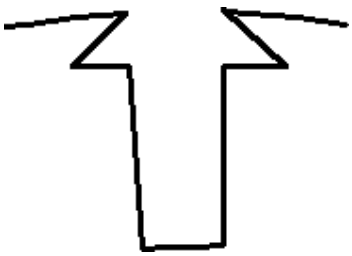
Step3:

Armature details:

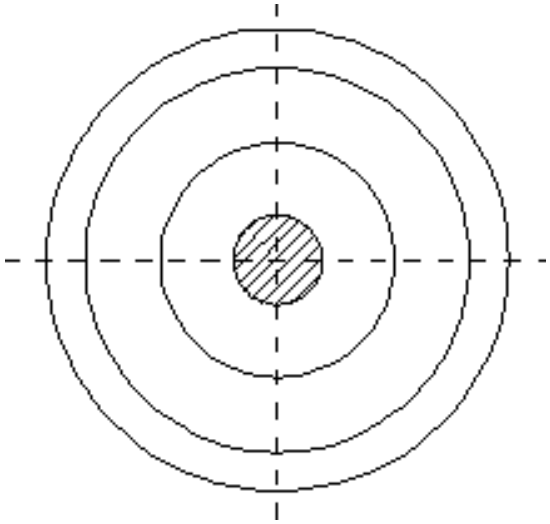
a) Draw armature of dia : Inner dia = 210mm & outer dia = 415mm



b) To draw armature slot



Offset , outer dia of armature by 35mm



Wkt: Pole arc =R Θ; where R=outer dia of arm – 3.5cm

= 41.5cm/2 – 3.5cm

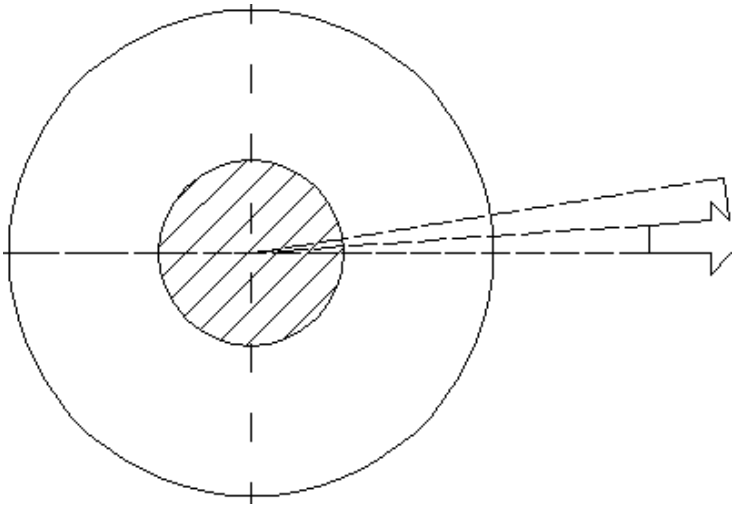
=17.25cm

Hence Θ= pole arc/R * 180/π

= 1.2cm/17.25cm * 180/ π = 4º

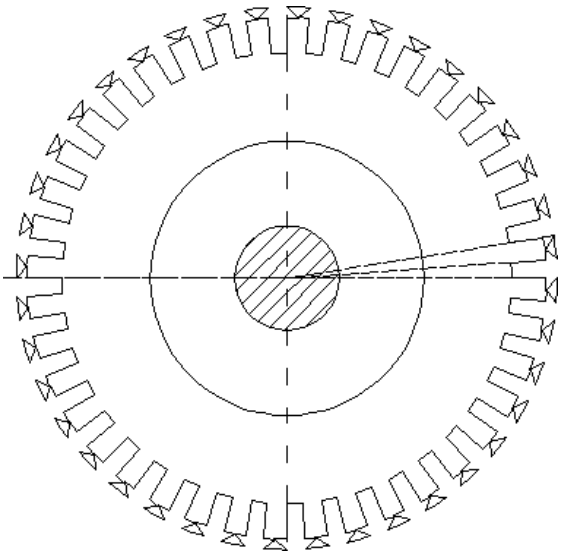
Given no. of slots = 39, Take 40 so that slot angle is a whole no.

Slot angle = 360/no.of slots = 360/40 =9 º

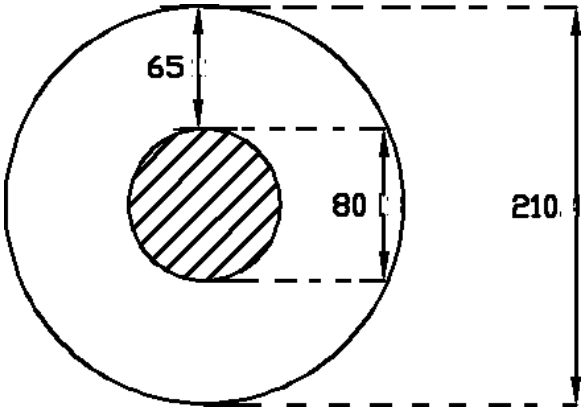


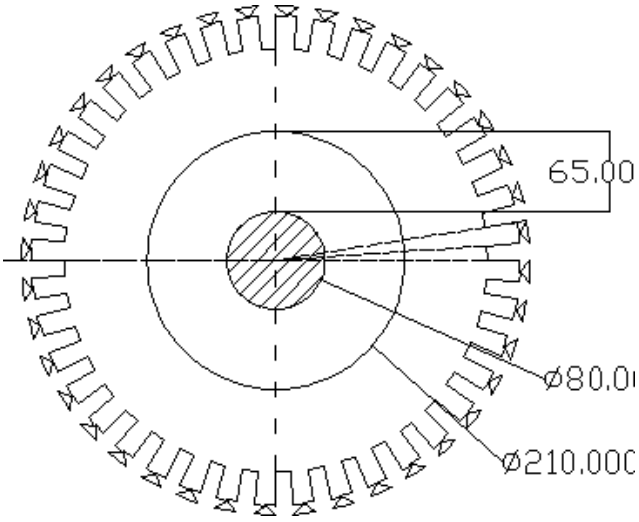
- Draw a inclined line
  - @415/2<4
  - @415/2<9
- Polar array, we get:
  - Select polar array
  - Select the object

- Total no. of item = 40
- Angle to fill = 360
- OK



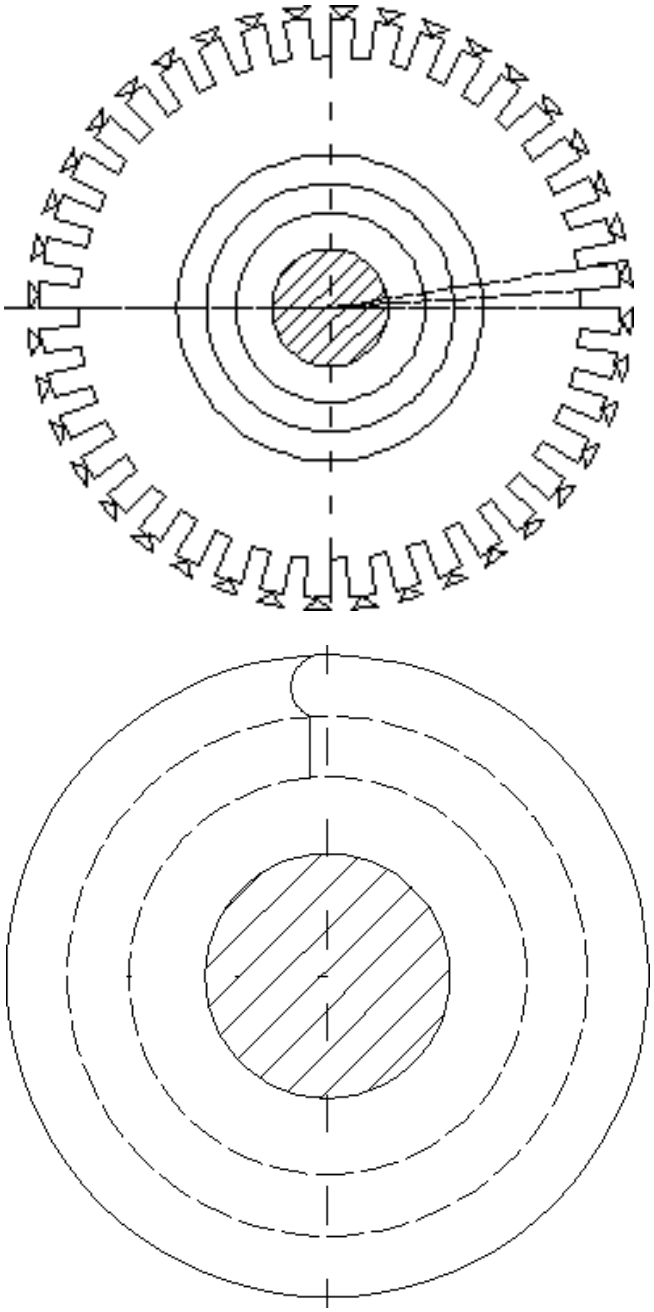
Step4 (spider):

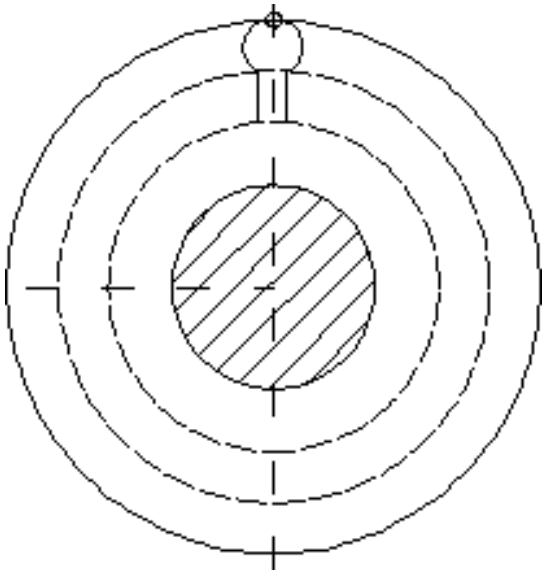


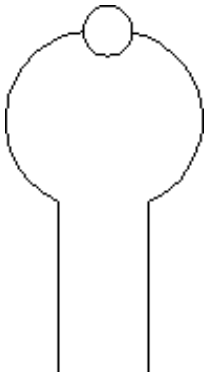


Divide gap 65mm into 3 parts

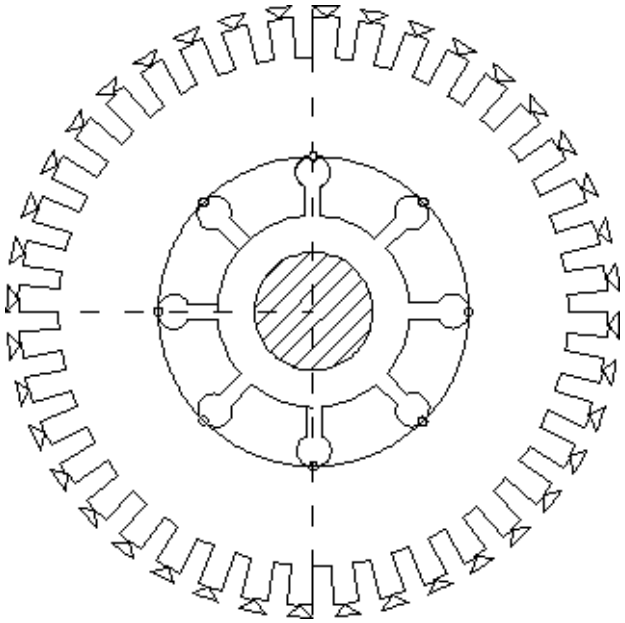
- Offset inner dia of arm by 20mm & again by 40mm, we get







After mirror

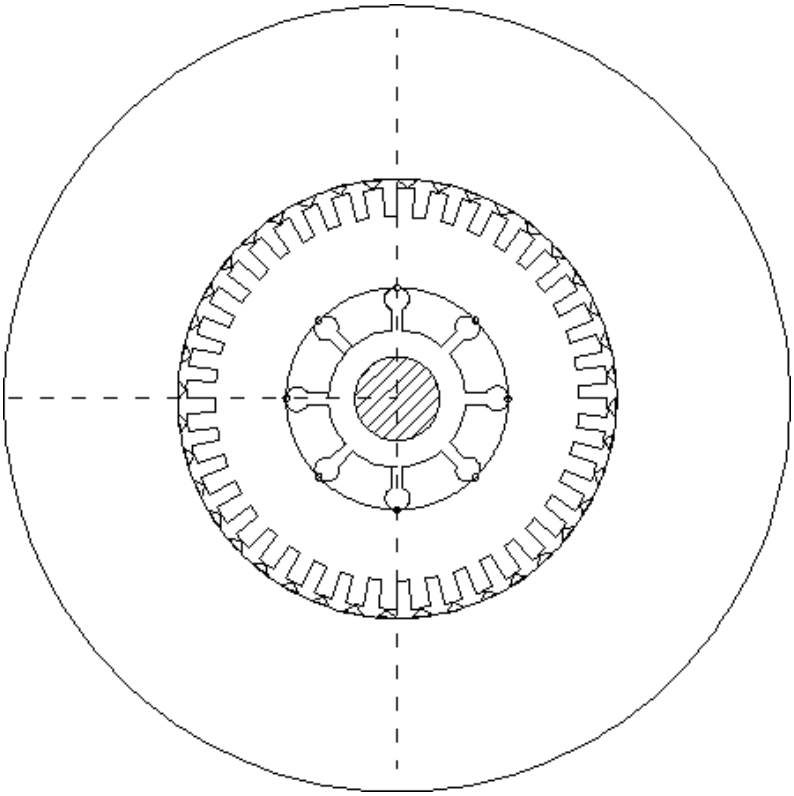


After array we get the above fig:

- Polar array
- Select the object
- Total no. of item = 08
- Angle to fill = 360
- Ok, we get

Step 5:

Draw outer dia of stator = 745mm
Inner dia of stator
= outer dia of arm + 2 * thickness of airgap
= 41.5 + 2 * (0.5mm assumed)
= 42.5



Draw a line:

- @425/2<61.5
- @212.5<118.5

Step 6: Main pole

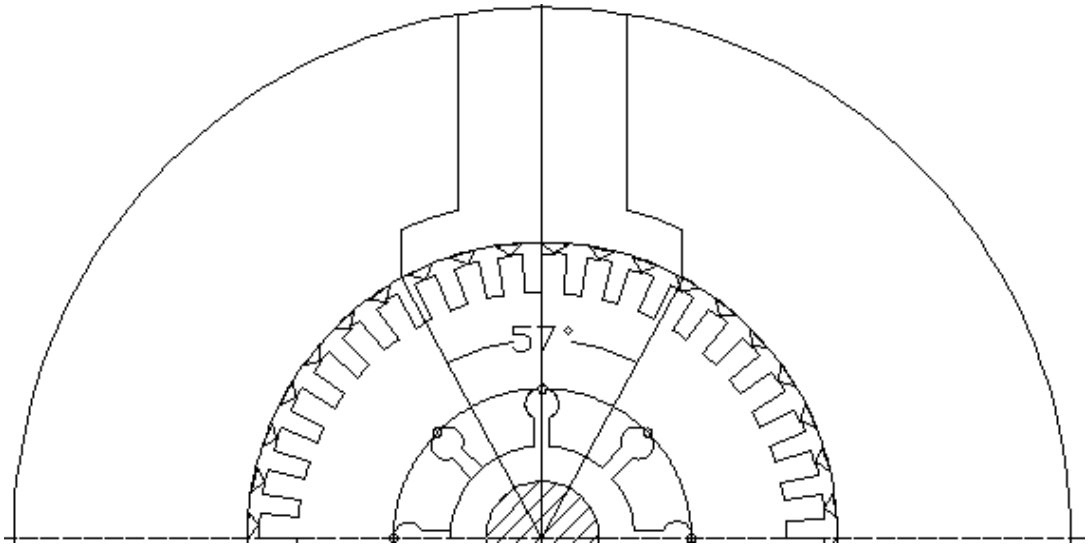
Height of pole with shoe = 16cm, assume shoe = 3cm

Height of pole = 16 – 3 = 13cm or 130mm

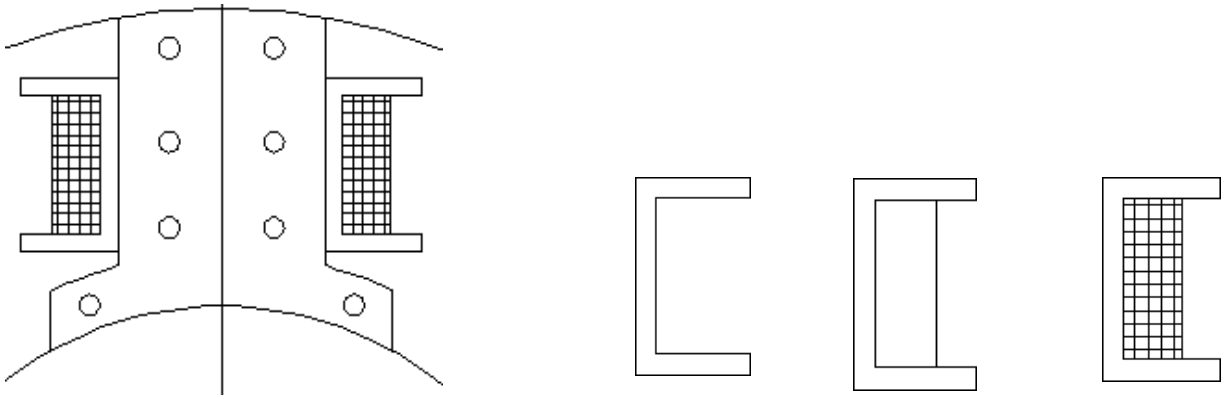
Width of pole = 12cm or 120mm

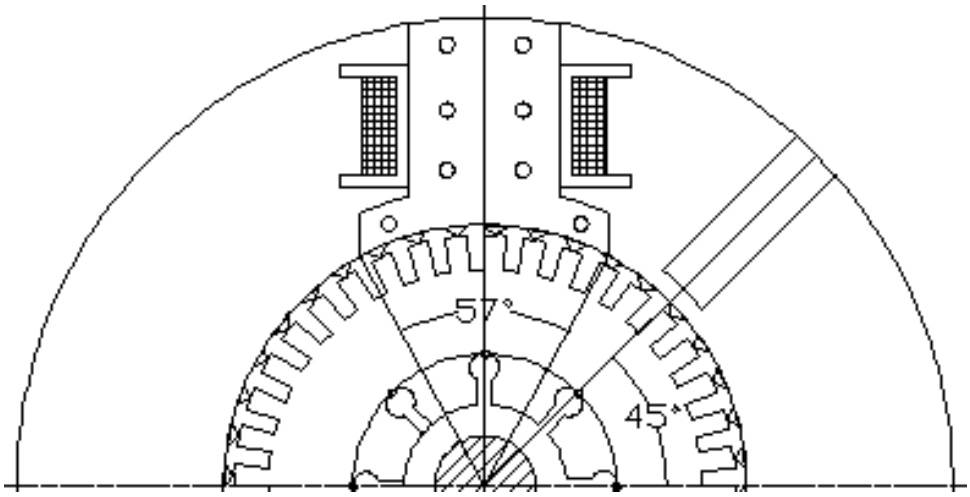
Offset pole arc = 30mm

Offset vertical axis both side by 60mm. After trim, we get



Step7: Field winding





Step8 : (Interpoles)

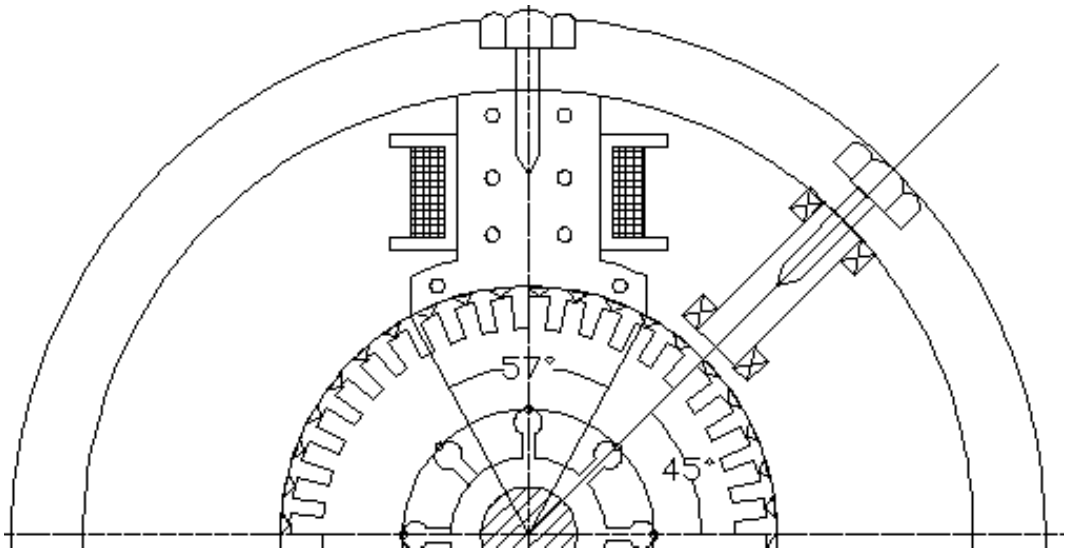
- Draw line at an angle of 45 º
  @745/2<45 º i,e 745/2=372.5
- Offset 45 º axis line both side by 22mm
- Offset the outer of stator by 150mm
- We get above fig

- ✓ Draw a rectangle
- ✓ Draw cross line inside, copy & mirror

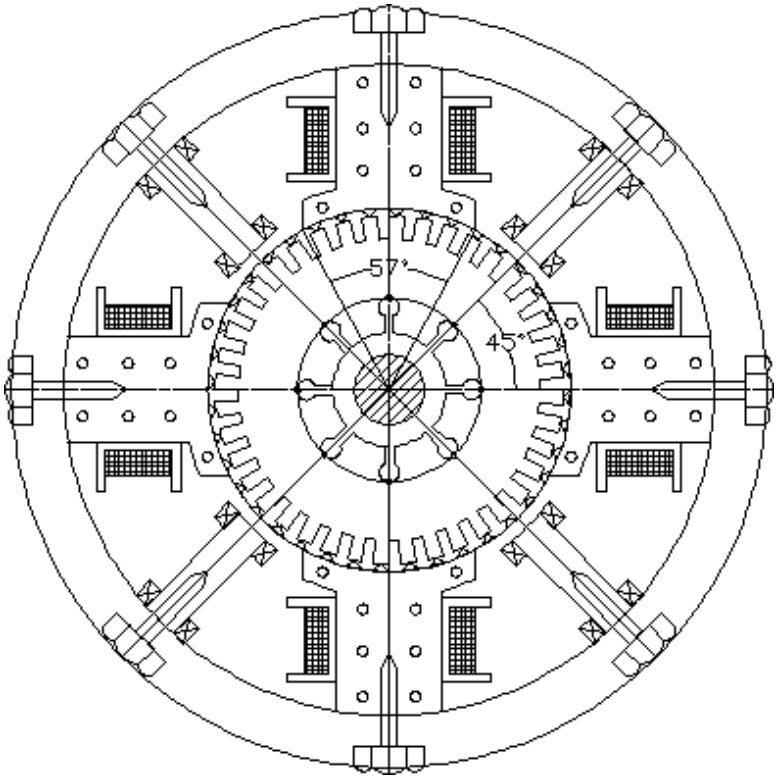
How to Rotate?

- Go to rotate icon
- Select objects
- Specify base point
- Specify rotation angle = 45 º
- Enter

Step9:

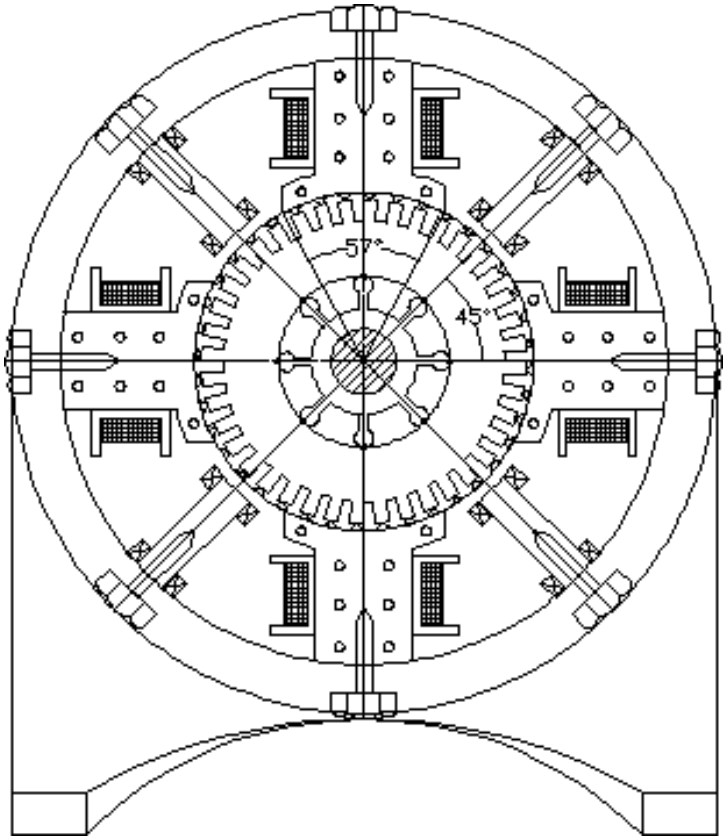


- Draw over all dia of machine : 865mm
- Draw bolt for main pole & interpole
- Polar array:
- ✓ Center point
- ✓ Select object
- ✓ Total no. of item : 4
- ✓ Angle to fill : 360



Step10: To draw pole shoe:

Using 3 point arc , we get:



Problem 5 :

Draw to suitable scale a neat and sectional view of the following as per dimension :
DC,6 poles, 150HP motor
Armature dia=55cm, no. of slots= 61, size of slot = 1 * 4.5cm, airgap length(radial) = 0.5 at main pole and 0.6 at interpole
Details of main pole: Breadth = 14, arc = 20, height with shoe = 21
Interpole details: Breadth = 4cm, outside dia of yoke = 115cm, shaft dia at bearing = 10cm
The method of fixing the pole lamination and the pole to the yoke should be clearly shown.

Solution:

1. Shaft = 10cm
2. Armature dia = 55cm
   Size of slot = 1 * 4.5
   Length = RΘ; R is radius of armature[D=55cm, hence R=27.5cm – 4.5cm= 23cm]
   Θ = l/R = 1cm/23 * 180/π = 2.5˚
   Slot angle = 360/no of slot = 360/60 = 6˚
3. **Main pole**:
   Pole arc = R Θ ; R = armature radius + airgap = 27.5 + 0.5 = 28
   Θ = pole arc/R ……in radians
   a) Θ = pole arc/R * 180/ π = 20/28 * 180/ π = 41˚

b) Breadth or width = 14cm
c) Height of pole with shoe = 21cm
Assume shoe = 3cm, hence height of pole body only = 21 – 3 = 18 cm

4. **Interpole** :

5. **Yoke**:

Inner dia of yoke = dia of armature + airgap + 2 * height of pole with shoe

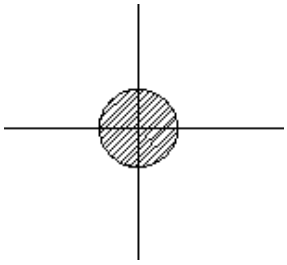
= 55 + 2 * 0.5 + 2 * 21cm = 98cm

Outer dia of yoke = 115cm

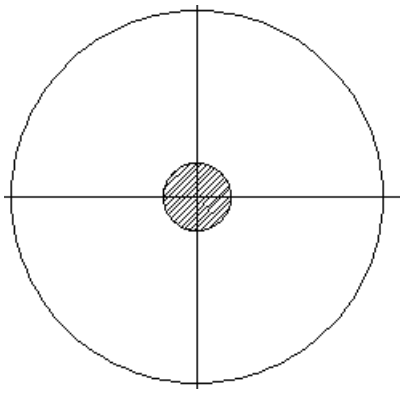
Step1: Limits: left corner 0,0 >> right corner : 1500,1500 >> zoom >> all

Step2: **To draw shaft, armature & armature slot**.

1. Draw a circle of radius 100mm/2 = 50mm…..... Fill shaft hatching lines

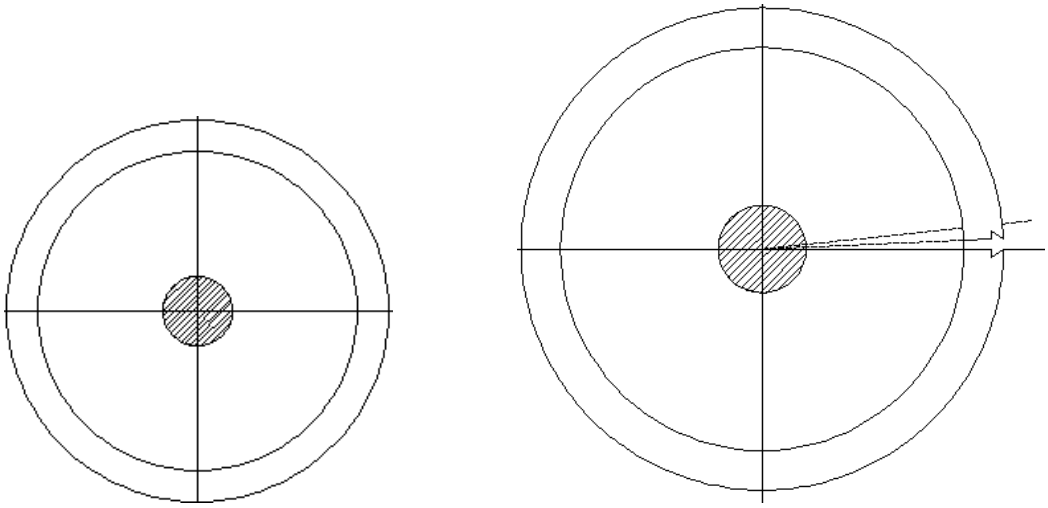


2. Draw armature of dia = 550mm



3. Offset armature by 45mm

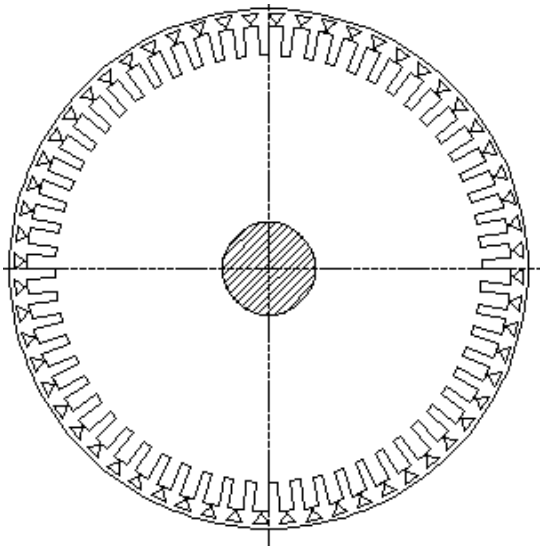
Draw a line : @550/2 < 2.5˚, again @550/2 < 6˚



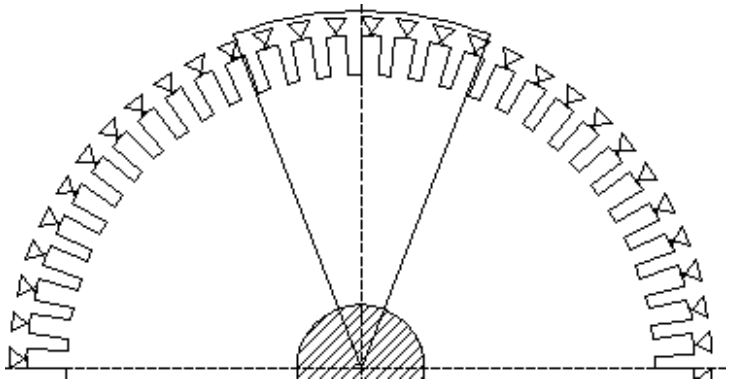
Polar array : Select center point >> total no of items:60 >> angle to fill : 360 >> OK

Step 3: Main pole

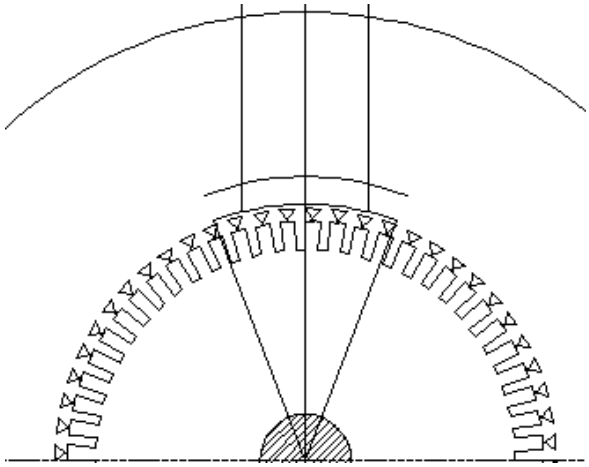
1. Draw a circle of radius = 280cm

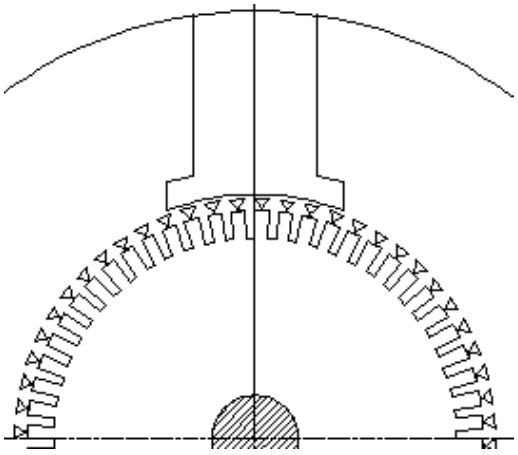


2. Draw a inclined line (pole arc)
   @280<69˚
   @280<111˚
   Trim we get



3. To draw pole width: Offset 70mm both sides (width = 140mm)

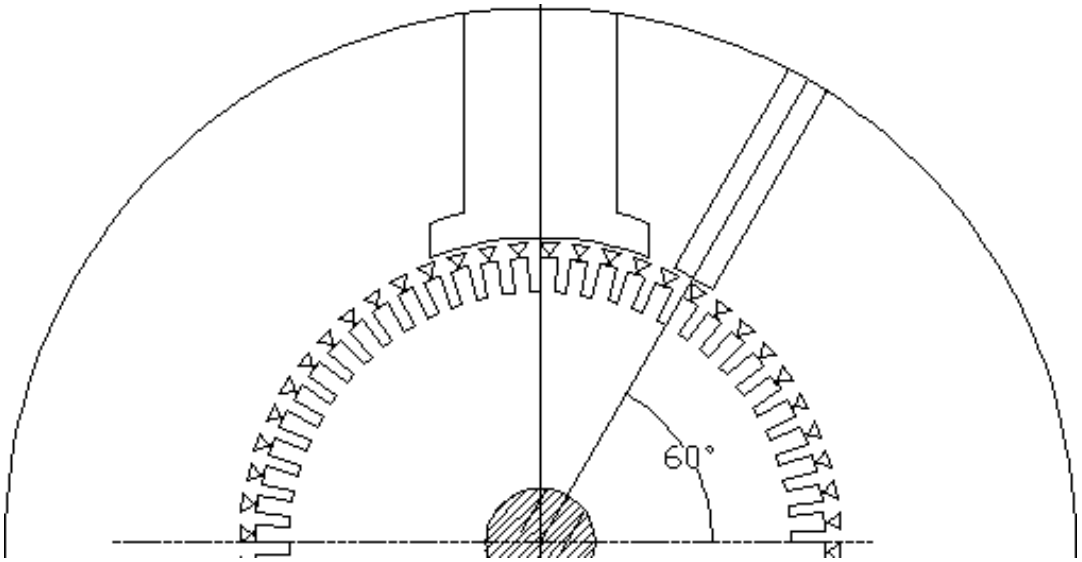




4. To draw pole shoe: Offset the arc by 30mm
5. To draw pole height with shoe: Draw the circle of dia = 98cm or 980mm i,e inner dia of yoke, we get.

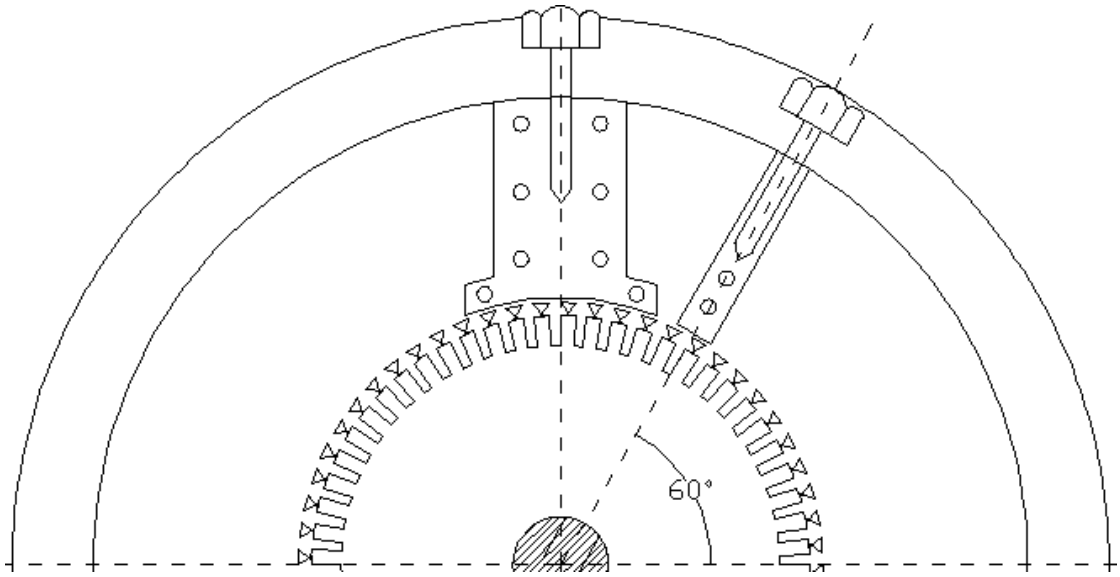
Step 4: **To draw interpoles:**

- Draw a 60˚ line i,e @980/2<60˚
- Offset 60˚ line by 20mm both side(because breadth of interpole = 40mm)
- Since height of interpole = height of main pole body with shoe. Offset inner dia of yoke by 210mm
- Trim , we get



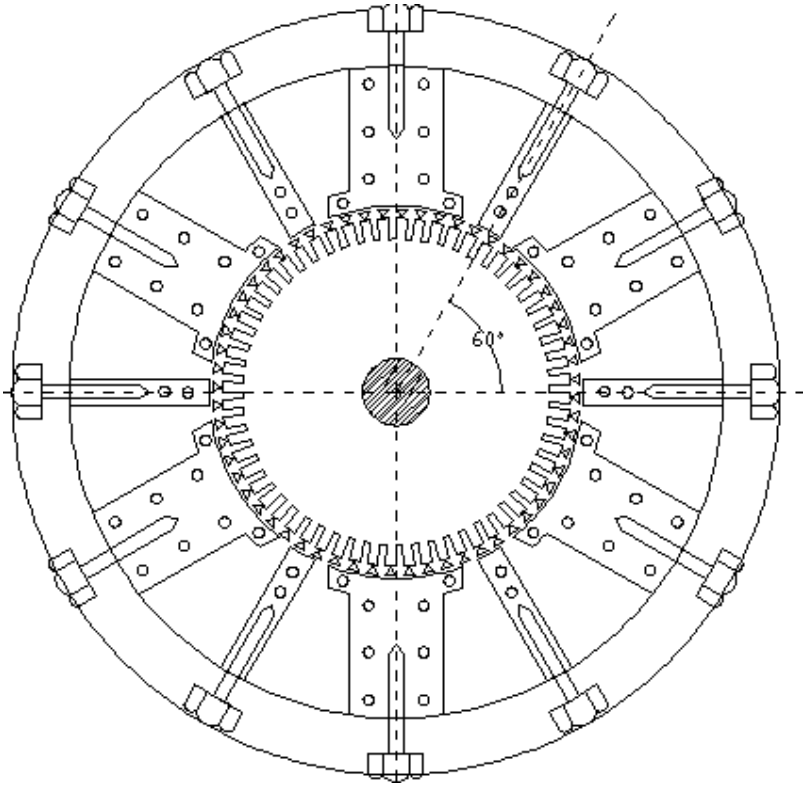
Step 5 : To draw yoke and bolt

- Draw outer dia of yoke = 1150mm
- Draw a bolt to main pole
- Using polar array, copy the bolt to interpole:
    - ✓ Select object
    - ✓ Select center
    - ✓ Total no of item = 2
    - ✓ Method : select angle to fill and angle between item.
    - ✓ Angle to fill = -30˚
    - ✓ Angle between item = 30
    - ✓ Ok

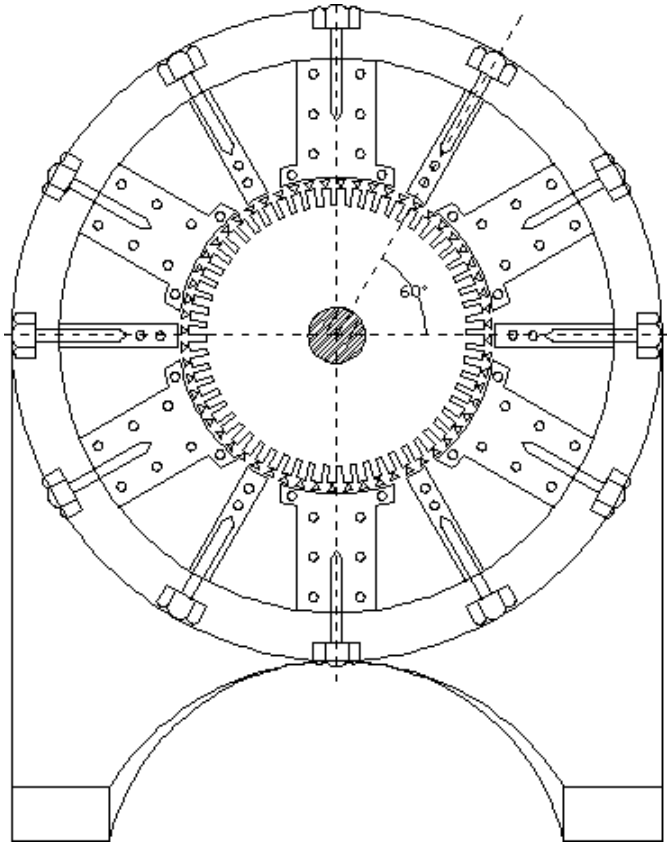


Step 6 : Polar array , main pole, interpole with their bolts

Select polar array >> Select center point >> Select object >> Total no of items :6 >> Angle to fill : 360 >>OK



Step 7: To draw pole shoe - Using 3 point arc , we get



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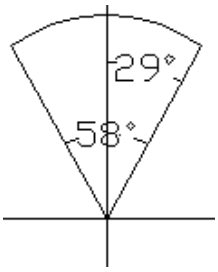
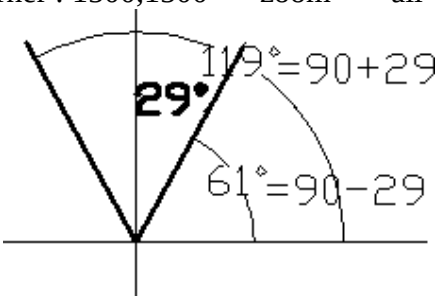
Problem 6:

Fig shows the isometric view of an field pole and its coil, draw the half sectional elevation and full plan assembled.
All dimensions are in mm.

Note: Rest of the data can be neglected
From fig: Radius R = 161.2mm, pole arc = 164.2mm , pole shoe = 55.8mm, height of pole body with shoe = 86.2mm
Pole arc = RΘ
Θ in deg = pole arc/R * 180/π = 164.2/161.2 * 180/π = 58˚
Step 1: Limits: Left corner 0,0 >> right corner : 1500,1500 >> zoom >> all





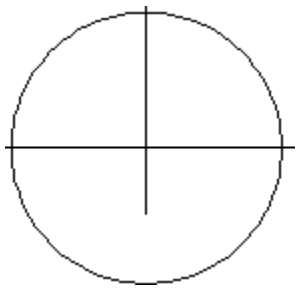
Step 2:

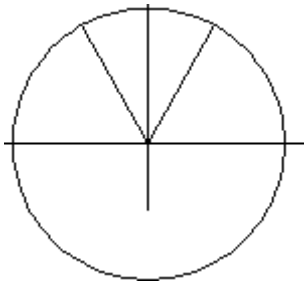
Draw a line at angle of 29˚ to either side of vertical axis

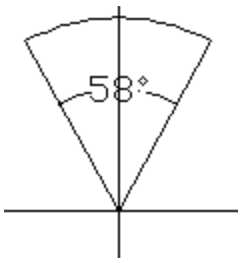
@161.2<61˚

@161.2<119˚

Draw a circle of radius 161.2mm……. after trim, we get







Step 3:

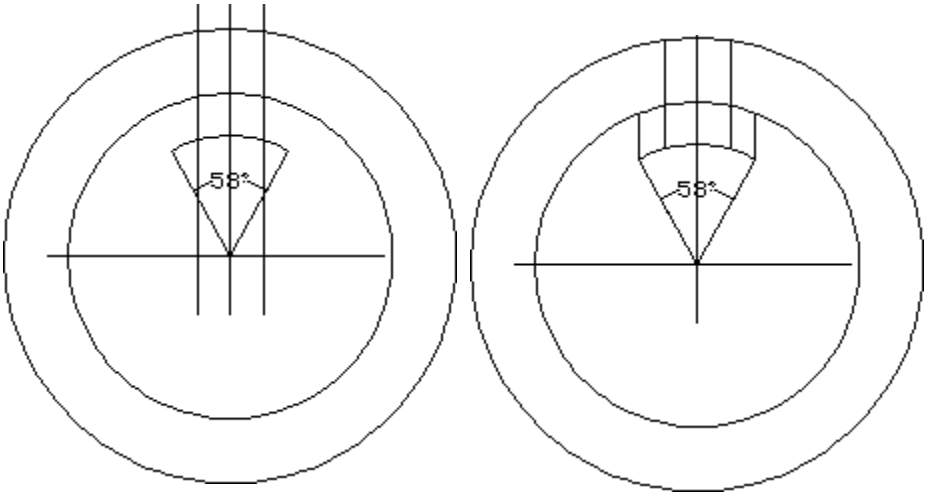
R=161.2mm

R1 = R + pole shoe = 161.2 + 55.8 = 217mm

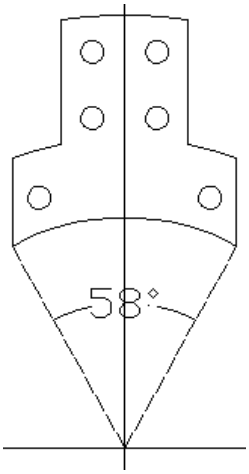
R2 = R1 + height of pole body without shoe = 217 + 86.2 = 303.2mm

Draw a circle of radius R1 = 217mm, R2 = 303.2mm

Offset vertical axis by 89/2 = 44.5mm by both sides, we get



After Trim



Step 4: Field winding

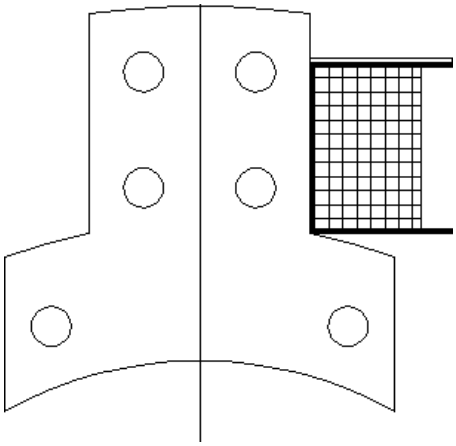
Offset 101.15 from vertical axis both side

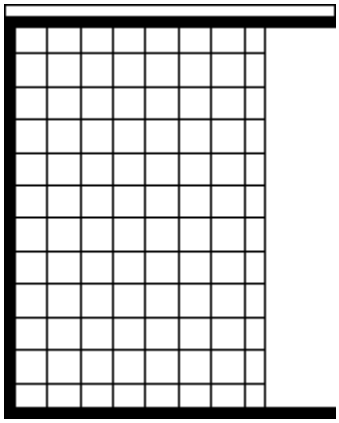
At point (a) draw line: @68.2<90˚ and @44.5<0

Offset 44.5mm line all side by 1.6mm

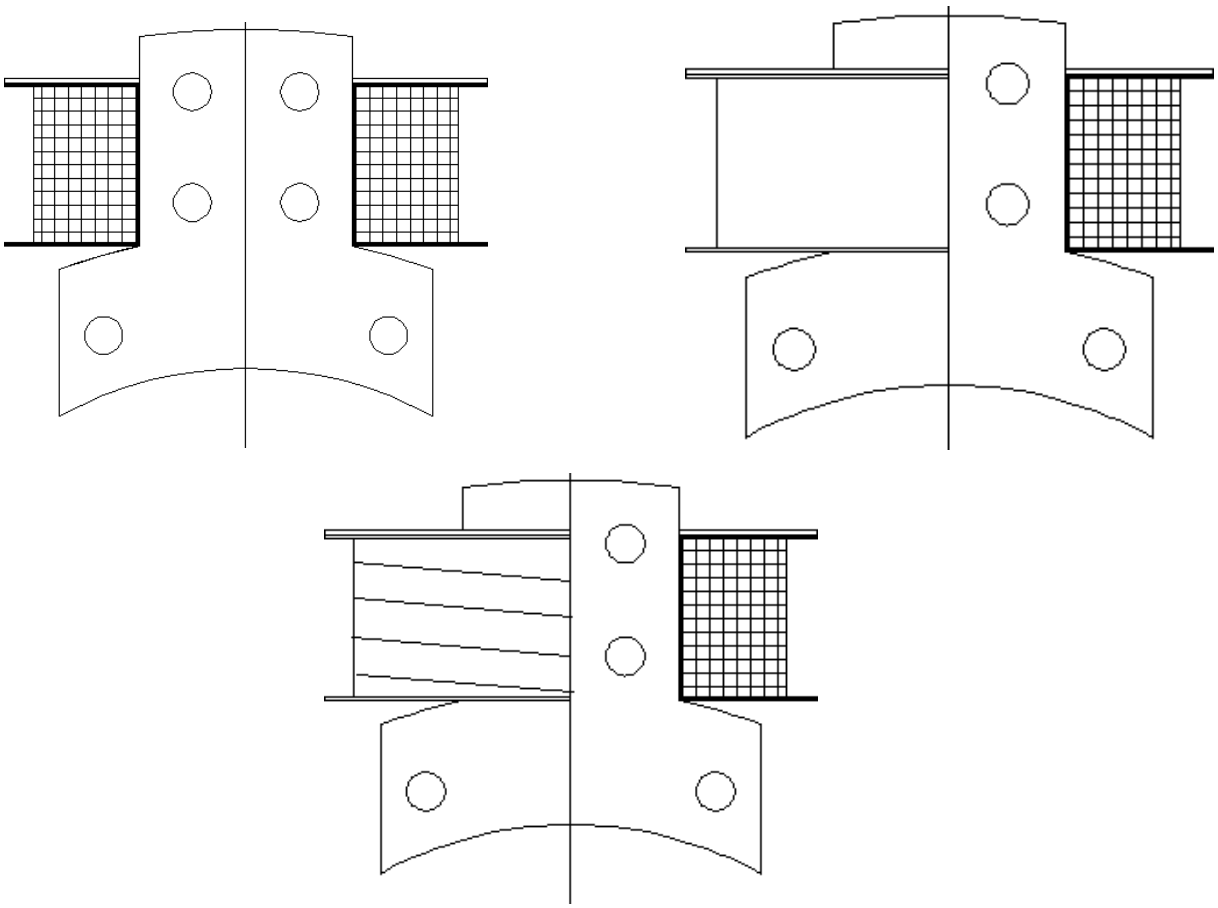
In the top offset by 2mm

- Fill solid for 1.6mm insulation
- Use "Net" in hatch





Step 5: Mirror the field winding to left side



Given :

Step 6 : Offset all side of axis by 44.5mm we get

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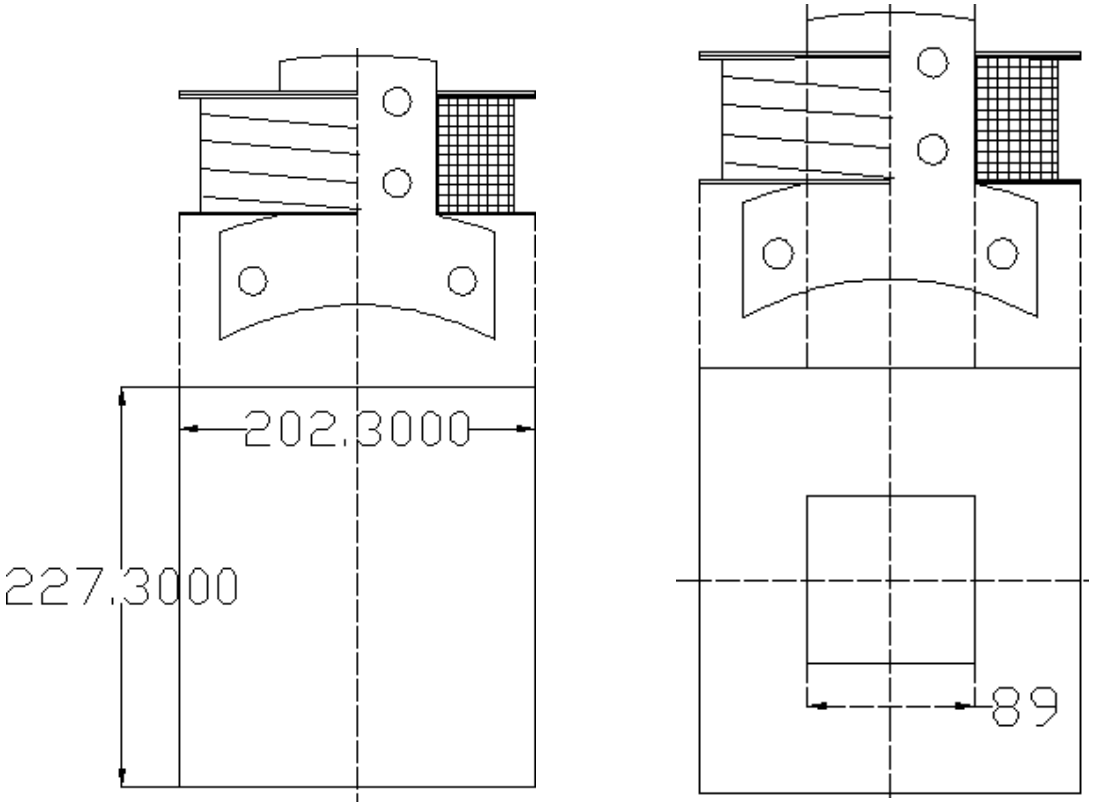

Outcome: students will be able to draw the sectional views of yoke, field system, armature and commutator