

## **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 Windings. 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

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### Module-5

### ALTERNATORS

**Objective:** to draw the sectional views of stator and rotor

#### Problem 1:

**Draw end view and elevation of the stator stamping of the given below dimensions:**

Inside or air gap dia of stator stamping	= 18cm
Slot size	= 2.9*0.95cm
Depth of iron behind the stator slot	= 4cm
Length of stator stamping	= 13.5 cm
One radial cooling duct	= 1cm wide
Total slots	= 36

#### Solution:

1. Inside dia of stator = 18cm = 180mm
2. Slot details:
3. Depth of iron core in stator = 4cm = 40mm
4. Outer dia of stator = Inner dia of stator + 2(depth of slot) + 2(thickness of iron core)  

$$= 180 + 2 * (29) + 2 * (40)$$

$$= 318\text{mm}$$
5. Slot angle =  $360/\text{no. of slot} = 360/36 = 10^\circ$
6. Length of stator stamping = 13.5cm = 135mm
7. No. of pulling duct = 1 ( of 1cm width )

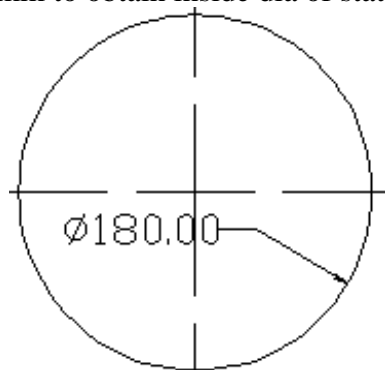
#### Step 1:

Units – millimeter

Set limits: Limits: left corner 0,0 >> right corner : 1500,1500 >> zoom >> all

#### Step 2:

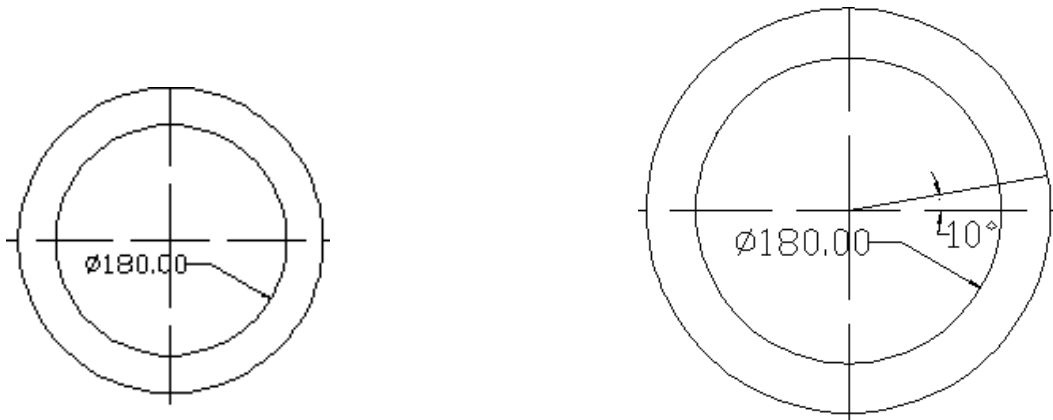
Draw a circle of dia 180mm to obtain inside dia of stator stamping



#### Step 3: Slot details:

Offset the circle by 29mm outwards ( because height of slot = 29mm)

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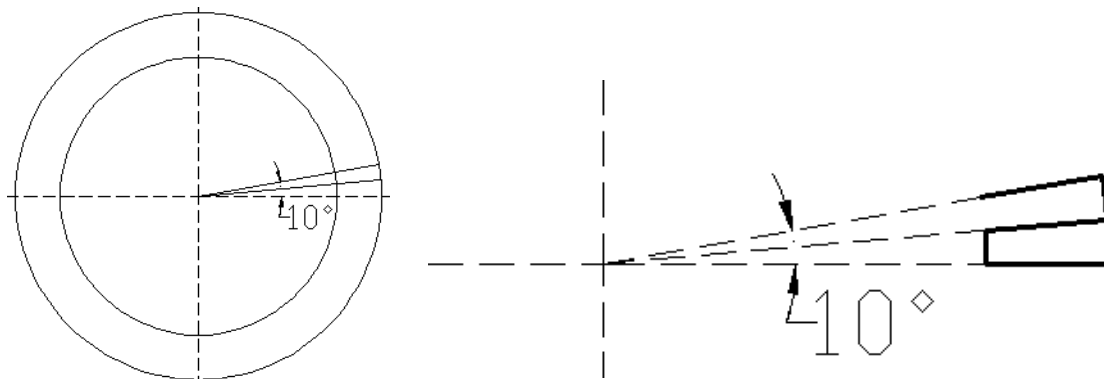


### Step 4: To include slots:

Draw a line from centre of circle @ 119<10 (since  $180/2 = 90\text{mm radius} + 29\text{mm} = 119\text{mm}$ ) as shown above

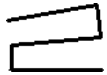
### Step 5: To draw the slot with in 10°

Obtain the midpoint within the arc of 10°, draw an inclined line at midpoint from center and trim to get a slot.

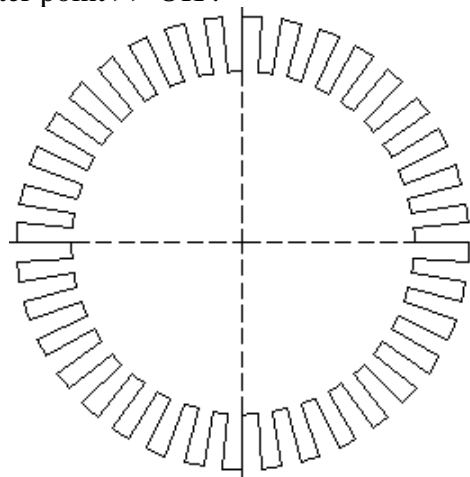


### Step 6:

To include 36 slots: polar array >> no of items – 36 >> angle to fill – 360 >> select object



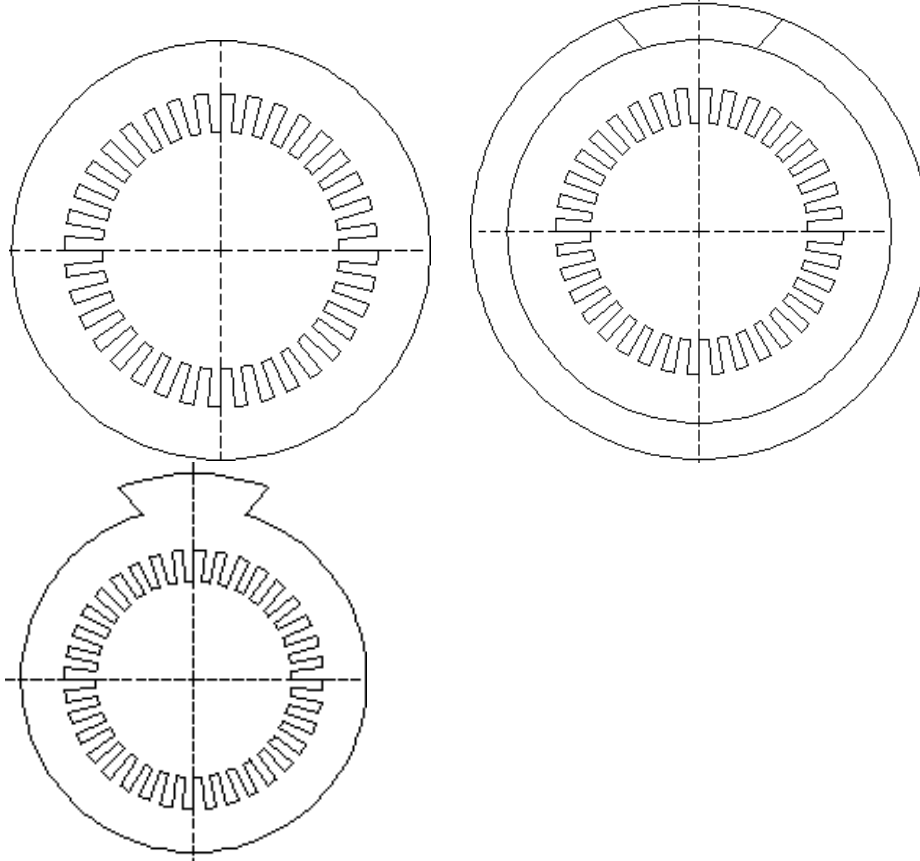
>> specify center point >> OK .



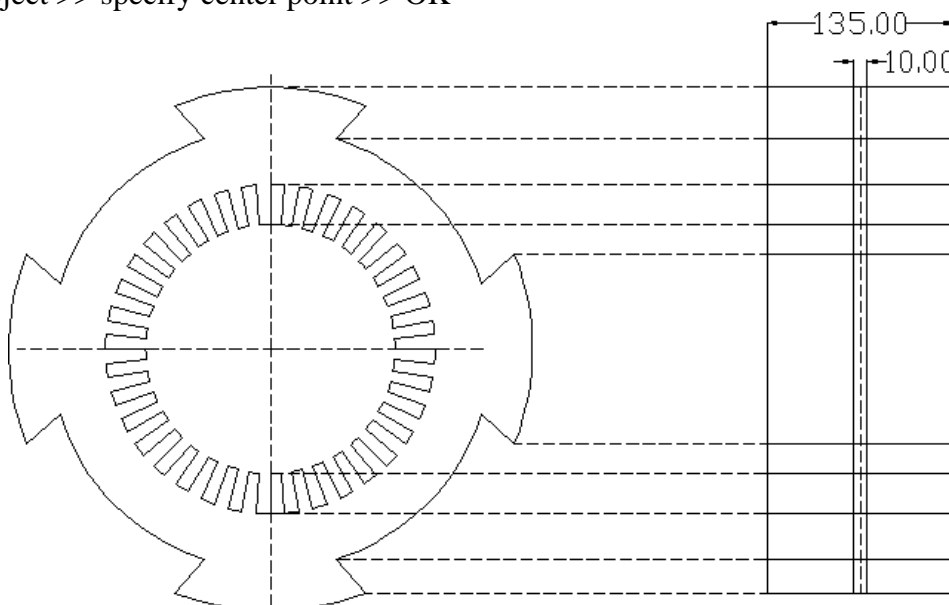
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### Step 7:

- Draw outer dia of stator as 318mm as calculated
- Offset the outer dia of stator by 30mm(arbitrary) and trim, we get



- Draw an inclined line 'ab' & mirror it as shown
- After trim and then : polar array >> no of items – 4 >> angle to fill – 360 >> select object >> specify center point >> OK



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### Step 8: Elevation :

- Project the lines as shown above
- Draw a line of length 135mm (given)
- Draw the radial pulling duct of 1cm = 10mm as shown above

### Problem 2 :

**Draw end view and elevation of the rotor stamping of the given below dimensions:**

Rotor outside diameter	=17.88cm
Number of slots	=31
Size of slots (circular) dia	=1cm
Slot opening	=2mm
Length of rotor	=13.5cm
One radial cooling duct	=1cm wide
Dia of shaft below rotor stamping	=3.5cm

### Solution:

1. Outer dia of rotor = 17.88cm = 18cm = 180mm
2. Inner dia of rotor = dia of shaft = 35mm
3. Slot details :

Type of slot – circular :

**Assume:** Depth of slot opening = 2mm, dia of slot = 8mm

No. of slots = 31

Slot angle =  $360 / \text{no of slots} = 360 / 31 = 11.61 = 12^\circ$

No of slots =  $360 / \text{slot angle} = 360 / 12 = 30$

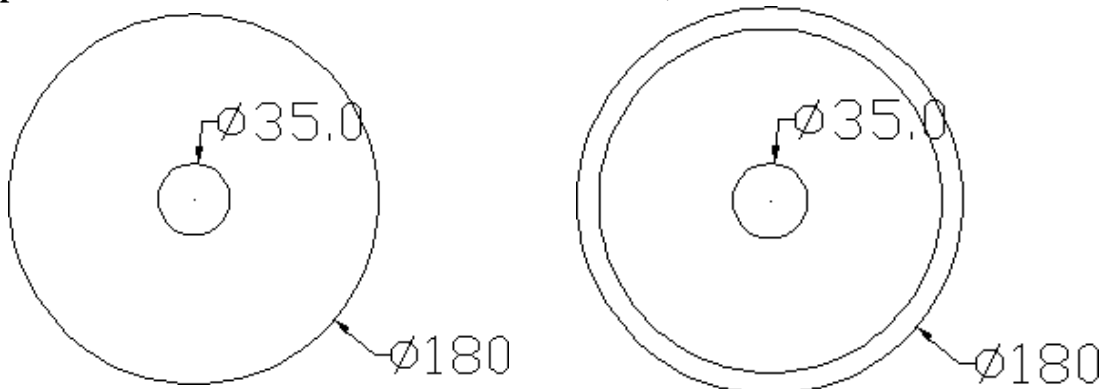
4. Length of rotor stamping = 13.5cm = 135mm
5. No of radial cooling duct = 1 ; whose width = 1cm = 10mm

### Step 1:

Units – millimeter

**Set limits:** Limits: left corner 0,0 >> right corner : 1000,1000 >> zoom >> all

**Step 2: Draw the 2 circles :** Inner dia of rotor – 35mm, outer dia of rotor – 180mm

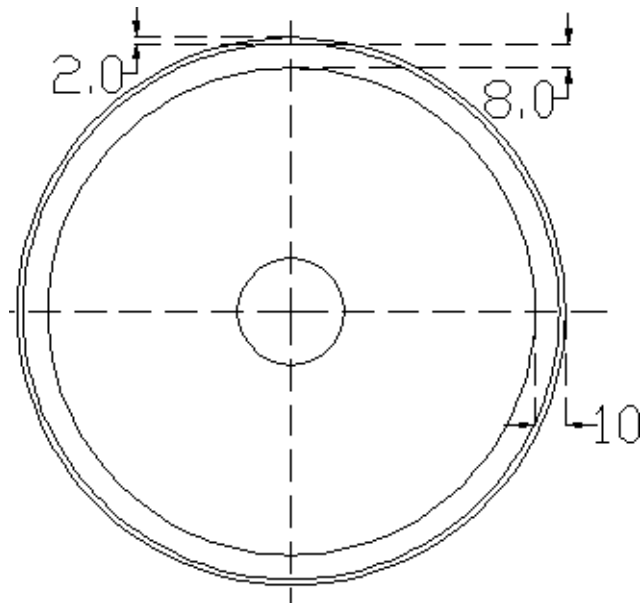


### Step 3: To draw slots:

Offset the outer dia of rotor by 10mm inwards ( slot dia = 1cm = 10mm) as shown above

Again offset the outer dia of rotor by 2mm inwards to include depth of slot opening

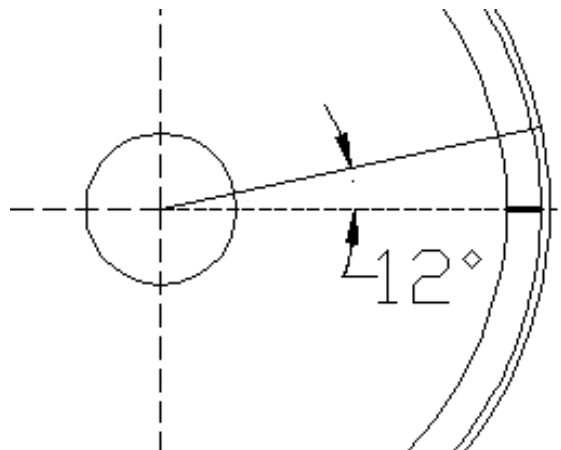
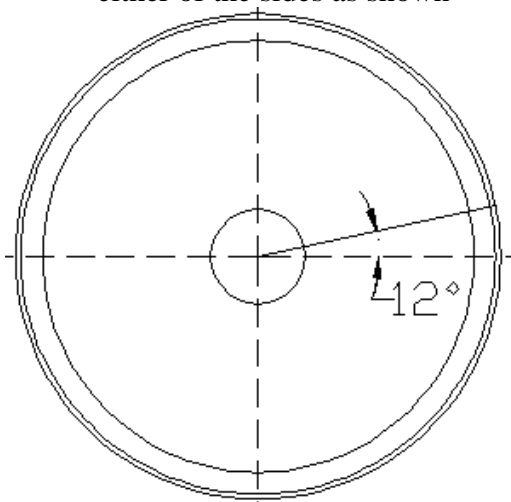
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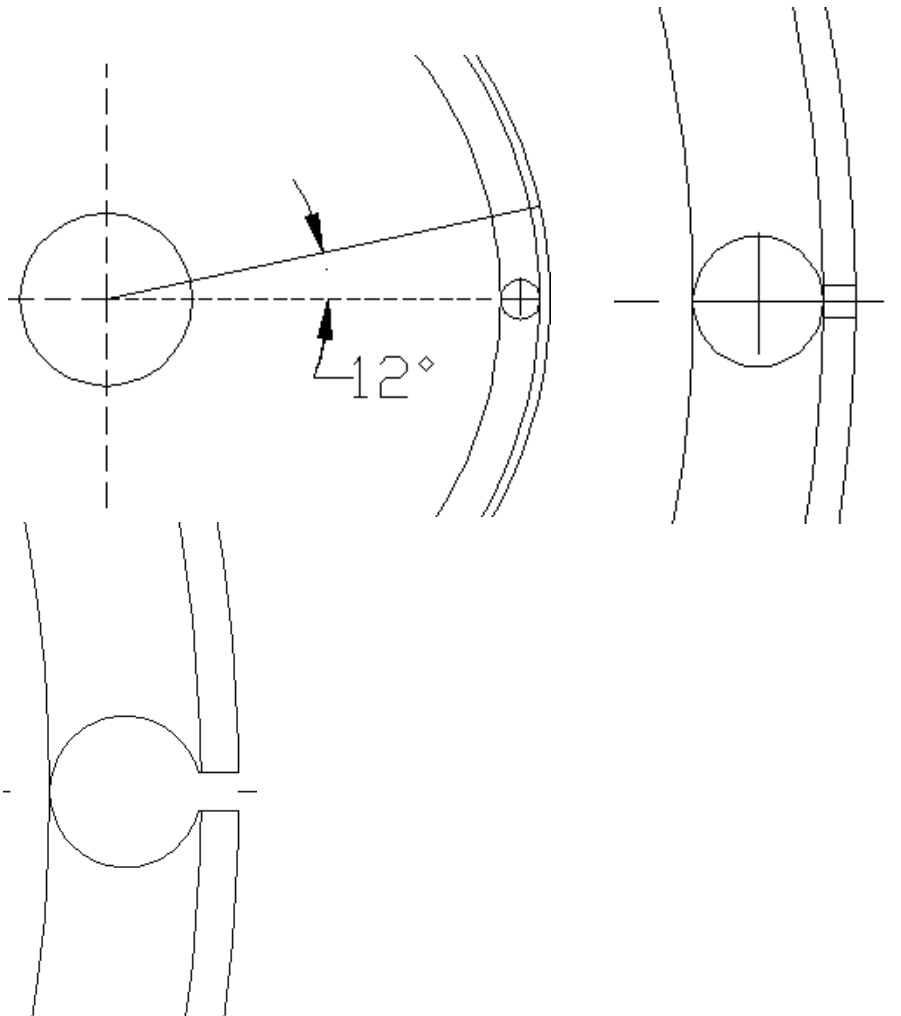
Slot angle is  $12^\circ$

Draw a line from center of circle @  $180/2 < 12^\circ = @90 < 12^\circ$

- Redraw the line ab and draw a vertical line at midpoint of ab
- On the line ab with 'o' as center draw a circle of dia 8mm
- To include width of slot opening as 2mm- Redraw line bc and offset it by 1mm on either of the sides as shown

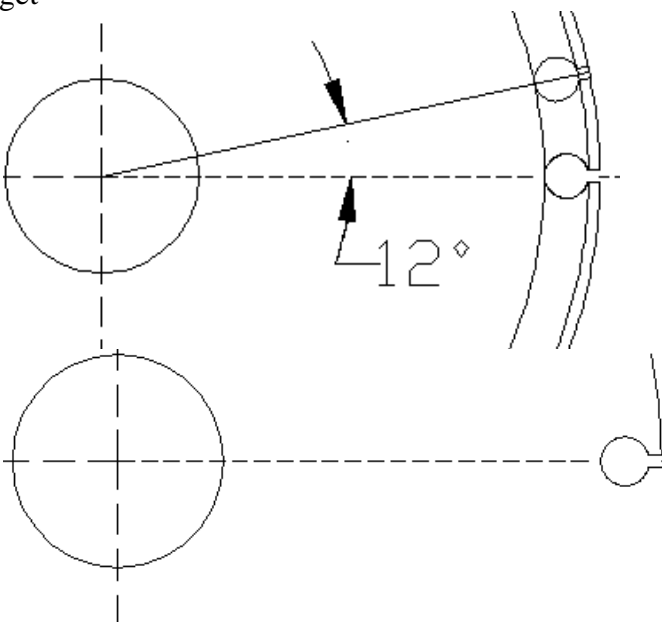


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### Polar array the slot:

No of items = 2 >> angle to fill =  $12^\circ$  >> specify center point >> select object >> OK..... we get



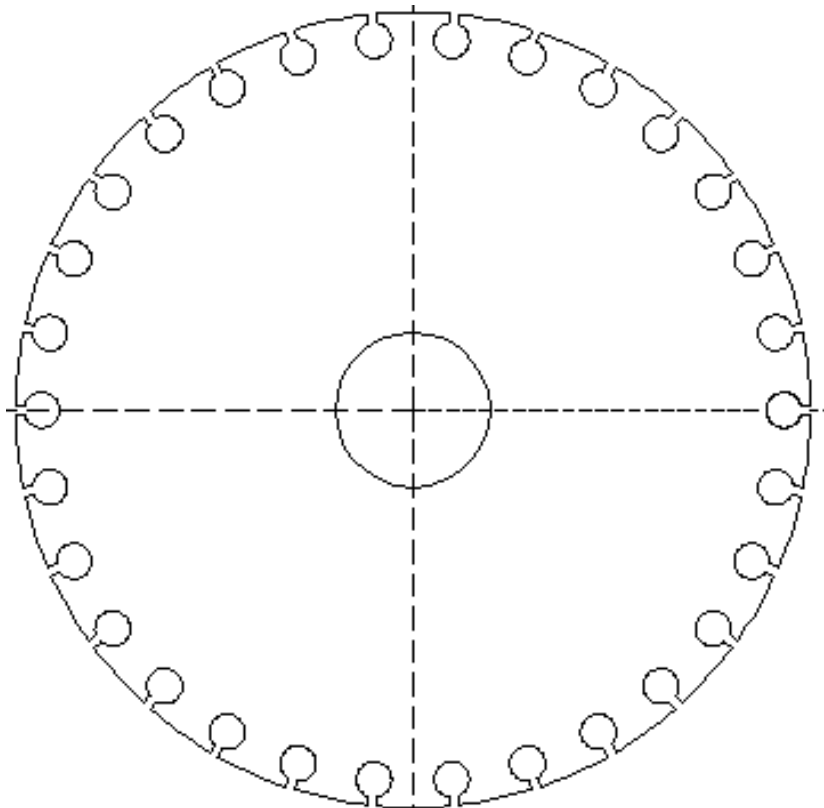
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After polar array

After Trim

Again polar array the slot :

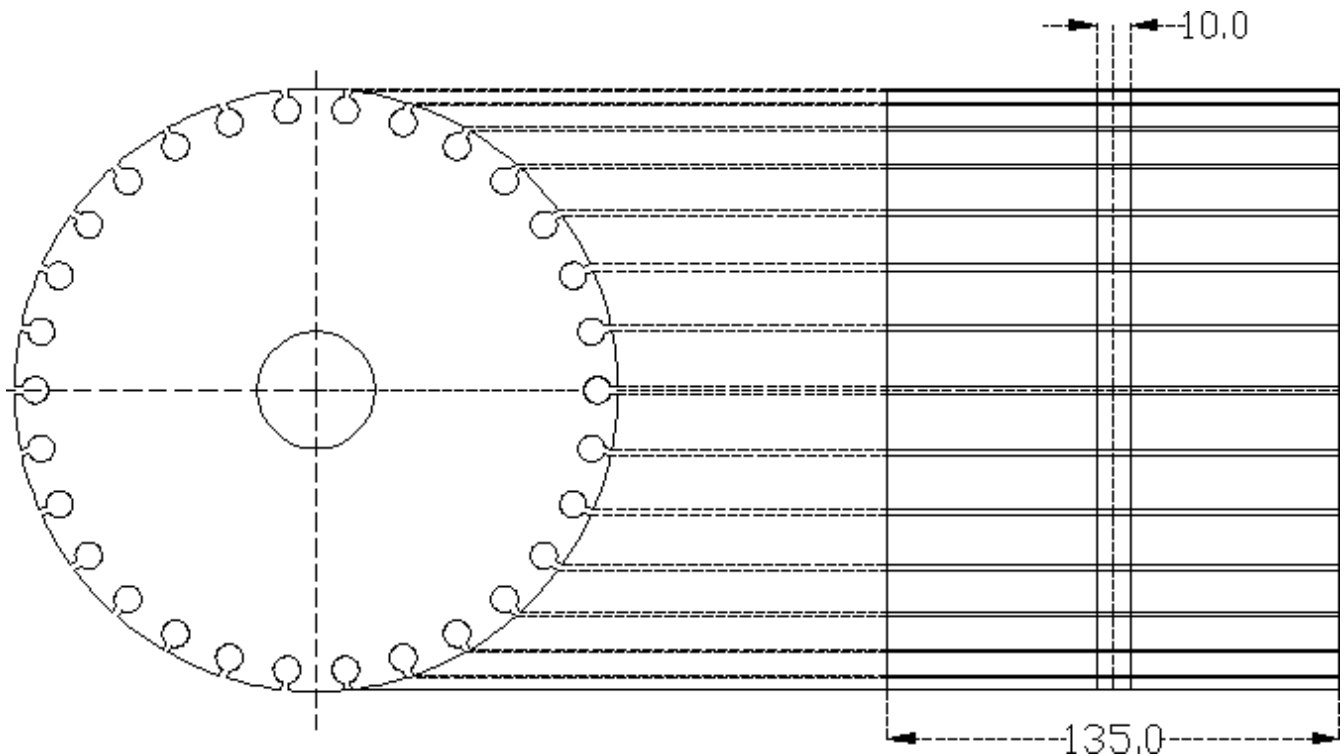
No of items – 30 >> angle to fill – 360 >> specify the center point >>select object >> OK, we get



### Step 4:

- Project the lines for elevation as shown
- Draw a line of dimension @135mm< 0°(since length of rotor is given as 13.5cm)

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### Problem 3:

The rotor of an alternator consists of a shaft, a spider and poles.

Draw the half sectional end view of the rotor assembly with the following dimensions.

Scale =  $\frac{1}{2}$  full size.

1. **Shaft** : It is made of mild steel and solid circular radius of the shaft = 3cms
2. **Spider** : It is made of cast steel and has four dovetail slots at its outer surface. The angle between the center line of the slots is 90. The spider is a square of sides 20cms.

Distance between the center of the shaft and bottom of the dovetail slot = 8cms

Height of the dovetail size of slot plate =  $6 \times 2$  cms

Width of the dovetail slot at the bottom = 5cms

Width of the dovetail slot at the top = 2.5cms

On both the sides of dovetail slot there is a hole of diameter = 0.5cms for fixing the retaining plate to the spider.

3. **Pole core**: It is made of sheet steel laminations and they are fixed rigidly by suitable nuts and bolts at regular intervals.

Height of the dovetail in the pole core = 2cm

Height of the core above dovetail = 8cm

Width of pole core = 10 cms

Width of pole face = 5 cms

Radius of pole arc at the top of the pole face from the center of the shaft = 20cms

4. **Pole winding** : Made of enameled wire and suitably insulated. Height of pole winding = 8cms

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**Width of pole winding = 15cms**

**Insulation between core and winding = 0.2cms**

**Solution:**

1. **Shaft :** Radius = 3cm = 30mm

2. **Spider :**

3. **Dovetail details:**

Width of dovetail slot at top = 2.5cm

Width of dovetail slot at bottom = 5cm

4. **Pole details:**

- Pole height without shoes = 8cm
- Width of pole = 10cm
- Radius of pole arc = 20cm

5. **Pole winding details:**

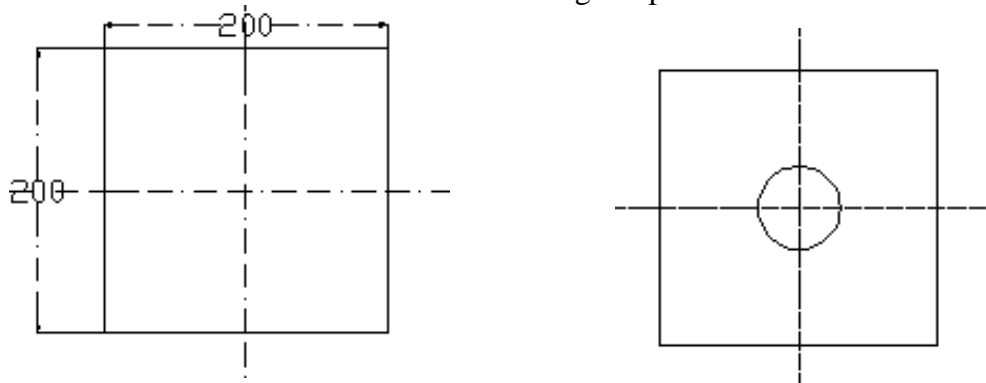
- Width of pole winding = 15cm
- Insulation between core and winding = 0.2cm
- Exclude dovetail plate details for full section

**Step 1 :** Units – Millimeter

Set limits: Limits: left corner 0,0 >> right corner : 1500,1500 >> zoom >> all

**Step 2 :** Draw a square of dimension 20cms = 200mm using rectangle command

- Specify 1<sup>st</sup> point
- Next type 'd' in command line
- Next specify the length and width for rectangle as 200mm
- Draw horizontal and vertical reference lines using midpoint

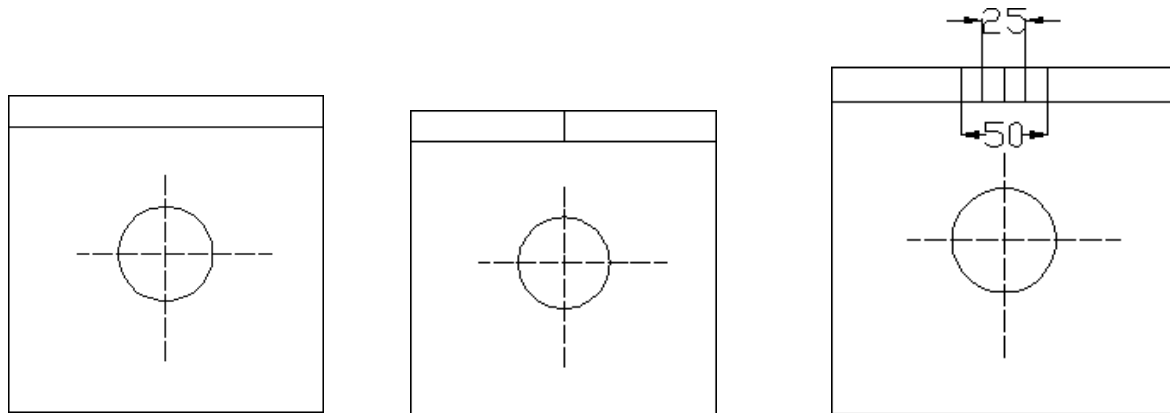


**Step 3 :** Draw a shaft of radius 30mm at center point as shown above

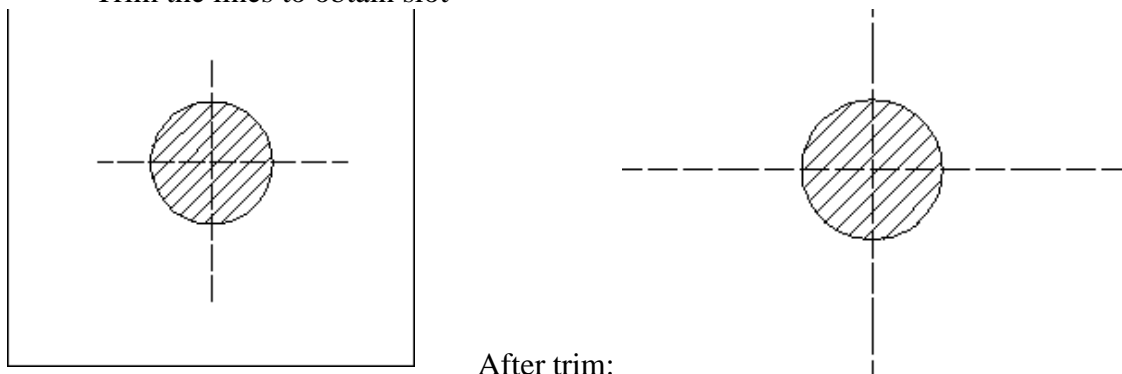
**Step 4: To draw dovetail :**

- Redraw the line 'ab' and offset it by 20mm

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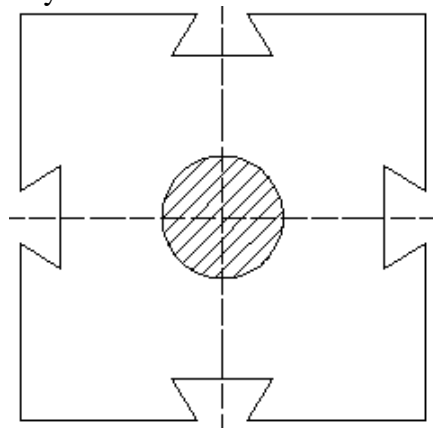


- Offset vertical line 'cd' by:  $25/2 = 12.5\text{mm}$  on both sides (top width)  
 $50/2 = 25\text{mm}$  on both sides (bottom width) as shown above
- Join 'ef' and join 'gh'
- Trim the lines to obtain slot



After trim:

- Polar array the dovetail:  
No of items – 4 >> angle to fill – 360 >> select object >> OK
- Resultant of polar array

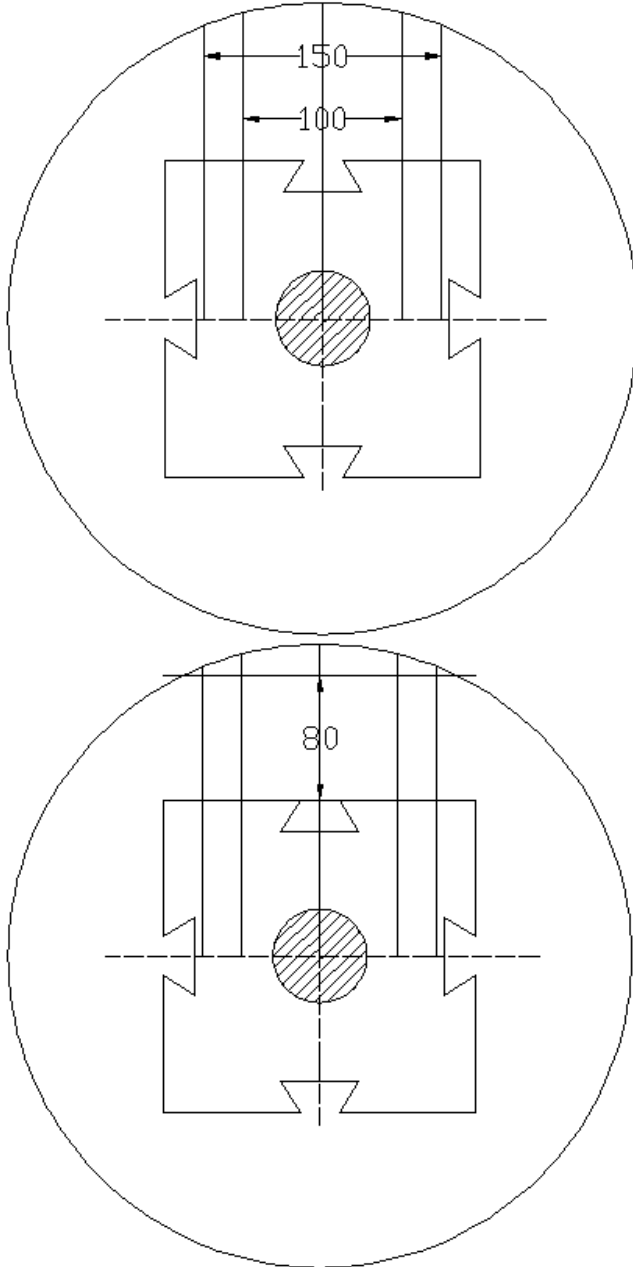


### Step5: To draw pole core and winding

- Draw a circle of radius 200mm (given radius of pole arc = 20cm = 200mm)  
Pole core width = 10cm  
Pole winding width = 15cm
- Offset vertical line 'mn' by:  $10\text{cm}/2 = 5\text{cm} = 50\text{mm}$  both sides

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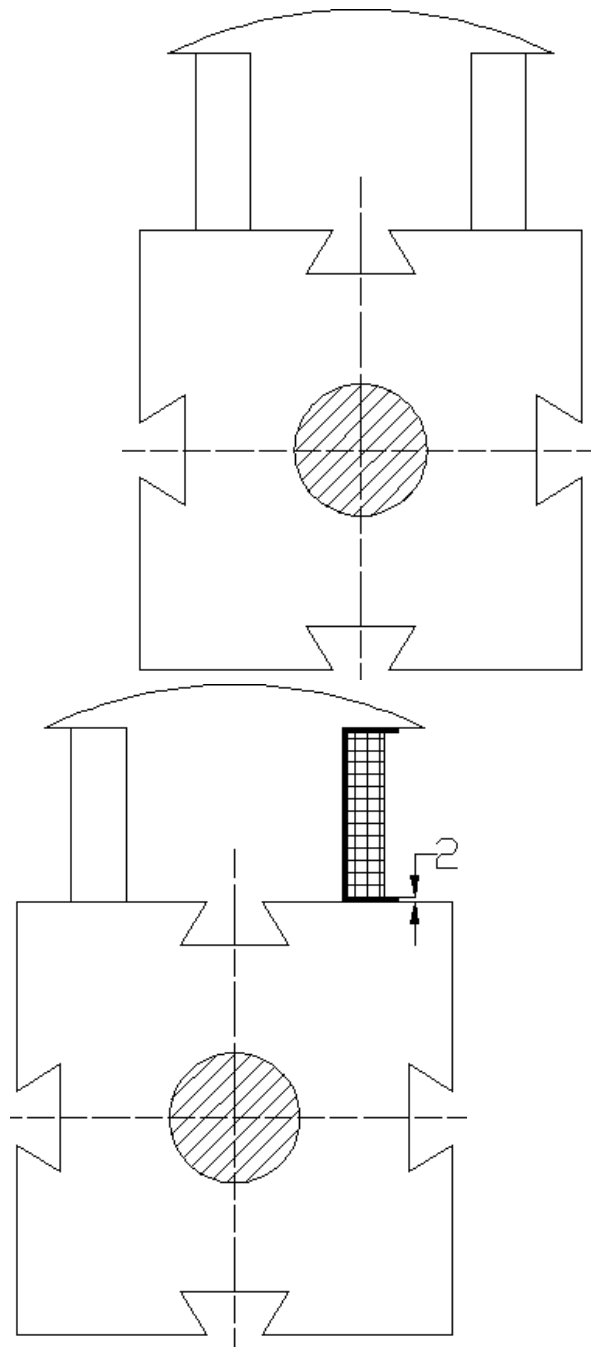
$$15\text{cm}/2 = 7.5\text{cm} = 75\text{mm both sides}$$



- Height of pole core above dovetail = 8cm
  - ✓ Redraw line 'ab'
  - ✓ Offset the horizontal line 'ab' by 80mm above
  - ✓ Trim the lines to obtain pole core and field windings as shown above

After trim we get,

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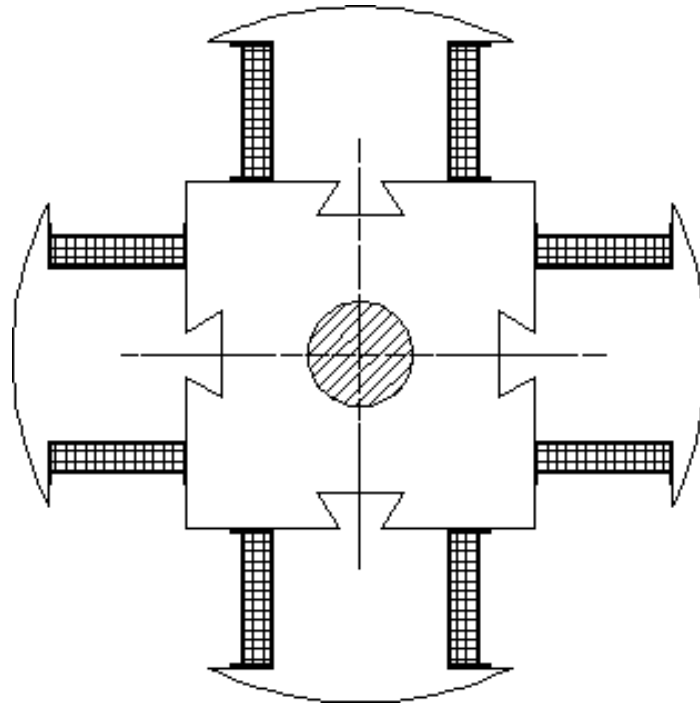
Provide 2mm thickness of insulation on all 3 sides as shown above

Mirror the pole winding on other side

Polar array the entire pole core with pole winding:

No of items – 4 >> angle to fill = 360 >> specify center point >> OK

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Draw the half section end view and half section elevation of the squirrel cage rotor directly mounted over the shaft. Show clearly the method of fixing the rotor with the shaft.

Rotor outside diameter = 17.88cm

Number of slots = 31

Size of slots (circular) dia = 1cm

Slot opening = 2mm

Length of rotor = 13.5cm

One radial cooling duct = 1cm wide

Dia of shaft below rotor stamping = 3.5cm

- Follow the same steps to draw the rotor outside diameter
- Draw one slot of 1cm dia
- Use polar array option to draw other 30 slots as explained in the above problem
- Elevate the half section of the squirrel cage rotor.

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Draw the half sectional end view of the rotor assembly with the following dimensions.

1. Shaft: it is made of mild steel and solid circular radius of the shaft = 3cms
2. Spider: it is made of cast steel and has four dovetail slots at its outer surface. The angle between the center lines of the slots is 90. The spider is a square of sides 20 cms.  
Distance between the center of the shaft and bottom of the dovetail slot = 8cms  
Height of the dovetail size of slot plate =  $6 \times 2$  cm  
Width of the dovetail slot at the bottom = 5cm  
Width of the dovetail slot at the top = 2.5cm  
On both side of the dovetail slot there is a hole of dia = 0.5cm
3. Pole core: it is made up of sheet steel laminations and they are fixed rigidly by suitable bolts and nuts at regular intervals  
Height of the dovetail in the pole core = 2cms  
Height of the core above dovetail = 7cms  
Width of the pole core = 10cms  
Width of the pole face = 10cms  
Radius of the pole arc at the top of the pole face from the center of the shaft = 20cms
4. Pole winding: Made of enameled wire and suitably insulated. height of pole winding = 8cms  
Width of pole winding = 15cms  
insulation between core and winding = 0.2cms.

**Outcome:** students will be able to draw and visualize sectional views of stator and rotor