AY 2024-25_Odd Sem

Computer Aided Electrical Drawing-CAED-21EE741

Prepared by,

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Dept of EEE

Course Objectives

1. To discuss the terminology of DC and AC armature windings.
2. To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
3. To discuss the substation equipment, their location in a substation and development of a layout for substation.
4. To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
5. To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.

COURSE OUTCOMES

At the end of the course the student will be able to :

(1)**Develop** armature winding diagram for DC and AC machines.

(2)**Develop** a Single Line Diagram of Generating Stations and substation using the standard symbols.

(3)**Construct** sectional views of core type and shell type transformers using the design data.

(4)**Construct** sectional views of assembled DC and AC machine and their parts using the design data or the sketches.

Software used- AutoCAD

Why AutoCAD?

- **AutoCAD** designer use software to create 2D and 3D drawings, which are widely used in the construction and manufacturing industries
- Organizations that employ AutoCAD designers range from construction firms to traditional manufacturing companies to firms operating in the energy industry
- A typical day of an AutoCAD designer may vary depending on project requirements.
- Some typical tasks performed by these professionals include meeting with team members to discuss project needs, creating design drafts and reviewing them with relevant personnel, and updating designs based on team feedback.
- They also use their knowledge of design to provide information and feedback to team members.
- Employers generally require at least an associate's degree for AutoCAD designer positions, as well as demonstrated proficiency in computer aided design software and satisfactory performance in relevant curriculum

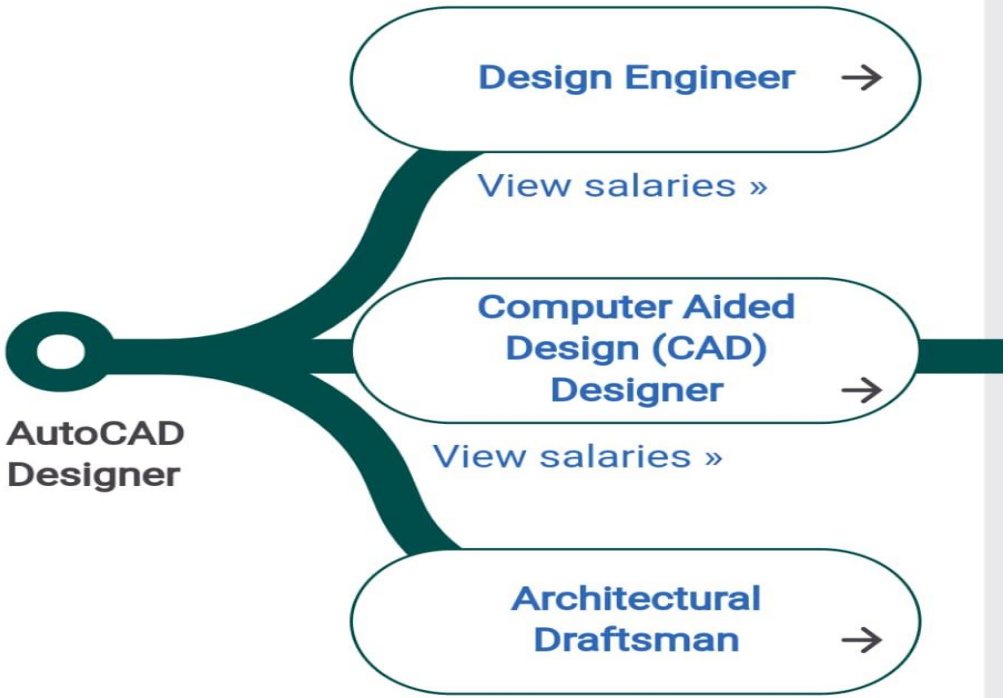
Scope of AutoCAD

- Scope of AutoCAD in India: In India maximum people use autocad for drafting 2d drawings, architecture, Civil , **Electrical** and Mechanical engineering drawings very few use it for 3D design and renderings.
- If you are looking for drafting Job in India then focus on 2d drawings and drafting.
- AutoCAD is a premium software which can provide you tonnes of commands and flexibility when it comes to the art of developing drawings.

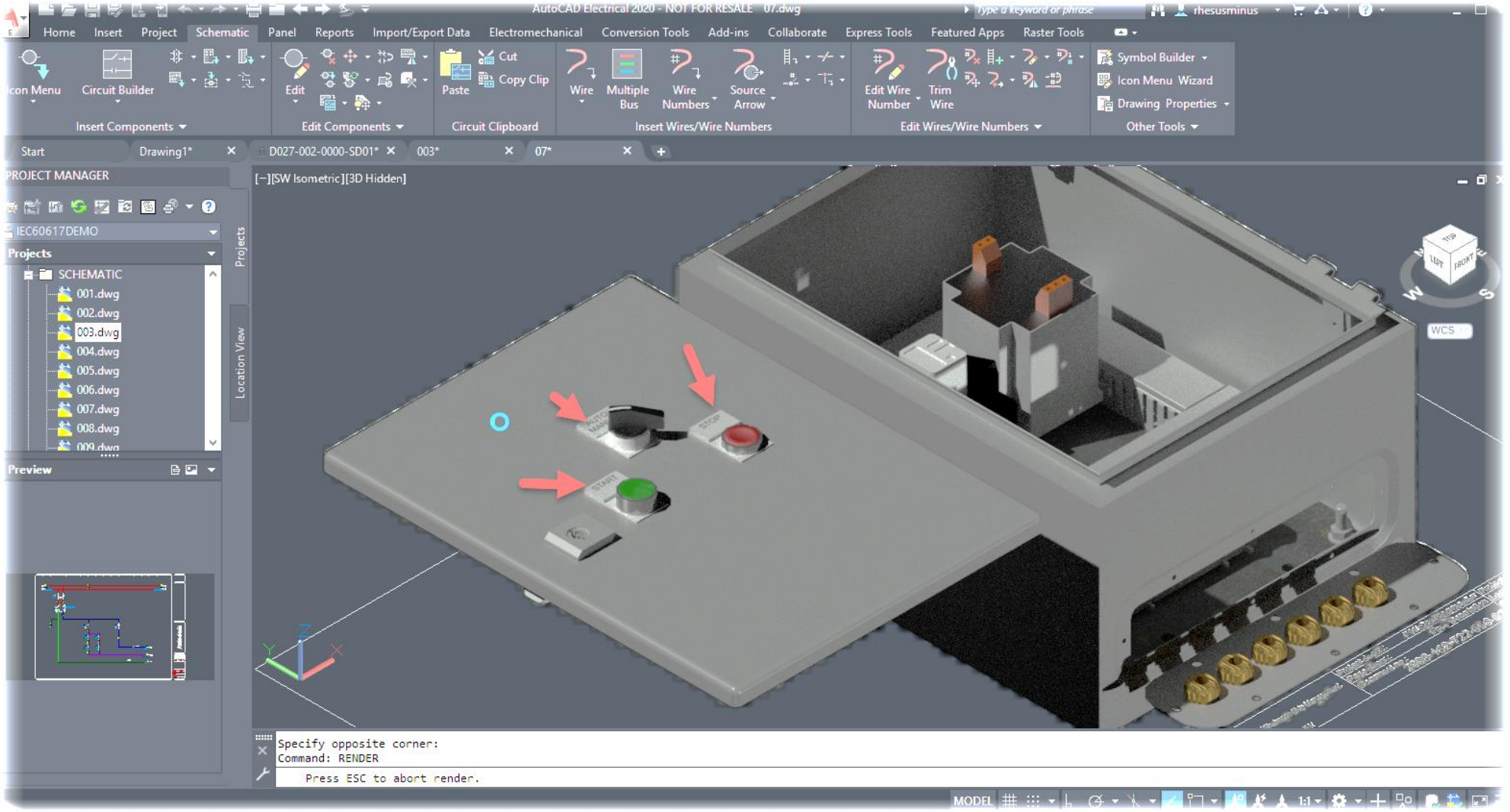
- In India, as a design engineer, you can have a lot of scope if you know AutoCAD along with any good 3D Modeling software.

Career Paths

Explore the most common career paths for AutoCAD Designer. Thickness and color of lines indicates popularity of movement from one job to the next. Visit our career path planner to research other job paths.



Understanding Real Time Application of AUTOCAD



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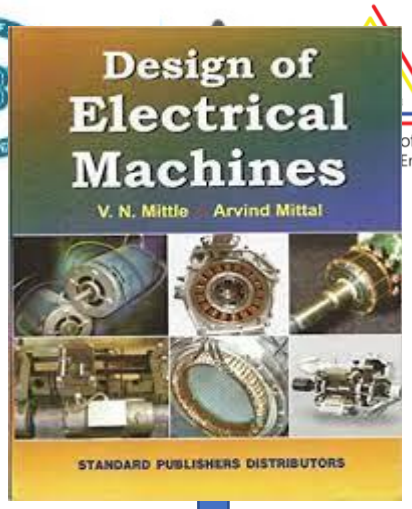
of Engineering

Customer Requirement

Type of machine-AC/DC and its use

Output Specification
Power rating
Current rating
voltage rating

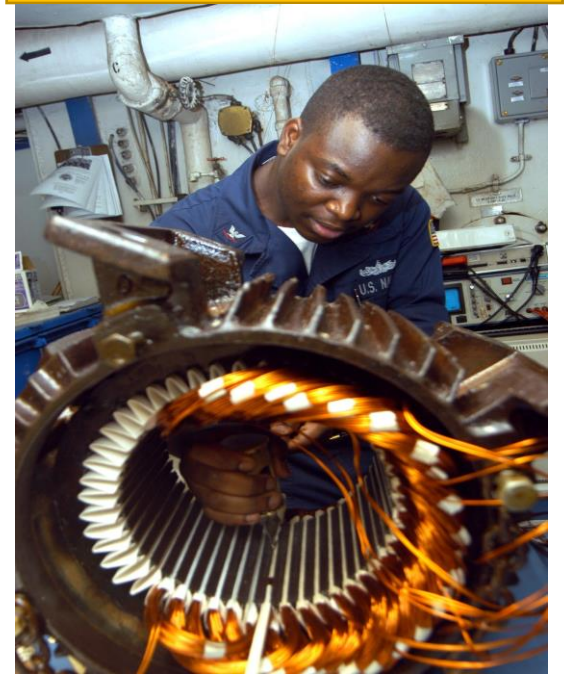
Design-



Design Validation and cost benefit analysis

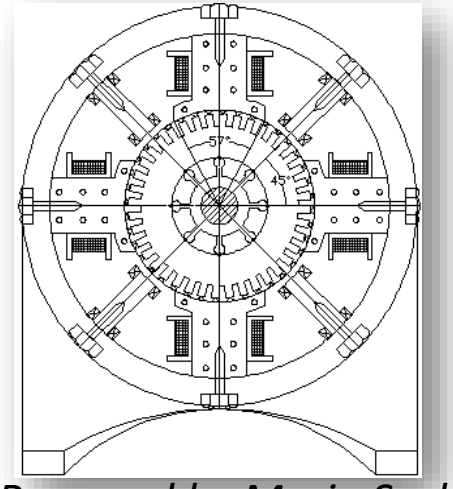
Blue print-Computer Aided Design with Complete dimension

Production sector-Laymen works based on the sketch received



End Product

Testing



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PART – A

Module-1

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..

L_1 – Remembering, L_2 – Understanding, L_3 – Applying.

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

L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.

Module-1

Winding Diagrams

(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Winding

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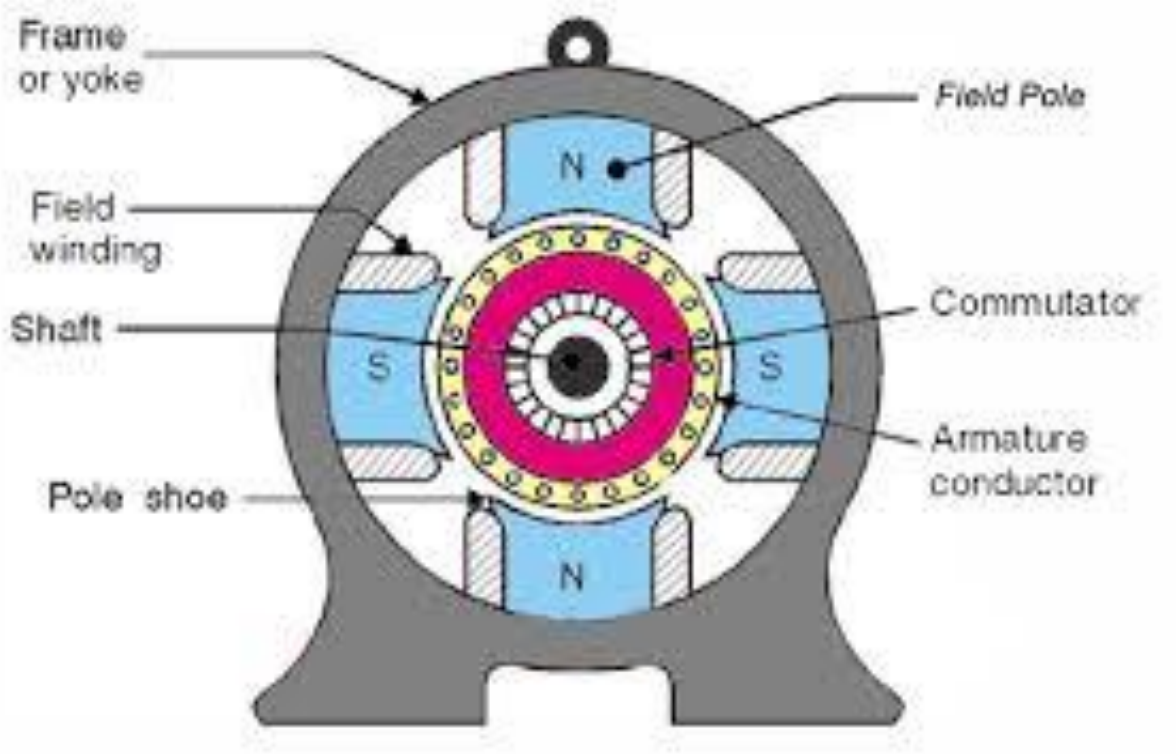
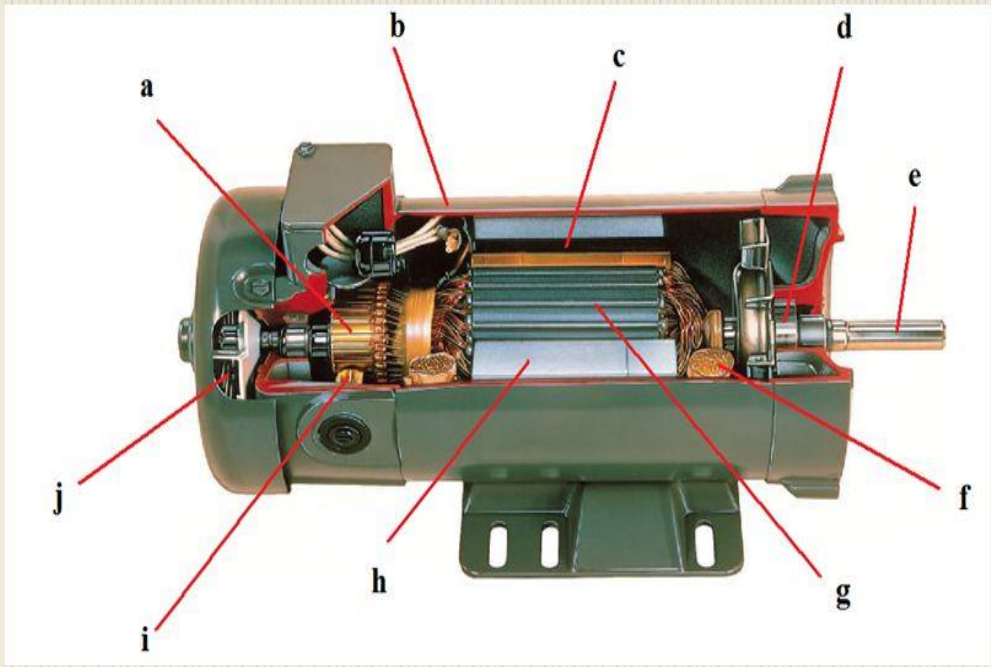


DC MOTOR



a. Commutator	e. Shaft	i. Carbon Brush
b. Frame	f. Stator Winding	j. Fan
c. Field Pole	g. Armature	
d. Ball Bearings	h. Terminal Box	

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D.C.ARMATURE WINDING :

Terms used in armature winding :

CONDUCTOR: Conductor is nothing but an individual length of wire laying within the magnetic field.

TURN : Two conductors connected in a series forms a turn, due to which resultant induced e.m.f. doubles (considering full pitch coil)

COIL : When one or more turns connected in series and its ends are connected to the adjacent commutator segments, (in lap winding) Then it is known as coil.

COIL GROUP: One or more single coils form a coil group.

WINDING : Number of coils arranged in coil group is said to be a winding.

POLE PITCH : Number of conductors per pole is known as pole pitch. If armature is having 24 conductors with 4 poles Then the pole pitch is 24/4=6.

FRONT PITCH : It is the distance covered by the front end connections in terms of conductors. It is represented by Yf.

BACK PITCH : It is the distance covered by the end connection in terms of conductors at the opposite side of the commutator. It is represented by Yb.

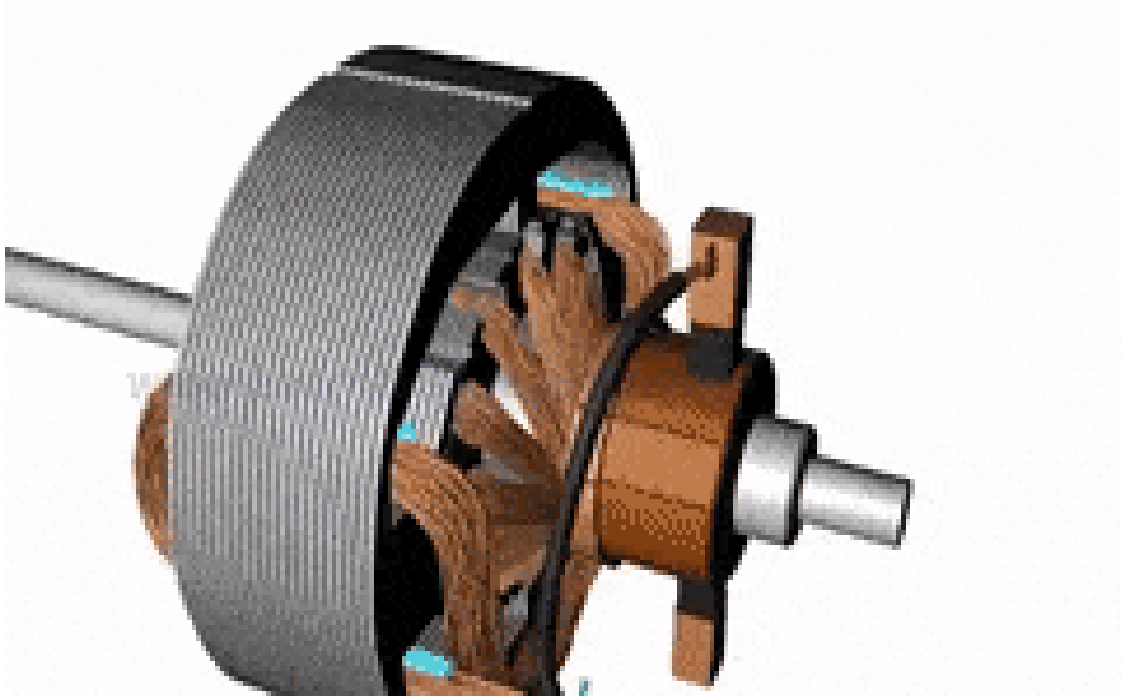
FULL PITCH WINDING: If coil pitch or winding pitch is equal to the pole pitch, then the winding is said to be full pitch winding.

CHORDED WINDING: In such winding, winding pitch is not equal to the pole pitch. If it is short then the winding is called as short chorded winding. In such winding less copper is required, hence copper loss will be less due to short end connections and harmonics become less.

SINGLE LAYER WINDING : It is that winding in which only one conductor or coil side is placed in each slot.

DOUBLE LAYER WINDING : In this winding two conductors or coil sides are placed in each slot.

Usually one side of coil lies in the upper half of one slot and other side lies in the lower half of some other slot.



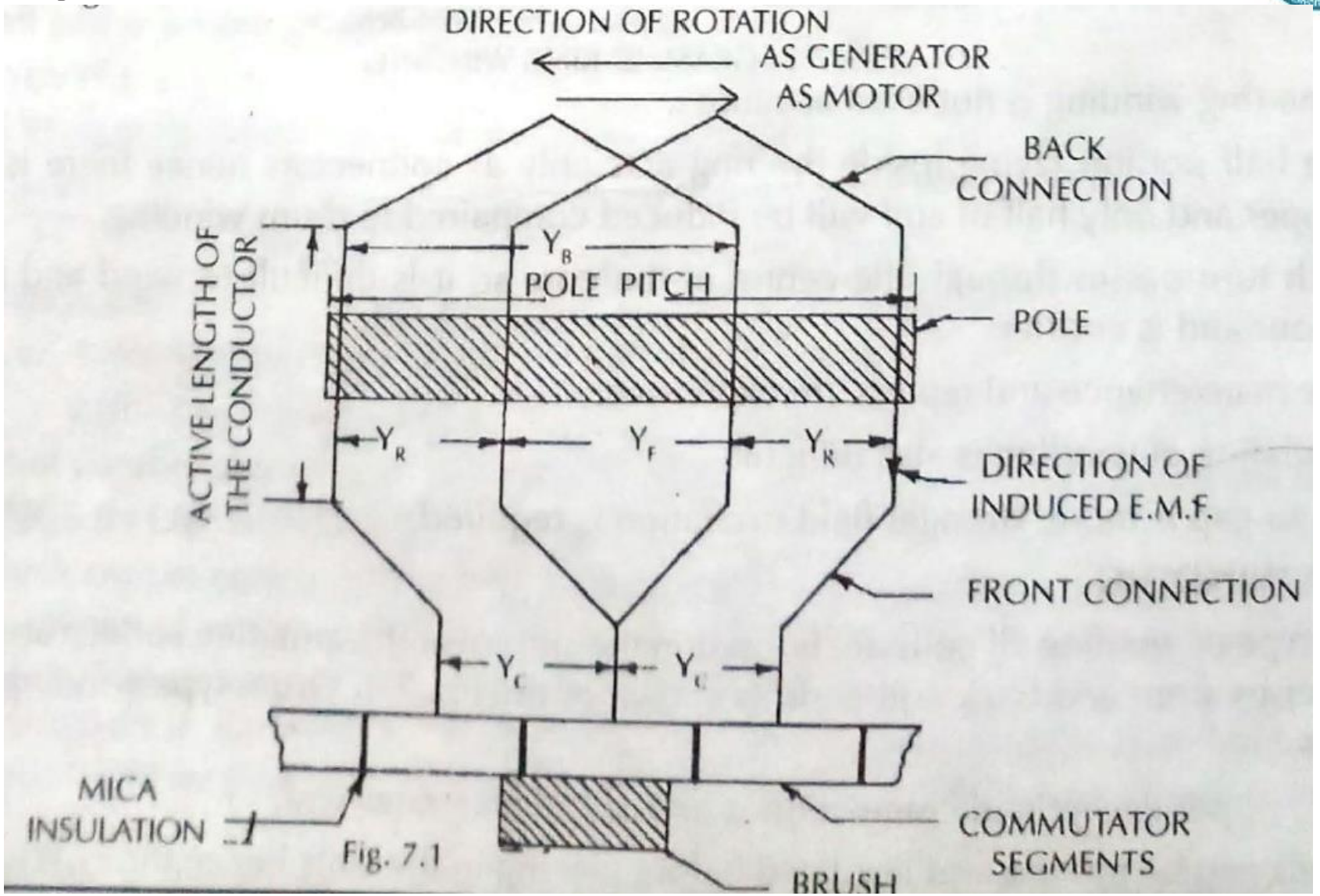

DIRECTION OF ROTATION
AS GENERATOR
AS MOTOR
BACK CONNECTION
Y_B
POLE PITCH
POLE
ACTIVE LENGTH OF THE CONDUCTOR
Y_R
Y_F
Y_R
DIRECTION OF INDUCED E.M.F.
FRONT CONNECTION
Y_C
Y_C
MICA INSULATION
COMMUTATOR SEGMENTS
BRUSH

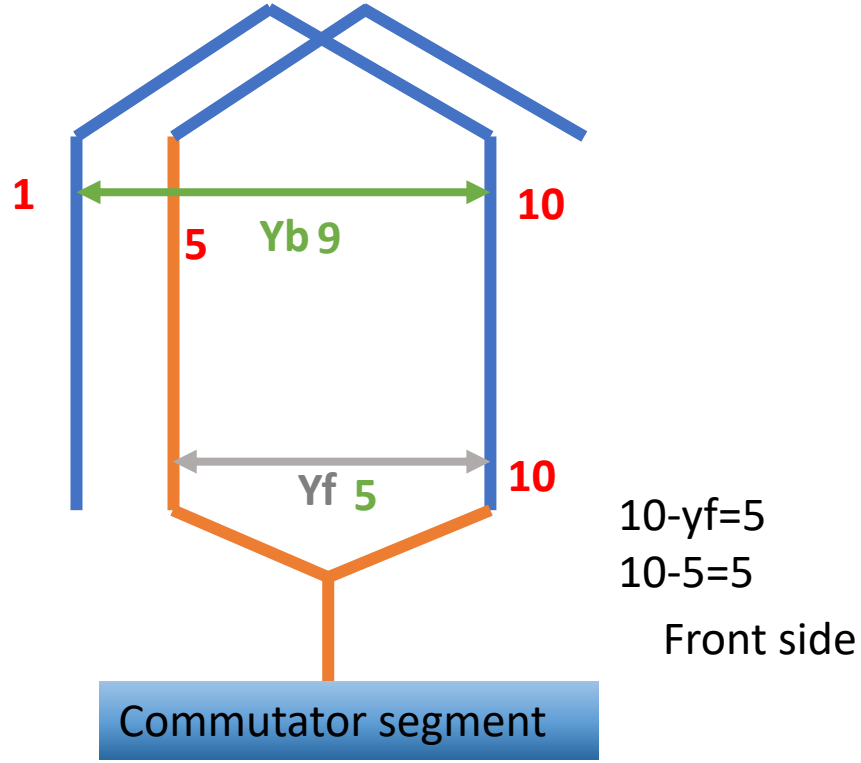
Fig. 7.1

Lap Winding diagram

Back side

1+9=10

1+yb=10



10-yf=5

10-5=5

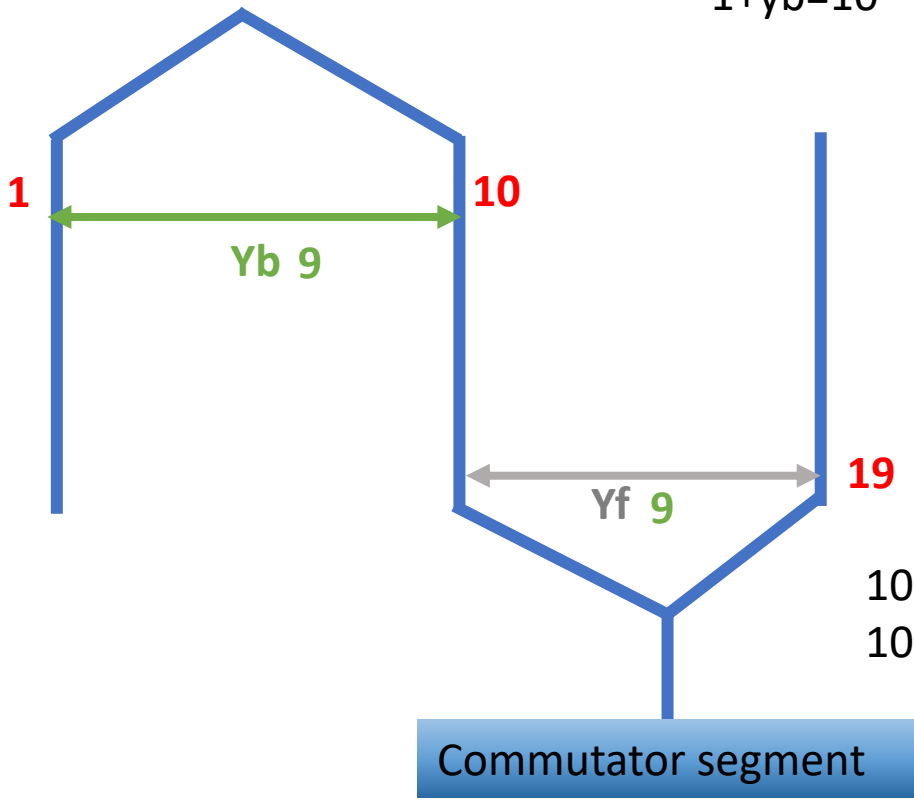
Front side

Wave Winding diagram

1+9=10

1+yb=10

Back side



10+9=19

10+yf=19

Front side

LAP WINDING

- Here the successive coils over lap each other
- Used for low voltage and high current machines
- It is of 2 types- Simplex and Duplex

Important Rule regarding Lap winding.

Let
- Z ⟶ Numbers of condutors.
- P ⟶ Number of poles.
- Yb ⟶ Back pitch.
- Yf ⟶ Front pitch.
- Yc ⟶ Commutator pitch.
- YA ⟶ Average pitch.
- YP ⟶ Pole pitch
- YR ⟶ Resultant pitch

1. Yb and Yf must be approximately equal to the Yp
2. Yb should be either lesser or greater then Yf by 2m where m is the multiplicity of the winding. When Yb is greater then Yf, the winding progresses from left to right and known as progressive winding. When Yb is lesser than Yf the winding progresses from right to left and is known as retrogasive winding.

   Therefore $Yb = Yf \pm 2m$.
3. Yb and Yf must be odd.
4. $YA = \frac{Yb+Yf}{2}$ and should be equal to Yp
5. YR is always even.
6. Yc=m i.e. 1–for Semiplex winding.
   2–for Duplex winding etc.
7. Number of parallel path=mp=number of brushes i.e. for simplex winding parallel path=P.

WAVE WINDING

- Connection always progresses in the same direction round the armature

IMPORTANT RULES REGARDING WAVE WINDING.

1. Yb and Yf both must be odd numbers and nearly equal to the pole pitch. They may be equal or differ by, 2
2. $Yc=Yav=\frac{Yb+YF}{2}$ should be whole number $\frac{Z\pm2}{P}$

The plus sign will give a progressive and negative sign a retrogessive winding.

DUMMY COILS :

These coils are used in wave winding because wave winding is possible only with particular number of conductors. Sometimes standard stamping do not consist of number of slots as per our requirement. At such times dummy coils are used. These coils are identical to armature coil but are not connected to commutator or active circut, these coils are used for mechanical balancing of a machine.

Numericals on Lap winding

1. Design and draw the developed single layer lap winding of DC armature with 24 conductors and 4 poles. Also show the direction current in the coils and the brush position

Sol. / : let No. of pole P = 4

No. of slots Z = 24

∴ No of conductors Z = 24 (∵ single layer)

$$\text{pole pitch } YP = \frac{Z}{P} = \frac{24}{4} = 6$$

$$\text{Average pitch} = YA = \frac{YB+YF}{2} = \text{Pole pitch}$$

$$\therefore \frac{YB+YF}{2} = 6$$

∴ YB + YF = 12 ⟶ eq (1)

For prograssive lap winding YB = YF + 2

∴ YB − YF = 2 ⟶ eq (2)

From eq 1 and 2 YB + YF = 12

YB − YF = 2

2YB = 14

∴ YB = 7

& YF = 5

Winding Table

YB=7	YF=5	Yb=7	YF=5
1 + 7 = 8	8 – 5 = 3	13 + 7 = 20	20 – 5 = 15
3 + 7 = 10	10 – 5 = 5	15 + 7 = 22	22 – 5 = 17
5 + 7 = 12	12 – 5 = 7	17 + 7 = 24	24 – 5 = 19
7 + 7 = 14	14 – 5 = 9	19 + 7 = 26 (2)	26 – 5 = 21
9 + 7 = 16	16 – 5 = 11	21 + 7 = 28 (4)	28 – 5 = 23
11 + 7 = 18	18 – 5 = 13	23 + 7 = 30 (6)	30 – 5 = 25 (1)

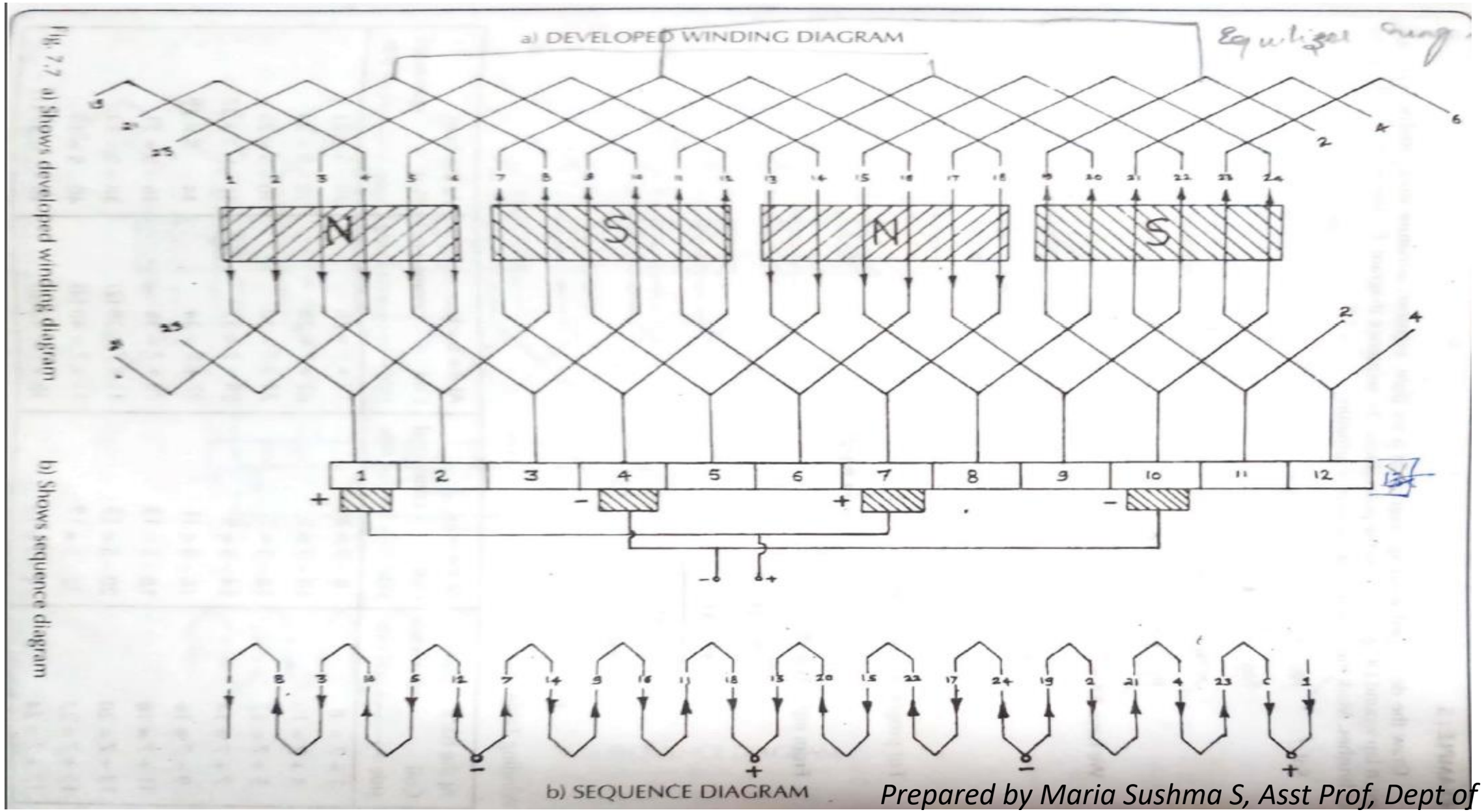
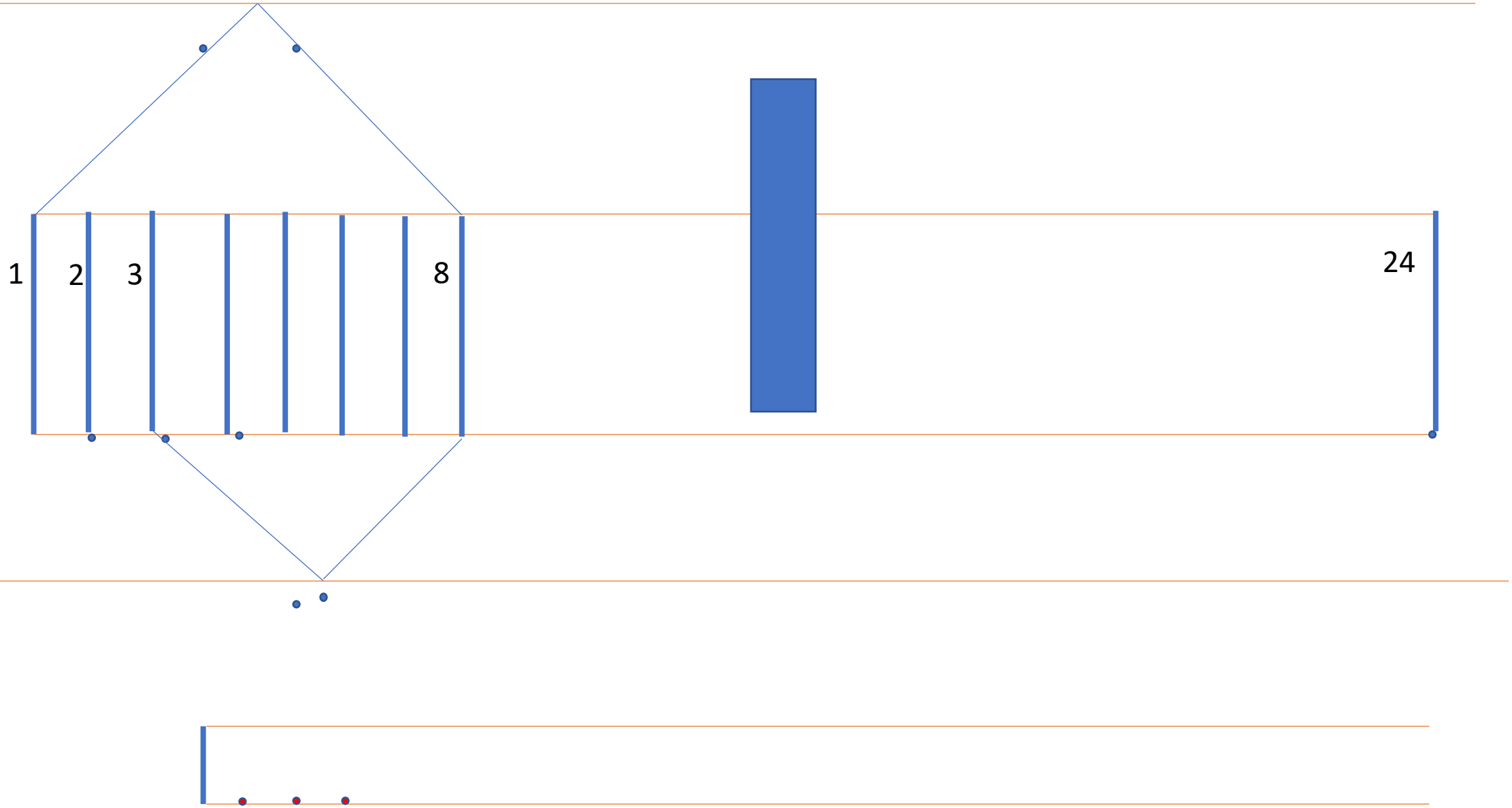
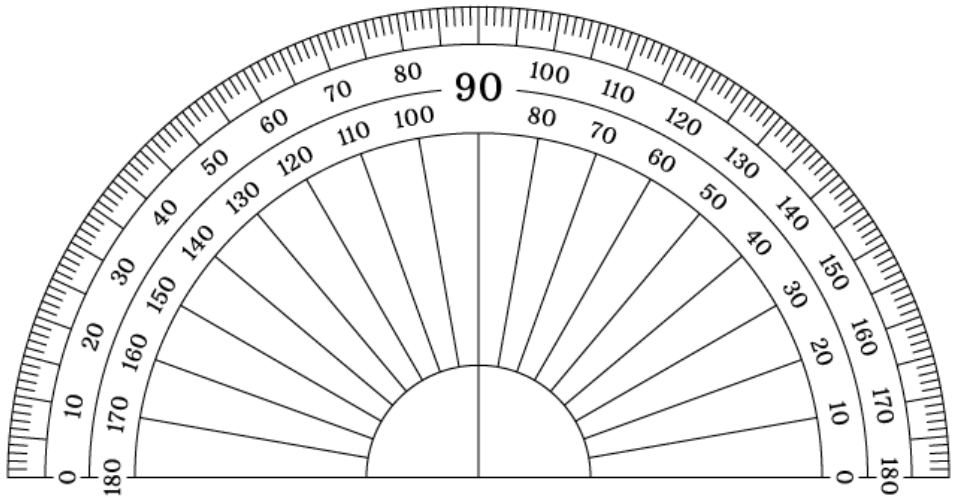


Fig. 7.7 a) Shows developed winding diagram b) Shows sequence diagram


1
2
3
8
24



PROTRACTOR

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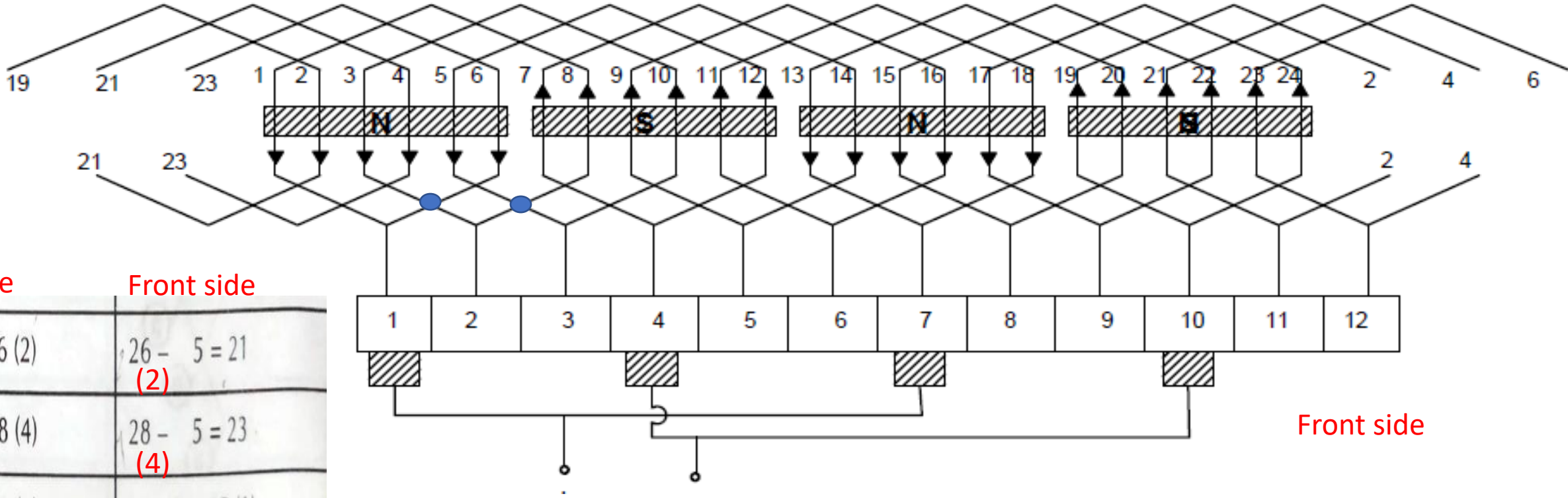
Back side

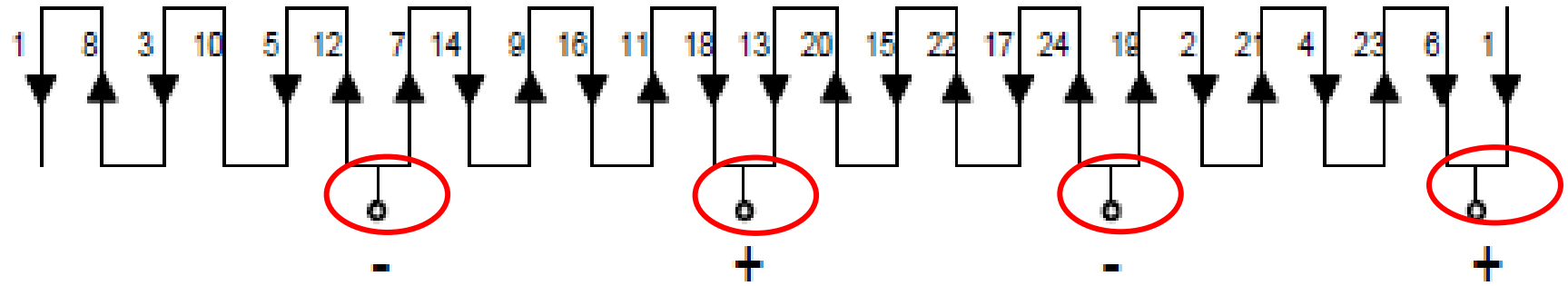
Developed winding diagram



Front side

Back side | Front side

19 + 7 = 26 (2)	26 – 5 = 21 (2)
21 + 7 = 28 (4)	28 – 5 = 23 (4)
23 + 7 = 30 (6)	30 – 5 = 25 (1) (6)



North +

South –

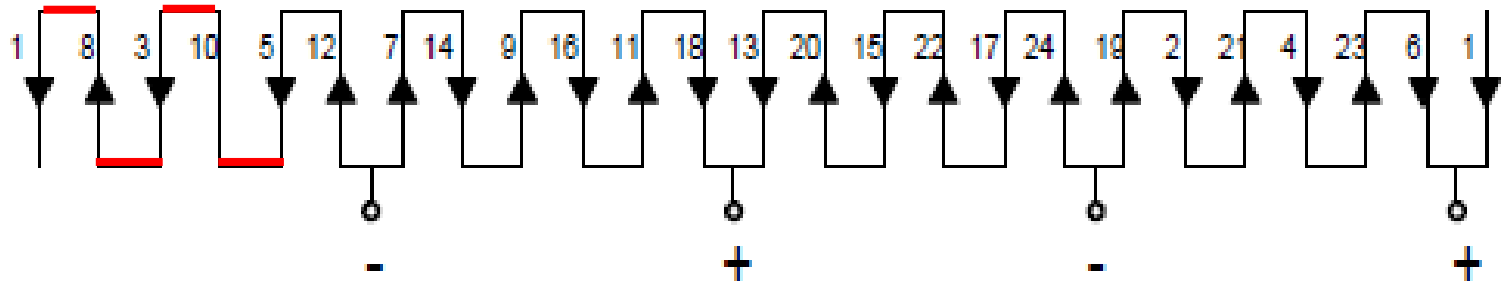
YB=7
1 + 7 = 8
3 + 7 = 10
5 + 7 = 12
7 + 7 = 14
9 + 7 = 16
11 + 7 = 18

YF=5
8 – 5 = 3
10 – 5 = 5
12 – 5 = 7
14 – 5 = 9
16 – 5 = 11
18 – 5 = 13

Yb=7
13 + 7 = 20
15 + 7 = 22
17 + 7 = 24
19 + 7 = 26 (2)
21 + 7 = 28 (4)
23 + 7 = 30 (6)

YF=5
20 – 5 = 15
22 – 5 = 17
24 – 5 = 19
26 – 5 = 21
28 – 5 = 23
30 – 5 = 25 (1)

Back side



Front side

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2. Draw the developed winding diagram and sequence diagram of 6 pole, 18 armature slots, double layer, full pitch lap wound DC generator. Indicate the direction of rotation of generator.

Sol. / : No. of pole P = 6,

No. of slots S = 18

∴ No. of conductors = 36

Pole pitch = $^{36}/_{6}$ = 6

We have $YA = \frac{YB+YF}{2}$ = Pole pitch

$$\frac{YB+YF}{2} = 6$$

∴ YB + YF = 12 ⟷ eq (1)

For prograssive winding YB = YF + 2

∴ YB – Yf = 2 ⟶ eq (2)

From eq/ : (1) & (2)

$$\begin{array}{r} YB + YF = 12 \\ YB - YF = 2 \\ \hline 2YB = 14 \end{array}$$

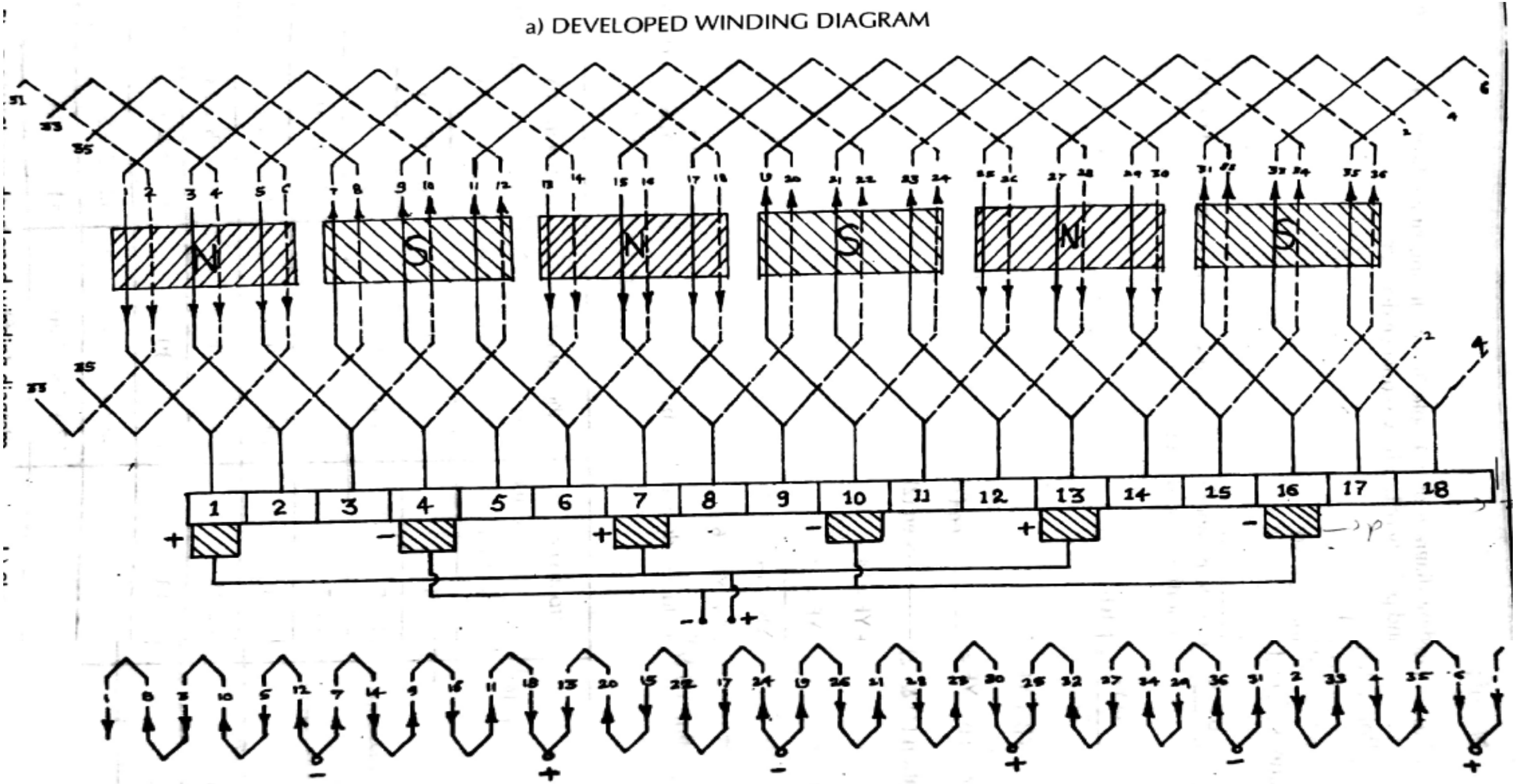
∴ YB = 7

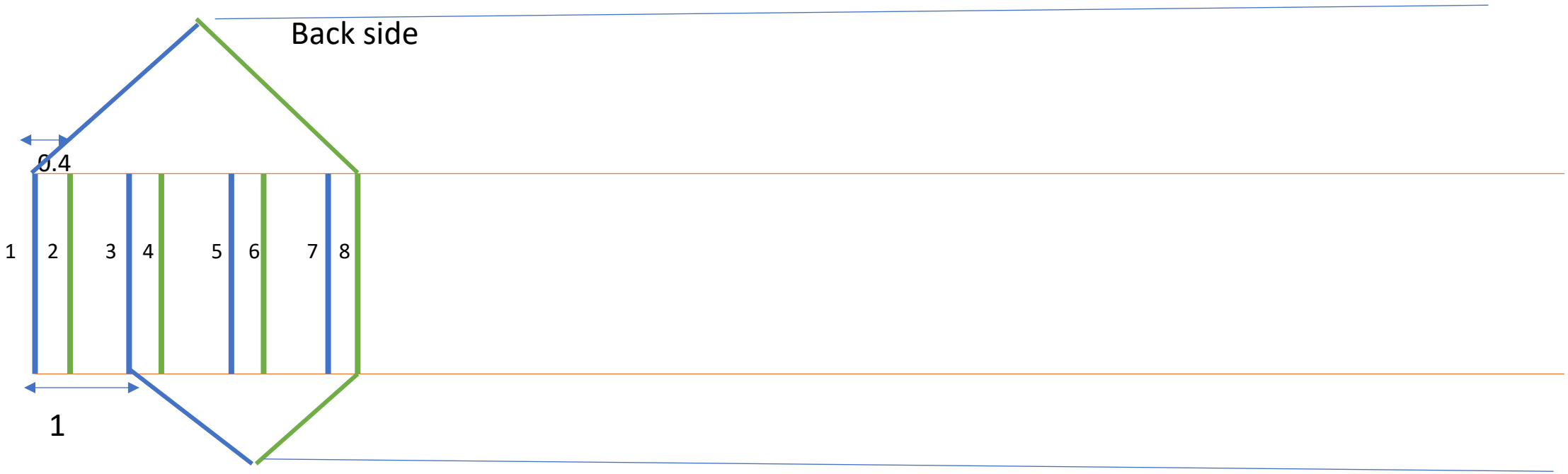
YF = 5

Winding Table

At the back Coil side → connected coil side	At the front Coil side → connected coil side	At the back Coil side → connected coil side	At the front Coil side → connected coil side
1 + 7 = 8	8 – 5 = 3	19 + 7 = 26	26 – 5 = 21
3 + 7 = 10	10 – 5 = 5	21 + 7 = 28	28 – 5 = 23
5 + 7 = 12	12 – 5 = 7	23 + 7 = 30	30 – 5 = 25
7 + 7 = 14	14 – 5 = 9	25 + 7 = 32	32 – 5 = 27
9 + 7 = 16	16 – 5 = 11	27 + 7 = 34	34 – 5 = 29
11 + 7 = 18	18 – 5 = 13	29 + 7 = 36	36 – 5 = 31
13 + 7 = 20	20 – 5 = 15	31 + 7 = 38 (2)	38 – 5 = 33
15 + 7 = 22	22 – 5 = 17	33 + 7 = 40 (4)	40 – 5 = 35
17 + 7 = 24	24 – 5 = 19	35 + 7 = 42 (6)	42 (2) – 5 = 37 (1) (4)

a) DEVELOPED WINDING DIAGRAM




Back side
0.4
1
2
3
4
5
6
7
8
1

3. Design and draw duplex winding diagram of DC machine with 32 conductors and 4 poles, show the direction of rotation of motor

Sol. : No. of poles P = 4

No. of conductors Z = 32

$\therefore$ Pole pitch = $Z/P = 32/4 = 8$

We have $\frac{YB+YF}{2}$ = Pole pitch

$\therefore \frac{YB+YF}{2} = 8$

$\therefore$ YB + YF = 16 ⟶ eq (1)

For duplex winding

YB - YF = 2m when m = 2 for duplex winding

$\therefore$ YB – YF = 4 ⟶ eq (2)

From (1) and (2) YB = 10 and YF = 6

For lap winding YB and YF should be odd and differ by 4 for progressive duplex winding. hence take YB=9 & YF= 5. In duplex there are two simplex winding, starts from 1 & 3

WINDING TABLE

FIRST WINDING		SECOND WINDING	
At the back YB=9 Coil side → connected coil side	At the front YF=5 Coil side → connected coil side	At the back YB=9 Coil side → connected coil side	At the front YF=5 Coil side → connected coil side
1 + 9 = 10	10 – 5 = 5	3 + 9 = 12	12 – 5 = 7
5 + 9 = 14	14 – 5 = 9	7 + 9 = 16	16 – 5 = 11
9 + 9 = 18	18 – 5 = 13	11 + 9 = 20	20 – 5 = 15
13 + 9 = 22	22 – 5 = 17	15 + 9 = 24	24 – 5 = 19
17 + 9 = 26	26 – 5 = 21	19 + 9 = 28	28 – 5 = 23
21 + 9 = 30	30 – 5 = 25	23 + 9 = 32	32 – 5 = 27
25 + 9 = 34 (2)	34 – 5 = 29	27 + 9 = 36 (4)	36 – 5 = 31
29 + 9 = 38 (6)	38 – 5 = 33 (1)	31 + 9 = 40 (8)	40 – 5 = 35 (3)

a) DEVELOPED WINDING DIAGRAM

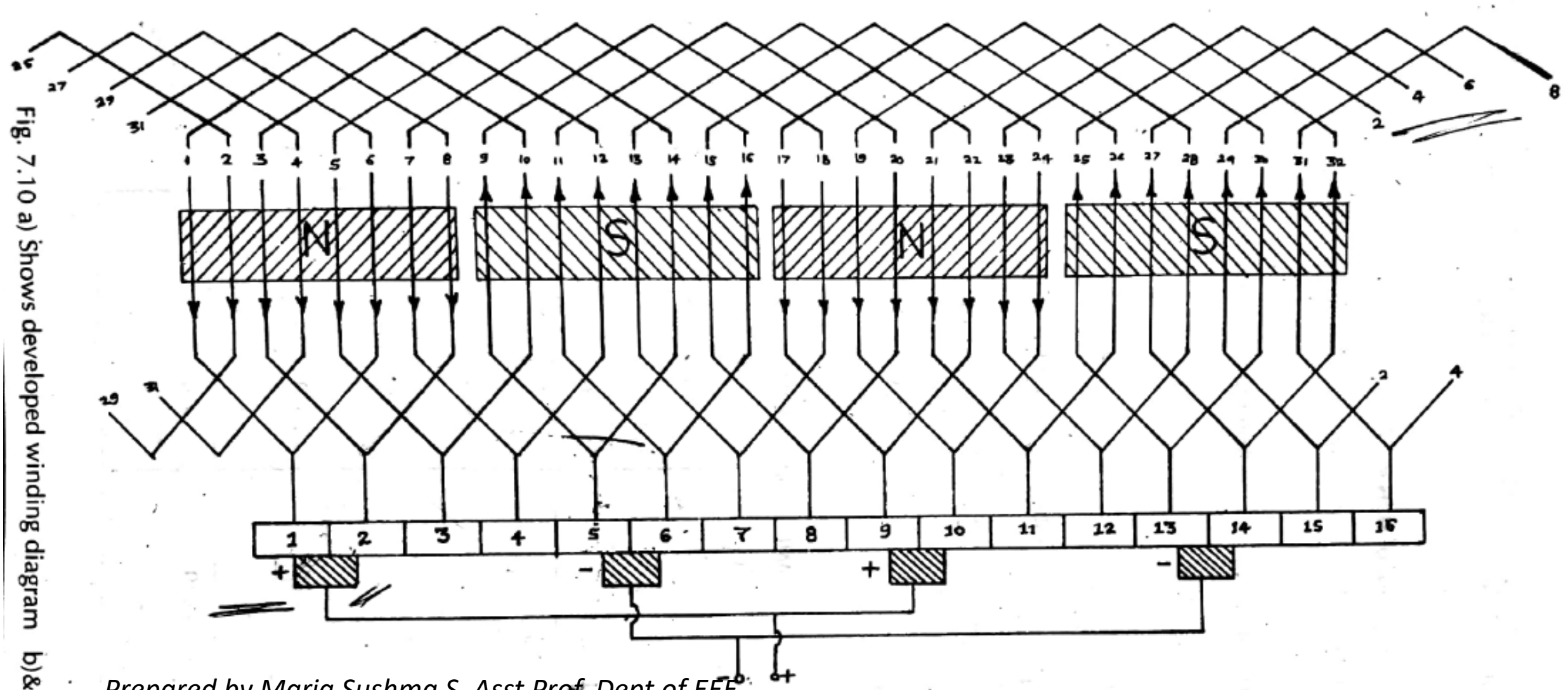
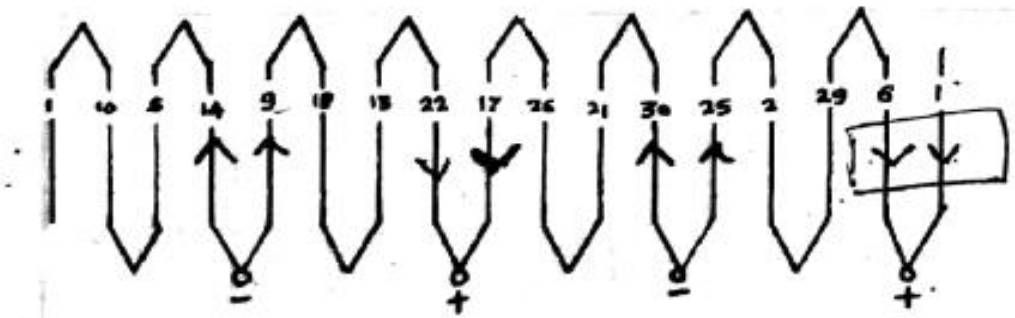
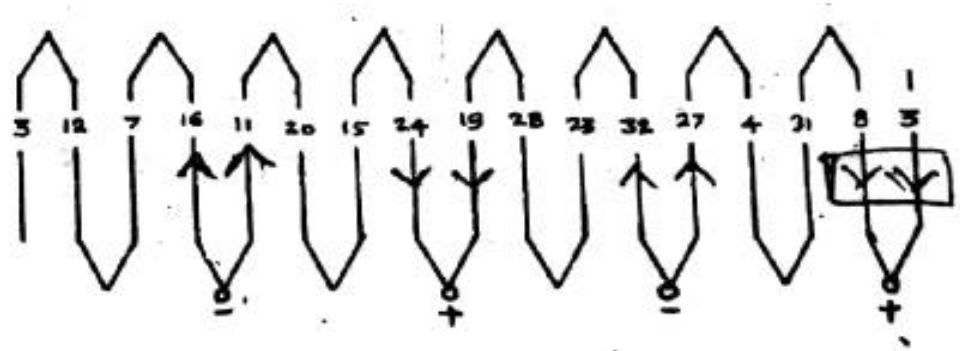


Fig. 7.10 a) Shows developed winding diagram b)&



b) SEQUENCE DIAGRAM IST WINDING



c) SEQUENCE DIAGRAM II nd WINDING