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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Asst. Professor

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

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Module-3

TRANSFORMERS

Objective: To draw the sectional views of single and three phase core and shell type transformers.

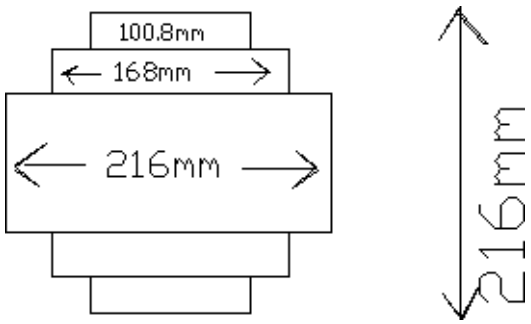
PROBLEM 1:

Draw to half scale the sectional plan of 1 limb showing the winding on a core of an oil immersed 12000/550V, 3phase transformer. The core is 24cm in dia& has 3 steps. The internal & external diameters of low tension windings are 25.4cm & 29.8cm respectively, & of high tension 2.3cm thick & outer dia 40.5cm. show the arrangements for keeping the coils in position & the oil ducts.

Given:

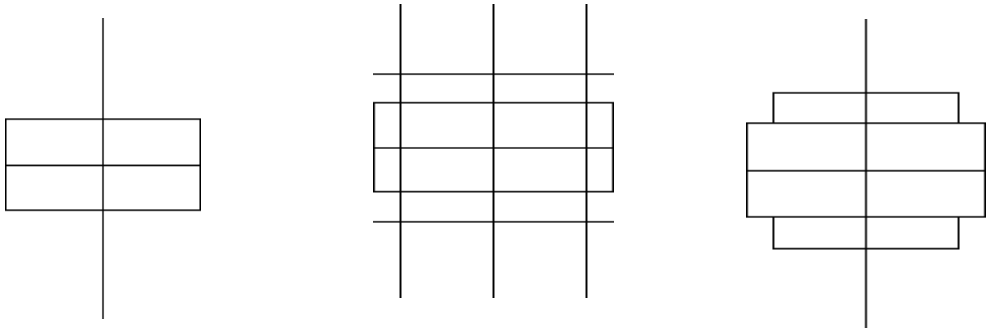
3 stepped core
Width of larger stamping = 216mm
Width of the intermediate stamping =168mm
Width of smaller stamping =100.8mm

To draw sectional plan:



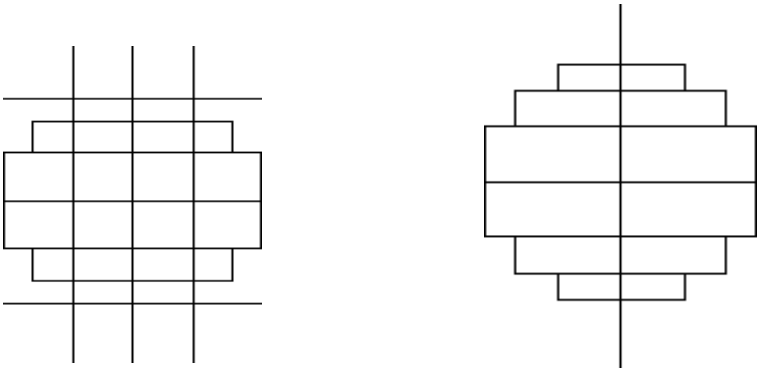
Step1: To draw 3 stepped core

1. Set limits
2. Type line, keeping polar status bar in ON mode
3. Draw a line @216<0, by obtaining midpoint draw a vertical reference line as shown
4. Offset horizontal line on both side by 50.4mm & join it as shown in fig (a)
5. Offset horizontal line again by 84mm on both sides
6. Next Offset vertical line on both side by 84 mm as in fig (b)
7. Trim the unwanted lines as shown in fig (c)



(a) (b) (c)

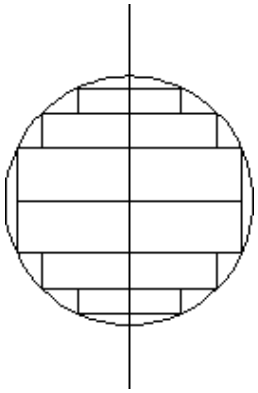
8. Offset horizontal line on both side by 108mm
9. Offset vertical line on both side by 50.4mm on both sides as shown in fig (d)
10. Trim the unwanted lines ,so that 3 stepped core appears as in fig (e)



(d) (e)

<u>Step 2:</u> To draw inner & outer dia for LV & HV winding

- Type ‘circle’ in the command prompt
- Specify the centre point
- Specify the radius of the circle or diameter: Type ‘D’ & press enter
- Specify dia of circle : 240mm



- Repeat the above 4 steps to draw inner & outer dia of LV & HV wndg with following details

Inner dia of LV= 254mm

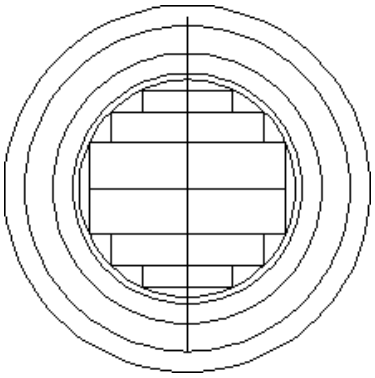
Outer dia of LV= 298mm

Inner dia of HV = 405-2(23)=359mm

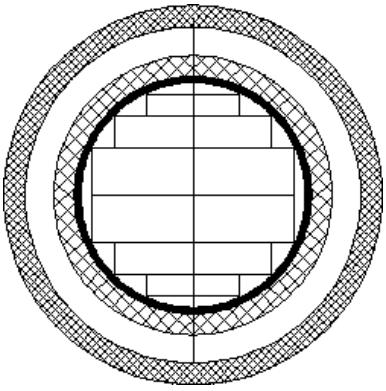
Outside dia of HV =405mm

Step3 : Hatching

Select hatch icon, select the pattern of hatch, then hatch LV & HV wndg as shown below



Before hatching LV & HV



Before hatching LV & HV

Step 4: To draw insulating ring:

- The space available for insulating ring between the region of LV & HV is calculated as:
- Inner dia of HV – outer dia of LV=359-298=61mm {61mm/3 = 20.3}
- Hence inner dia of insulating ring = 298+20.3=318.3mm
- Outer dia of insulating ring = 359+20.3=338.7mm
- Hatch the region of insulating ring
- Draw a rectangle as shown below & hatch it in fig(1)
- Use array command (polar array) , to array the rectangles as shown below in fig(2)specify total no. of items as 12 & angle to fill as 360 & also select the centre point & click OK & next place d bolts using line & arc command as shown

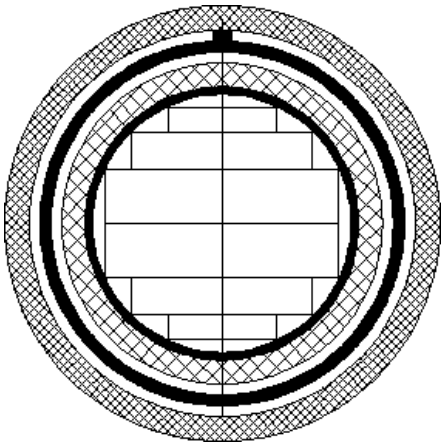


Fig 1

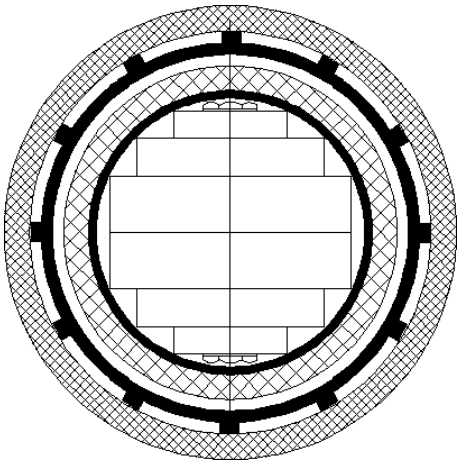


Fig 2

PROBLEM 2:

Make a proportional longitudinal cross section of a 3phase,oil cooled power transformer showing the HT & LT windings, diameter of circumscribing iron core =22.6cm,dia of secondary winding in 2 concentric layers, inside 25cms,outside 28.1cms,height of secondary winding 41.2cm,dia of primary winding, inside 32cm,outside 36.8cm.total height of primary winding , including 10 spacers, 40 cms.

Given: Dia of circumscribing circle =d=22.6 cm=226mm

Width of larger stamping Wd=0.9d=(0.9*22.6)=20.34cm=203.4mm

Step 1 : Set limits

Step2 : Draw the line **ab** of length 203.4mm using line command as shown

a ——————— 203.4 mm ——————— b

Step 3: To find total height :

Total height = ht.of sec wndg + Insulatn at top +Insulation at bottom

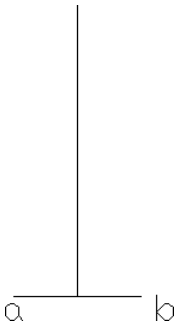
= 41.2 cm + (wooden packing + metal ring + moulded Bakelite) + (wooden packing + metal ring)

= 412mm + (1+1+1.8…….cms) + (1+1……cms)

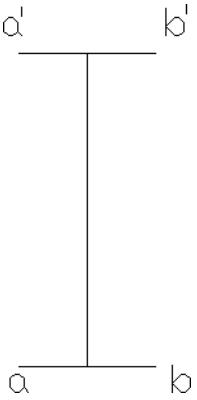
= 412mm + 38mm + 20mm

= 470 mm

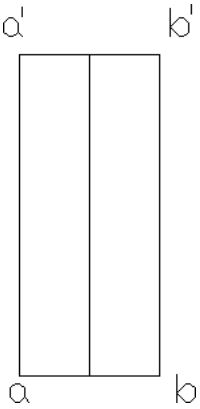
1. Next obtain the midpoint of line **ab**, from that midpoint draw a vertical line using line command of height of 470mm as shown in fig(1)
2. Offset the line **ab** above at a distance of 470mm to obtain line **a'b'** as in fig(2)
   Join the lines **aa'** & **bb'** as in fig(3)
   Extend the line **ab** on either of the sides
   Extend the line **a'b'** on either of the sides as shown below in fig (4)



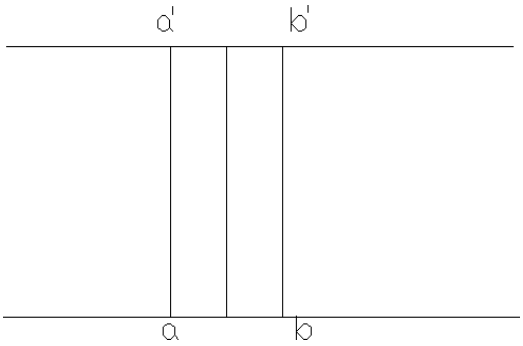
Fig(1)



fig(2)



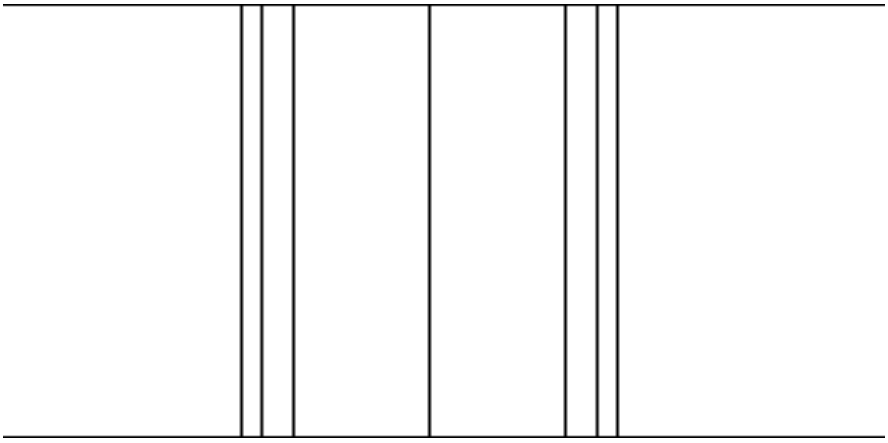
Fig(3)



fig(4)

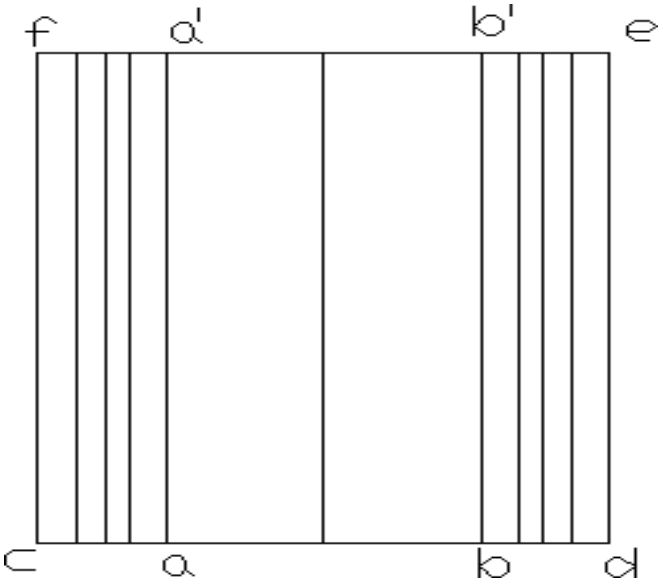
<u>Step 4</u> : To include primary & secondary windings

<u>Secondary wndg</u> : Inner dia = 25cm = 250mm
Outer dia = 28.1cm = 281mm
Again offset centre reference line on both the sides to draw Inner dia ,therefore offset distance is 250mm/2 = 125mm
Similarly offset centre reference line to draw outer dia, hence offset distance is 281mm/2 = 140.5mm… .....as shown below



Primary winding : Inner dia = 32cm = 320 mm
Outer dia = 36.8cm = 368 mm

Similarly offset the reference line to draw inner & outer dia of pri with offset distance of 320mm/2 = 160mm & 368mm/2=184mm respectively & trim the extended lines which are beyond points **c, d, e, f** as shown below.



Step 5 :To include insulations at top & bottom for pri& sec wndgs

To include wooden packing & metal ring

Select line **ac**

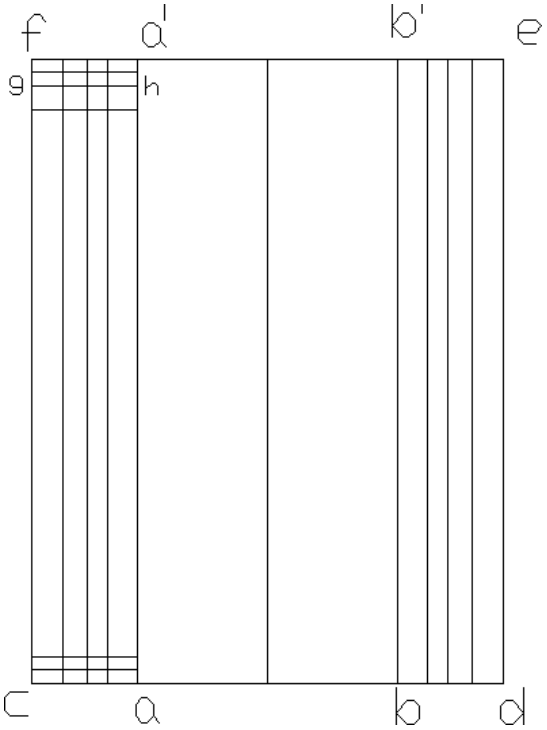
Offset the line **ac** horizontally at a distance of 10mm above, again offset the line obtained at a distance of 10mm above

Similarly offset the upper part .

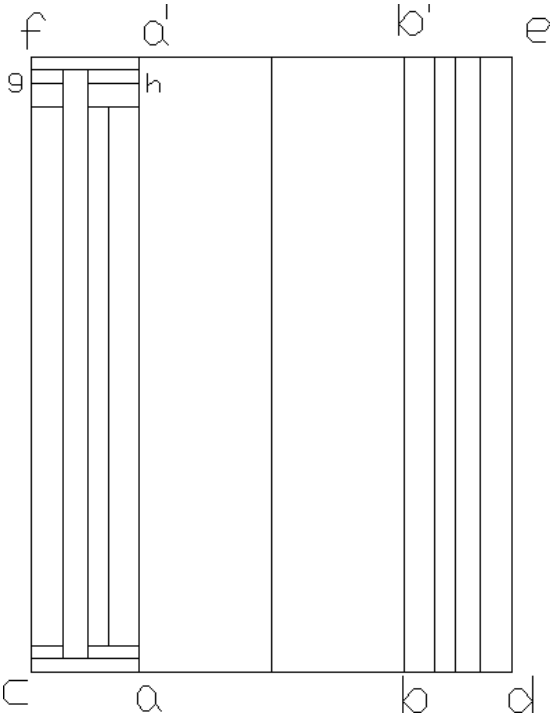
To include moulded Bakelite insulation at top:

Offset the line **gh** horizontally at a distance of 18mm at the top as in fig(1)& trim the Unwanted lines by selecting proper cutting edges as in fig(2)

& hatch the corresponding 3 different kinds of insulation with different types of hatch Pattern as shown below in fig (3)



Fig(1)

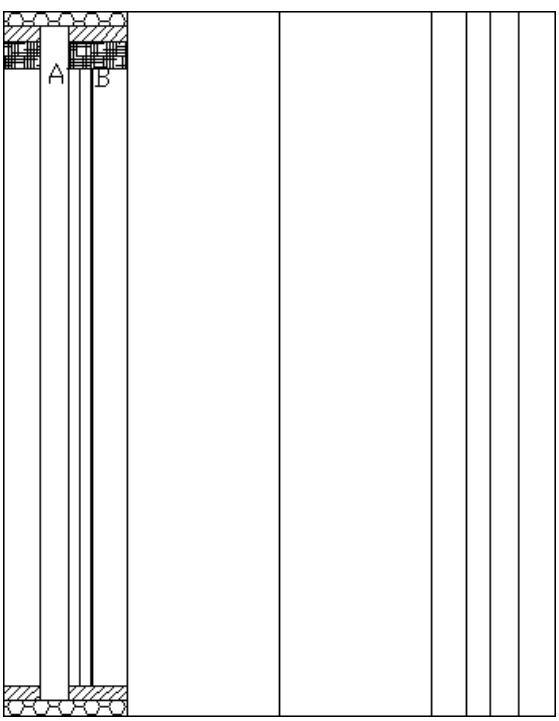


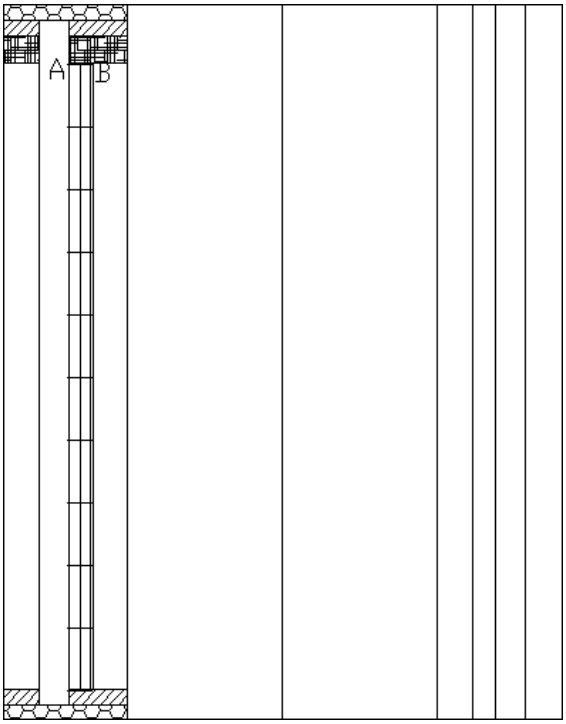
Fig(2)

Step6: To draw concentric type of winding for sec wndg

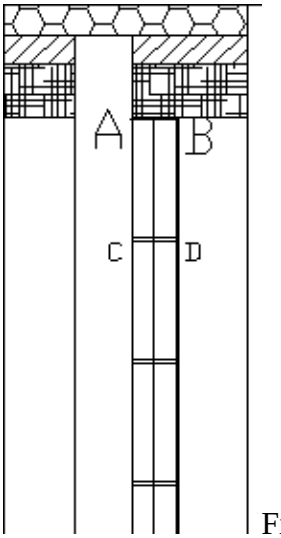
Height of sec wndg = 41.2cm=412mm
Obtain the midpoint of line **AB**, draw a vertical line from the midpoint.
As shown in fig (3)
To include : 10 concentric wndg : 412mm/10 = 41.2mm
Select line AB, then offset it at a distance of 41.2mm, next select line CD offset it at a

distance of 1mm or 1.5 mm above it. repeat the same for entire height of sec wndg
Hatch it as shown

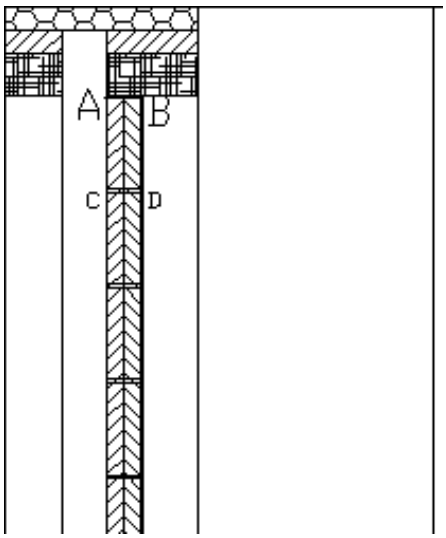




To include : 10 concentric wndg : 412mm/10 = 41.2mm
Select line AB, then offset it at a distance of 41.2mm, next select line CD offset it at a distance of 1mm or 1.5 mm above it. repeat the same for entire height of sec wndg as in fig(a).Hatch it as shown in fig (b).



Fig(a)



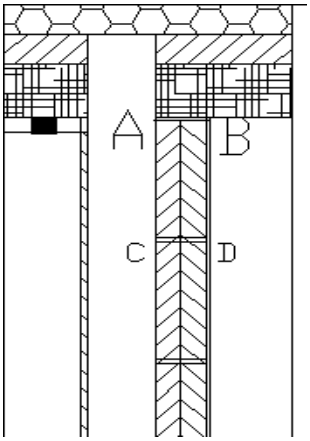
Fig(b)

<u>Step 7:</u> To draw disc type winding for primary:
Height of primary wndg is = 40 cm= 400mm
Thickness or height of insulation = 0.5cm(top) + 0.5 cm(bottom)
= 1cm = 10mm
Height of each disc type wndg= (400mm-10mm) / 9

= 390/9
=43.3mm

Consider primary wndg,

--------->>>Offseted line at a distance of 0.2cm (or 2mm) from reference line & hatch it as shown
----->>>reference line



To draw insulation at top & bottom: draw a rectangle of height of 0.5cms (5mm) & hatch it & place it appropriately as shown above in fig(3)

To draw disc type wndg:

- Select line **rs** offset it at distance of 43.3mm which is the height of each disc type wndg, so that line tu is obtained .Offset the region of pri windg so that 9 U shaped coils are obtained..
- Next offset the line **tu** above at a distance of 2mm or 2.5mm to include the spacer as in fig(4)
- Select the block **rstu,** offset the 3 sides of block at a distance of 2.5mm as in fig(5).Then hatch it solidly
- Inside this U shaped disc hatch it as shown fig (6)
- Copy the disc type winding & place it appropriately

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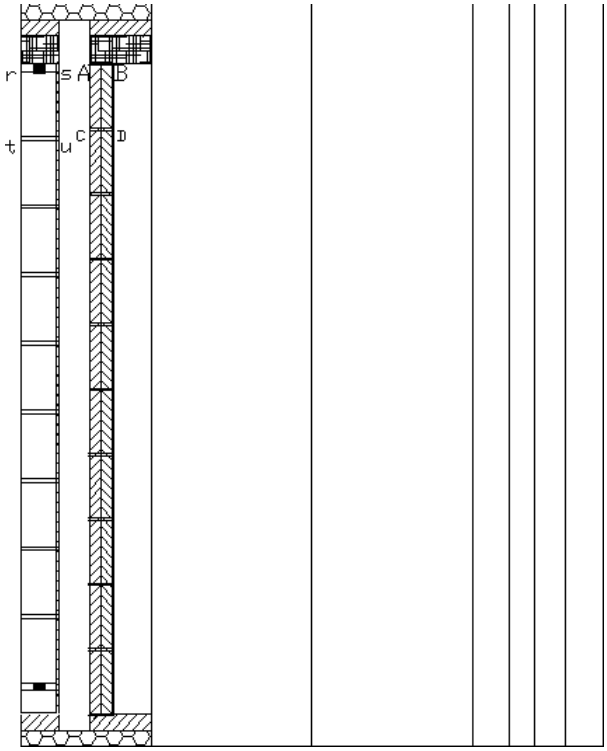
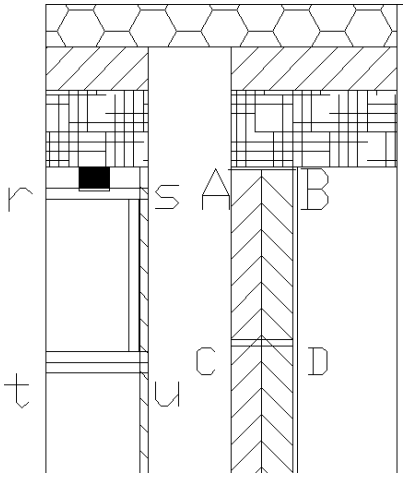
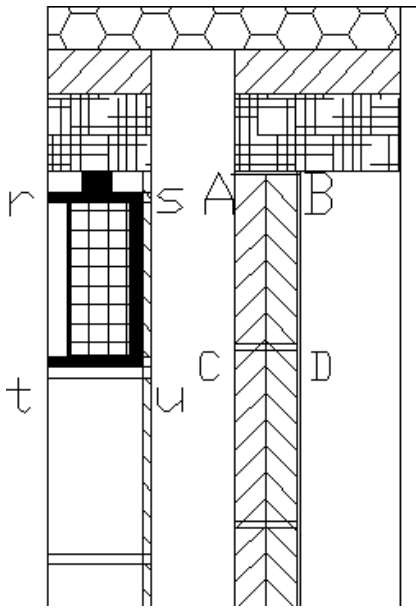
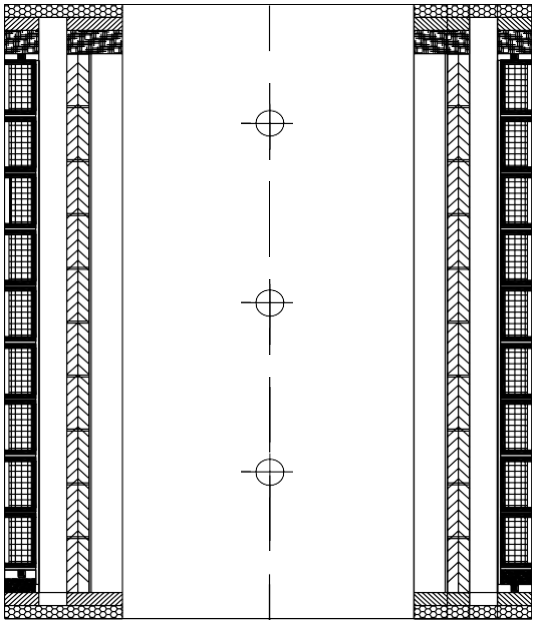






Once primary & secondary winding is drawn ,using mirror command, place the pri& sec wndg on right half of elevation as shown



PROBLEM 3 :

Draw the detailed drawing of each part separately for a 500KVA, 6600/400V single phase power transformer & then full assembled sectional plan & elevation

Detailed dimensions of parts:

Core:Laminated steel plates of 0.35mm thickness , core cruciform

Diameter	**=33cm**
Width of the largest stamping	**=28cm**
Width of the smallest stamping	**=17.5cm**
Height of core , H	**= 43cm**
Centre to centre distance between cores	**= 49cms**

Core laminations are fixed by means of two end plates 3mm thick by a bolt of dia 1.2cm

Yoke: construction cruciform

Yoke height		**=25cm**
Yoke length	**=49+0.85*33**	**=77cm**
Total height of transformer		**=93cm**

Winding:

LV winding :(placed near the core) helical type

LV winding total turns	**=22**
No. of turns per limb	**=11**
LV winding conductors cross section made from 20 square straps of size 5*5mm & with insulation 5.5*5.5mm	**=500sq.mm**
Height of 1 turn	**= 28.5mm**
Radial thickness of 1 turn	**=23mm**
Total height of the core occupied by the LV winding	**=36.2cm**
Inside dia of LV winding	**=33.75cm**

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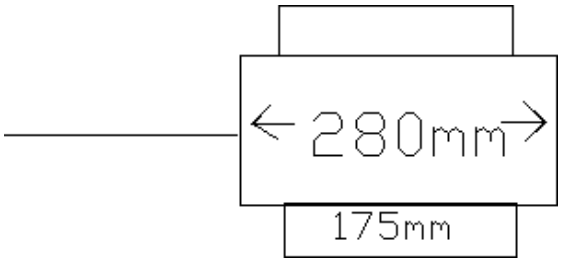
Outside dia of LV winding **=38.35cm**
HT winding:(in two layers)"concentric type"
Total no. of turns **=378**
No. of turns per limb **=189**
Cross section of HT conductor made from made from one rectangular size strap of size 3*9mm **=27sq.mm**
Inside dia of HT 1st layer **=41.5cm**
Outside dia of HT 1st layer **=43.3cm**
Inside dia of HT 2nd layer **=45cm**
Outside dia of HT 2nd layer **=46.8cm**

Solution:

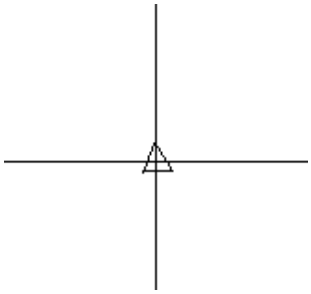
Given:

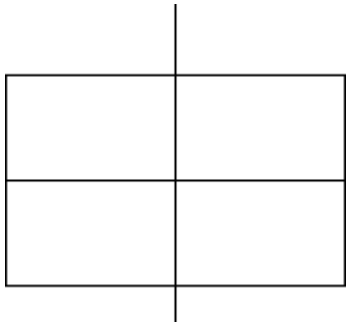
2 stepped core
Width of larger stamping= 28cm=280mm
Width of smaller stamping=17.5cm=175mm
To draw sectional plan:



Step1: To draw 2 stepped core

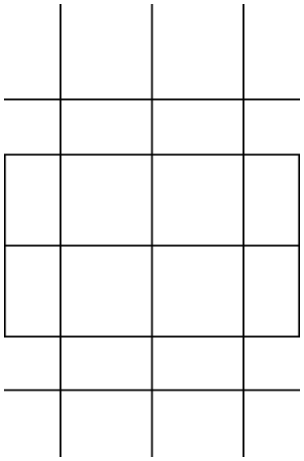
1. Set limits
2. Type line, keeping polar status bar in ON mode
3. Draw a line @280<0, then by obtaining midpoint on this horizontal line draw a vertical reference line as shown in fig(a)
4. Offset the horizontal line by 87.5mm on both sides. Join the lines as shown in fig(b)

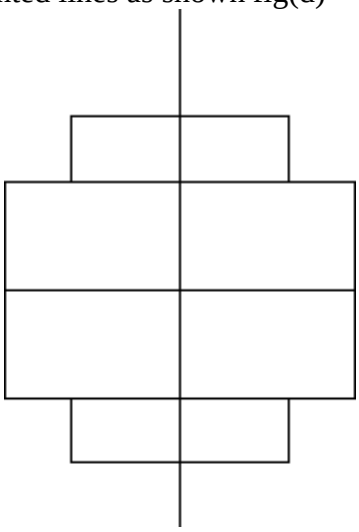




Fig(a) fig(b)

5. Next offset the horizontal line by 140mm on both sides
6. Offset vertical line by 87.5mm on both sides as in fig(c)
7. Select the proper cutting edges & trim the unwanted lines as shown fig(d)





Fig(c) fig(d)

Step 2: To draw inner & outer dia for LV & HV winding

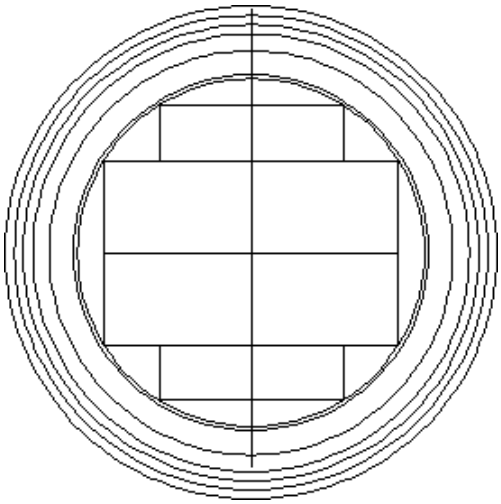
- Type 'circle' in the command prompt
- Specify the centre point
- Specify the radius of the circle or diameter: Type 'D' & press enter
- Specify dia of circle : 33cm=330mm

Repeat the above 4 steps to draw inner & outer dia of LV & HV wndg with following details as shown in fig(e)

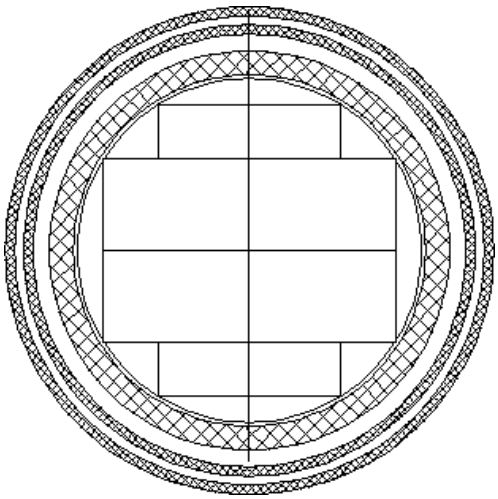
Inner dia of LV= 337.5mm
Outer dia of LV= 383.5mm
Inner dia of HV 1st layer = 415mm
Outside dia of HV 1st layer = 433mm
Inner dia of HV 2nd layer = 450mm
Outside dia of HV 2nd layer = 468mm.

Step3 : Hatching

Select hatch icon, select the pattern of hatch, then hatch LV & HV wndg as shown in fig(f)



Fig(e)

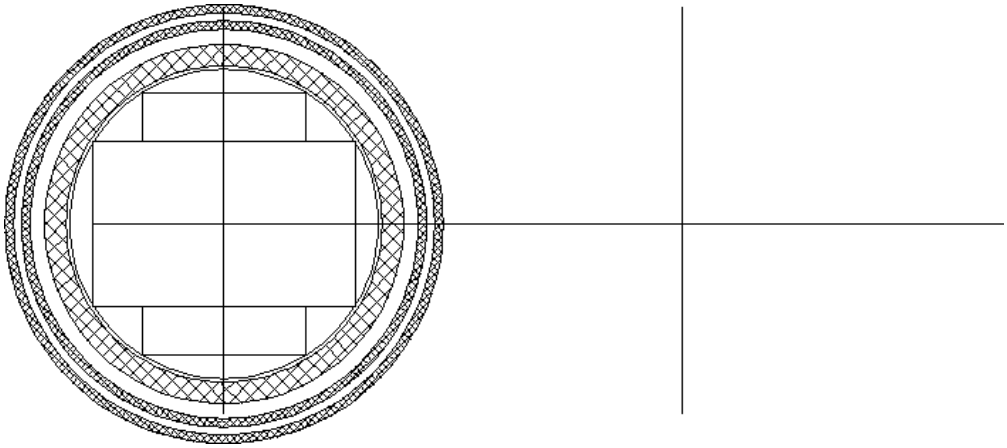


Fig(f)

Step 4:

Given centre to centre distance of the core = 490mm

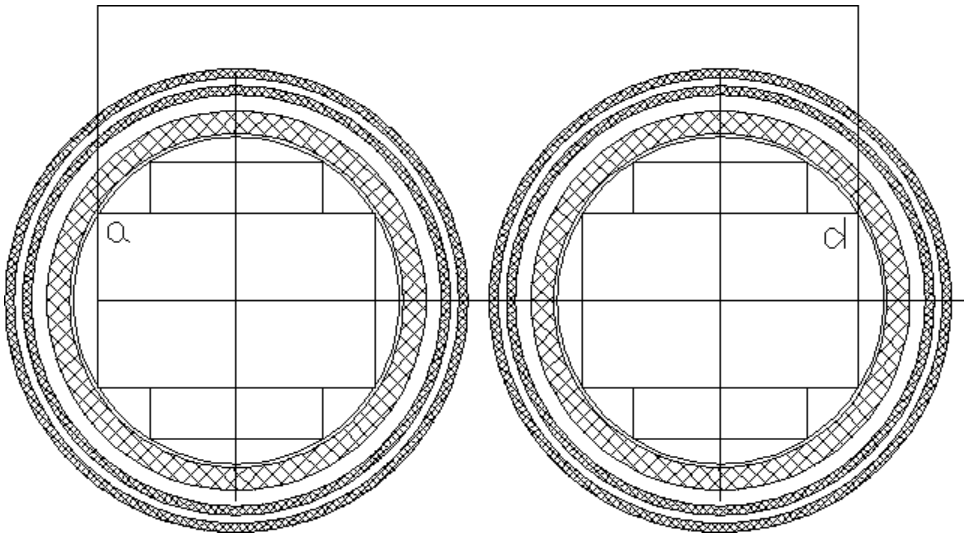
- Offset the vertical line at a distance of 490mm
- Extend the horizontal reference line as in fig(g)
- Using copy command , copy the entire core by specifying the base point as shown & place it at the reference point O.
- This completes the sectional plan of transformer as in fig(h)



Fig(h)

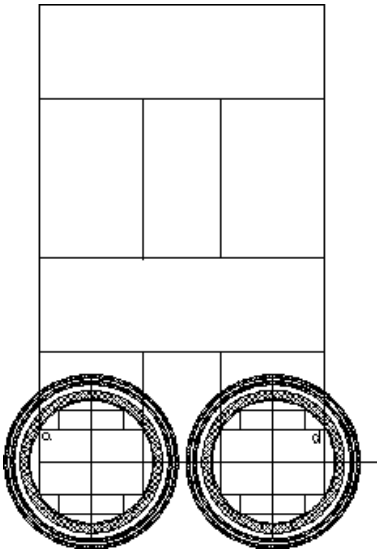
Step5: To draw sectional elevation

- Extend or project the lines from the point a & from the point d vertically upwards, draw a horizontal line to join the extended lines as shown in fig(h)

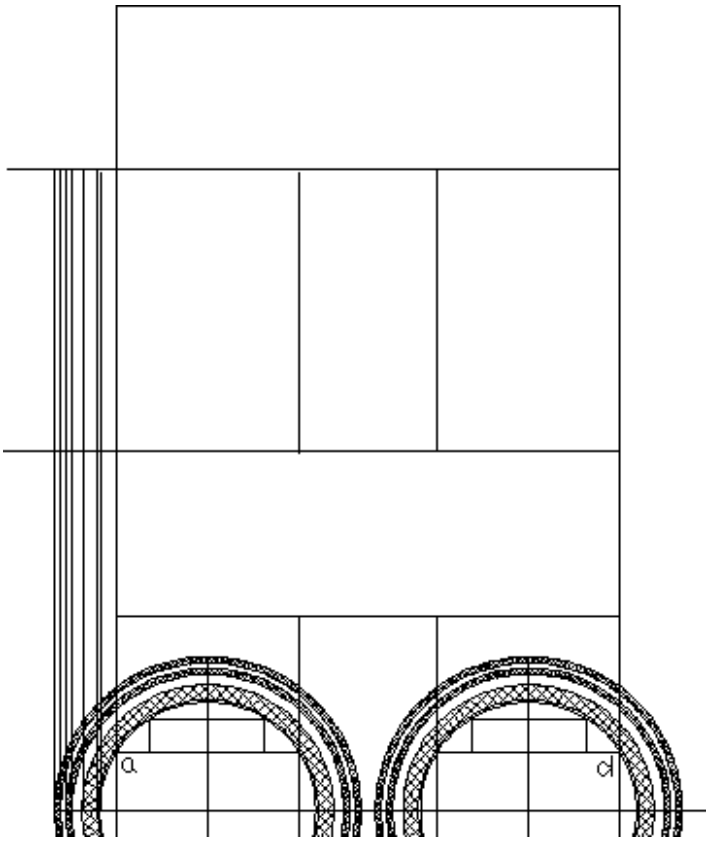


Fig(h)

- Offset the horizontal line above at a distance of 250mm(height of yoke)
- Next offset the 2nd horizontal line at a distance of 430mm(height of core) above
- Next offset the 3rd horizontal line at a distance of 250mm(height of yoke) above as in fig(i)



- Project the points from LV & HV(2 layers) wndg, 2 stepped core to carry out elevation as shown



Step6: Using text command write the height (dimensions) of LV & HV windg

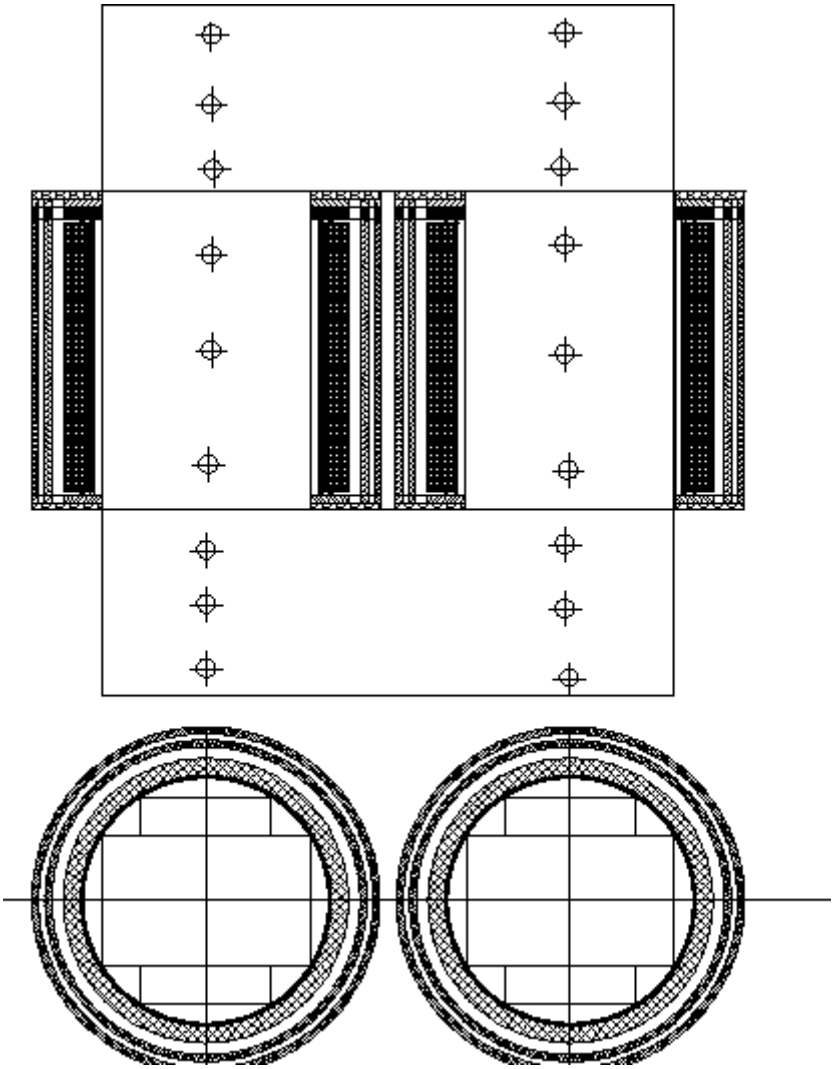
Step 7: Refer problem 2 to provide insulations using offset command at top & bottom

Step 8: To represent the type of wndg for LV& HV with respect to elevation

- Given: height of LV wndg=36.2cm=362mm
- Type of LV wndg= helical
- No. of turns/ limb= 11
- Similar to 2nd prblm, draw 11 coils of height(362/11 =32.9mm) using offset command, between each coil provide spacing of 1mm, next hatch it as shown
- Next hatch the 2 layers of HV wndg in the elevated part

Step9 : Select the elevated winding part, using mirror command place it on right half section for 1st core.

Next copy & paste the elevated part represented with winding for the 2nd core



PROBLEM 4:

Draw the sectional elevation of single phase shell type transformer for the given below dimensions:

Core width	**=14cm**
Core depth	**=37cm**
Core height	**=38cm**
Core length	**=54cm**
Window size	**= 13*24cm**
LV coil	**= 4**
HT coil	**= 4**
No. of turns in LV per coil	**=10**
No. of turns in HT per coil	**=40**
Cross section of the HT conductor	**=28sq mm**
Average height of one turn	**=1.8cm**

Coil to be arranged over medium reactance

Solution:

Step1:

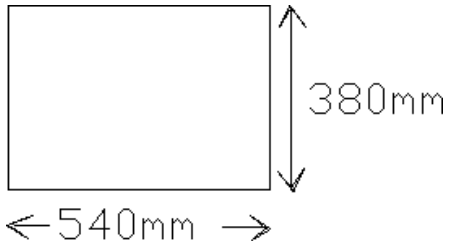
Set limits

- Lower left corner 0,0
- Upper right corner 2500,2500
- Zoom
- Type "ALL"
- Set the units to millimeters

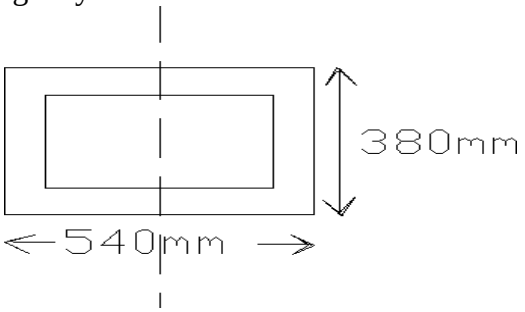
Step 2:

Draw rectangle of dimension 540mm,380mm

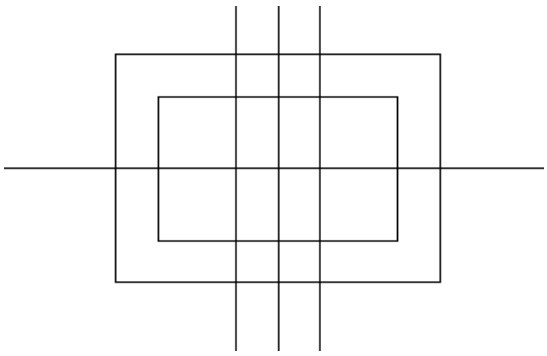
- Select 'rect' icon
- Select a point on screen
- It displays"Area/dimension/rotation" in the command window
- Type "D"
- Length of rectangle=540
- Width of rectangle=380
- Click on screen we get



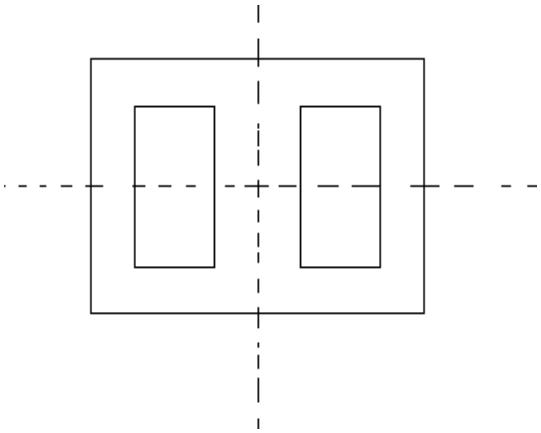
Step 3: a) Offset rectangle by 70mm & draw a reference mid axis as shown



b) Offset vertical mid axis on either side by 70mm & trim we get & also draw horizontal axis as shown below



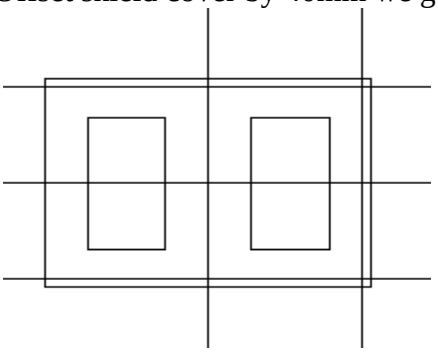
Before trimming



After trimming

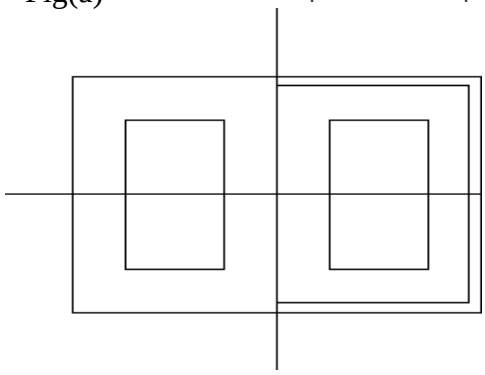
Step 4: To draw end shield plate:

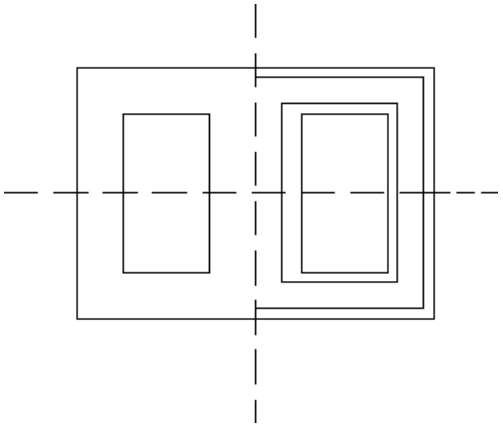
- Offset vertical reference line by 510/2=255mm
- Offset horizontal reference line by 350/2=175mm as in fig(a)before trimming
- Fig(b) shows the diagram after trimming
- Offset shield cover by 40mm we get (all sides) as in fig(c)



Fig(a)

Fig(b)

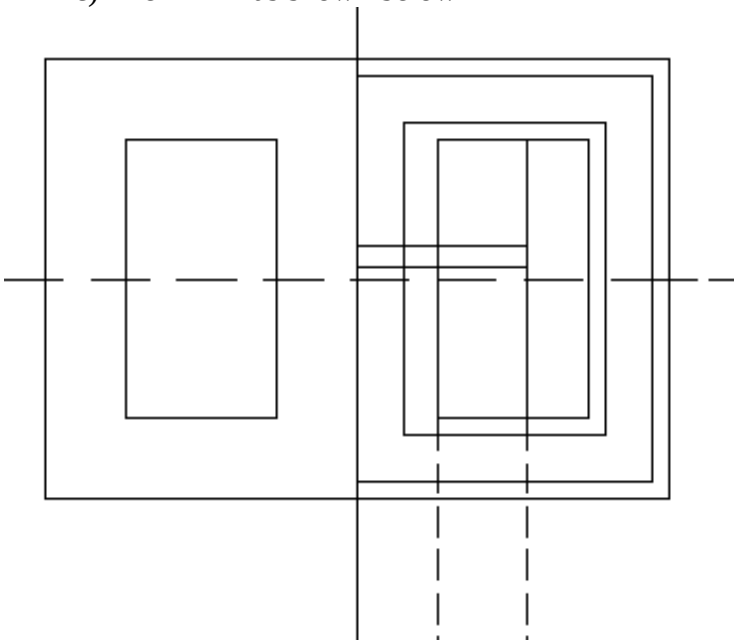




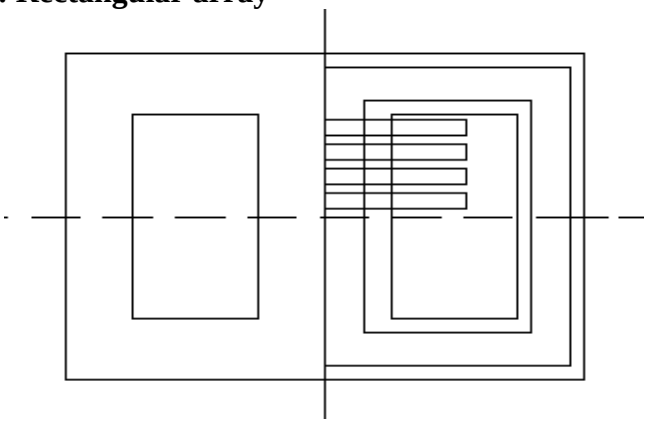
Fig(c)

Step 5:

- Offset right side of window by 76mm(length of coil)
- From horizontal axis:
  a) Offset 10.1mm(clearance)
  b) Offset 18mm(width of coil)
  c) Then Trim as shown below

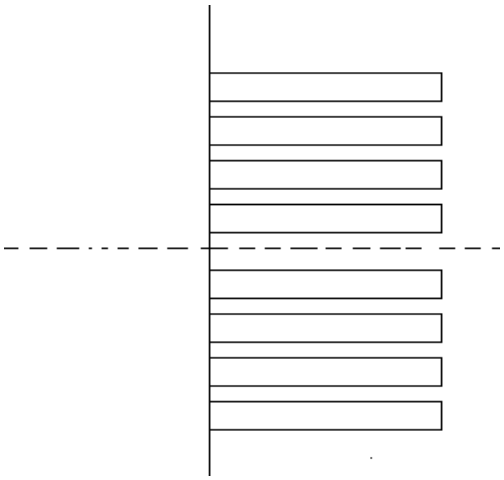


Step6: Array the coil: Rectangular array

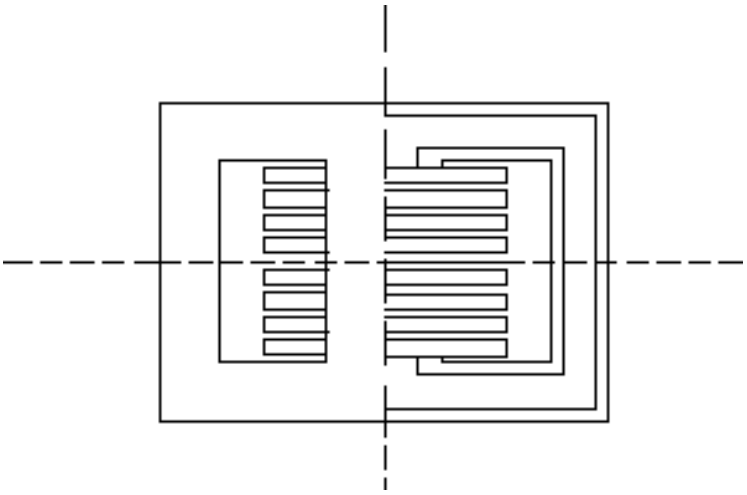


- Row=4
- Column=1
- Row offset=28.1(18mm thickness of coil+ 10.1 clearance)
- Column offset=1
- Select the object
- Click ok then diagram appears as shown above

Step 7: Mirror down we get

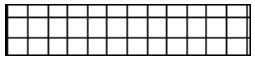


Step 8: Mirror to the left side of window & after trimming we get

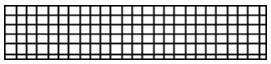


Step 9: Arrangement of LV & HV winding

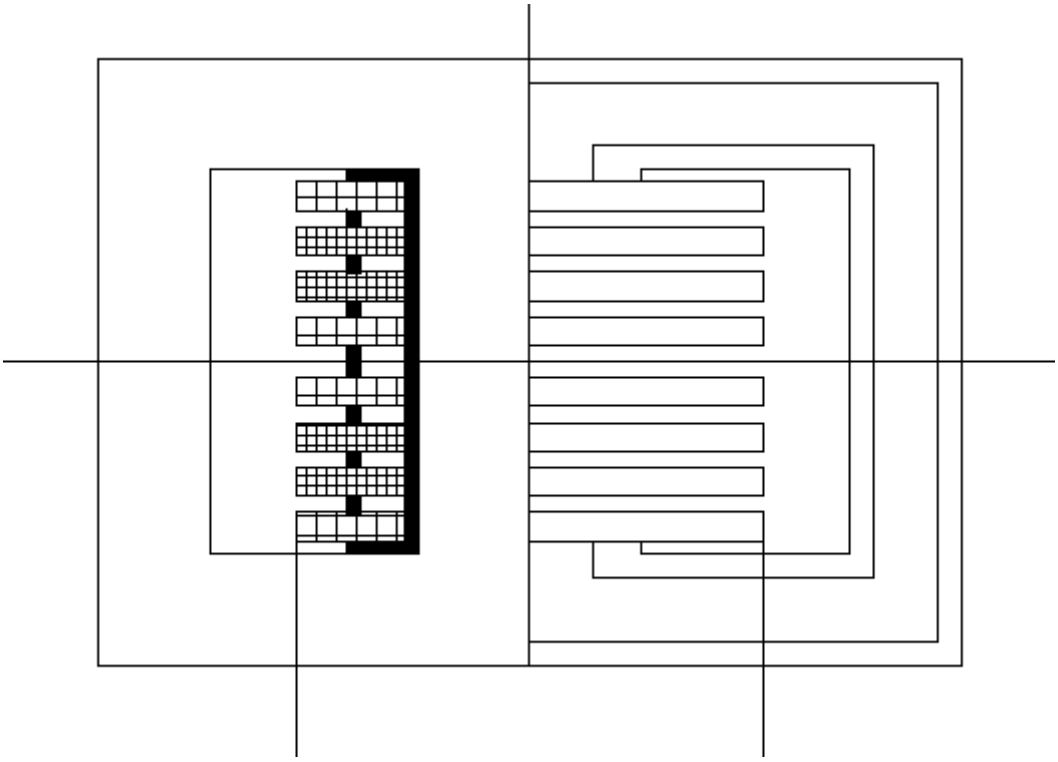
LV: use “Net” pattern in hatch , select scale as 100 as shown below



HV: Use “Net” in hatch command, select scale as 50

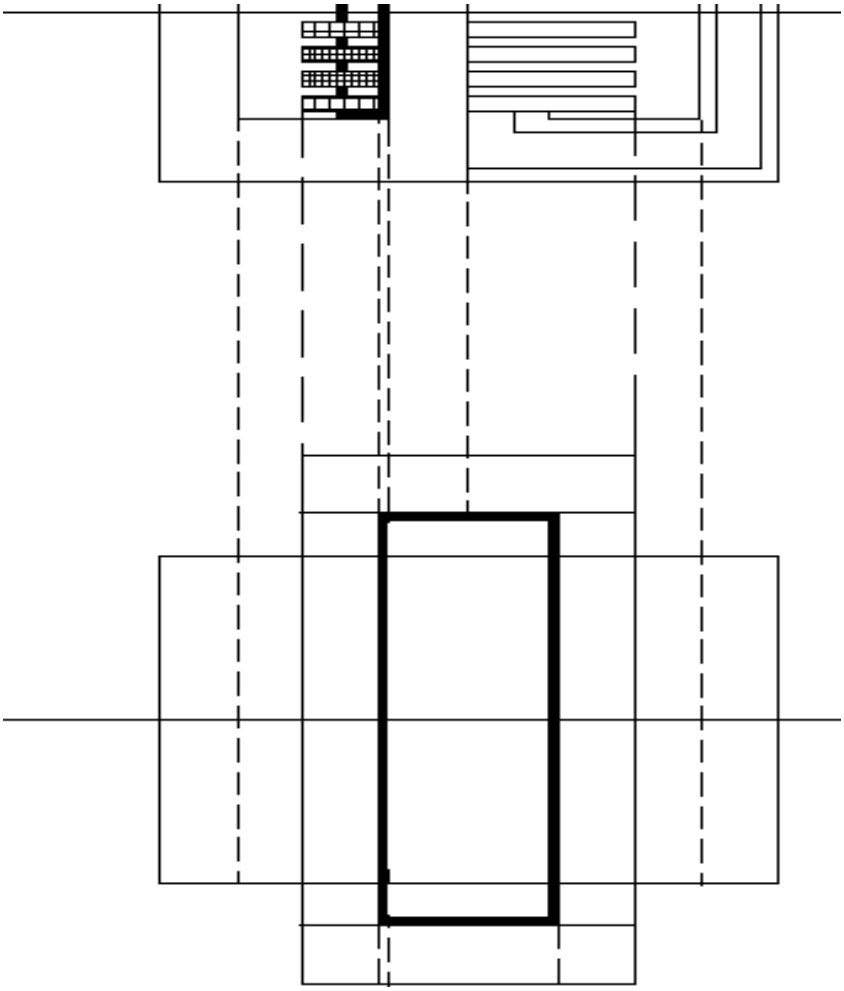


Over all arrangement of LV & HV winding & insulation thickness of 10mm is shown below : (project the lines downwards for elevation as shown below)



Step 10: To draw elevation:

- Draw a rectangle of dimension 540*370mm
- Project the coils down as shown below
- Coil length=76mm
- Assume insulation as 10mm,then length of coil=76-10=66mm
- Hatch the coil & insulation with the patterns:
  - ✓ ANSI37
  - ✓ Solid



Step11: place the bolts and nuts on both sides.

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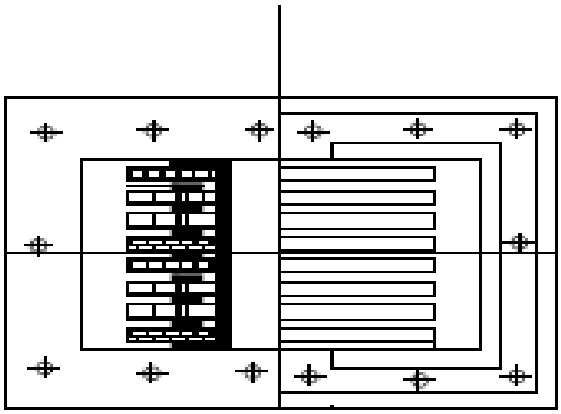

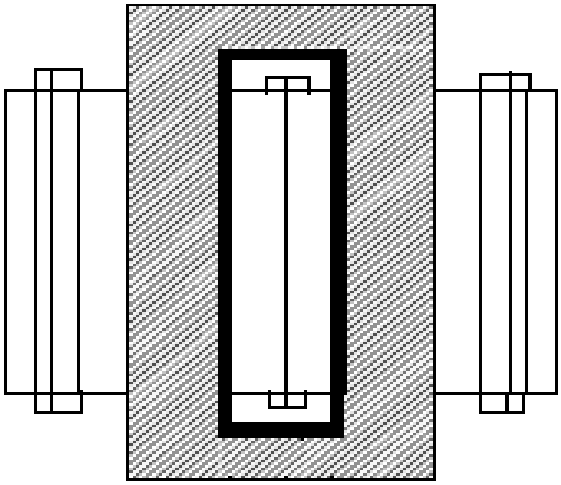

Outcome: students will be able to draw and visualise the sectionals views of various kinds of transformers