

Code: 23EE2602

**III B.Tech – II Semester - Regular Examinations – APRIL 2026**

**ELECTRICAL WIRING ESTIMATION AND COSTING**  
(Common for ALL BRANCHES)

Duration: 3 hours

Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.

2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.

3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.

4. All parts of Question paper must be answered in one place.

BL – Blooms Level

CO – Course Outcome

**PART – A**

		BL	CO
1.a)	List any four commonly used electrical symbols in domestic wiring.	L3	CO2
1.b)	Draw the circuit of a simple one-lamp controlled by one switch.	L3	CO2
1.c)	What is a three-phase four-wire distribution system?	L2	CO1
1.d)	What is meant by permissible voltage drop?	L2	CO1
1.e)	What are the factors to be considered while planning wiring for a commercial building?	L4	CO5
1.f)	State any four materials required for electrical installation in a small industry.	L3	CO4
1.g)	Define a substation.	L1	CO2
1.h)	What is a pole-mounted substation?	L3	CO4
1.i)	List any four components used in a contactor control circuit.	L3	CO4
1.j)	What is meant by motor protection?	L3	CO4

## PART – B

			BL	CO	Max. Marks
<b>UNIT-I</b>					
2	a)	Describe the system of connection of electrical appliances and accessories in a residential installation.	L2	CO1	5 M
	b)	Draw and explain a ceiling fan circuit with regulator and switch.	L3	CO2	5 M
<b>OR</b>					
3	a)	Compare series and parallel connections used in electrical installations.	L4	CO3	5 M
	b)	Draw and explain the wiring diagram of a two-point light control circuit (staircase wiring).	L4	CO3	5 M
<b>UNIT-II</b>					
4	a)	Explain the three-phase four-wire distribution system with a neat sketch.	L3	CO2	5 M
	b)	Explain the importance of earthing in electrical installations.	L3	CO2	5 M
<b>OR</b>					
5	a)	Explain the factors affecting the selection of size of wires in an installation.	L4	CO3	5 M
	b)	Explain the concept of voltage drop and derive the expression for voltage drop in a single-phase feeder.	L3	CO2	5 M

<b>UNIT-III</b>					
6	a)	Explain the procedure for estimating and costing of electrical installation for a residential building.	L3	CO4	5 M
	b)	Estimate the quantity of wire, switches and accessories required for a single-bedroom house having: <ul style="list-style-type: none"> <li>• 4 light points</li> <li>• 2 fan points</li> <li>• 2 socket outlets</li> </ul> Assume PVC conduit wiring system. Prepare a detailed material schedule and approximate cost.	L4	CO5	5 M
<b>OR</b>					
7	a)	Describe the role of case study analysis in electrical installation planning.	L4	CO5	5 M
	b)	Estimate the electrical installation cost for a small industry floor measuring 20 m × 10 m requiring: <ul style="list-style-type: none"> <li>• 10 light points</li> <li>• 4 exhaust fans</li> <li>• 3 three-phase motors (7.5 HP each)</li> </ul> Prepare load calculation, sub-circuit arrangement and material cost estimation.	L4	CO5	5 M
<b>UNIT-IV</b>					
8	a)	Describe the classification of substations based on service requirement and constructional features.	L3	CO4	5 M

	b)	Explain the equipment used in a distribution substation.	L3	CO4	5 M
<b>OR</b>					
9	a)	Describe the layout and main components of an indoor (floor-mounted) substation.	L4	CO5	5 M
	b)	Sketch the single line diagram of a pole mounted substation.	L3	CO4	5 M
<b>UNIT-V</b>					
10	a)	Explain the starting method of a three-phase squirrel cage induction motor using DOL starter.	L3	CO4	5 M
	b)	Draw and explain a star-delta starter control circuit.	L3	CO4	5 M
<b>OR</b>					
11	a)	Describe the starting of a wound rotor induction motor with neat sketch.	L3	CO4	5 M
	b)	Draw and explain the control circuit for forward and reverse operation of an Induction motor.	L4	CO5	5 M

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 Department of Electrical and Electronics Engineering  
 III B.Tech -II Sem Regular examinations (Apr 2026)  
 Key for Electrical Wiring Estimation and Costing (23EE2602)

Q1 a)	Any four symbols	2M
Q1 b)	Circuit diagram	2 M
Q1 c)	Explanation of line , phase and neutral wires	2M
Q1 d)	Definition of voltage drop Permissible voltage drop range	2M
Q1 e)	Specification of any two factors	1M each (2M)
Q1 f)	Any four materials	2M
Q1 g)	Definition of substation	2M
Q1 h)	Explanation of pole mounted substation structure	2M
Q1 i)	Identifying any four components	2M
Q1 j)	Explanation of necessity and protection types	2M
Q 2 a)	Circuit diagram, Explanation joint box and looping system	3M 2M 5M
2 b)	Circuit diagram either schematic or wiring Explanation	3M 2M 5M
Q 3a)	Circuit diagram Explanation of circuit operation	3M 2M 5M
3b)	Circuit diagram either schematic or wiring Explanation of circuit operation	3M 2M 5M
Q4a)	Diagram of 3ph 4 wire distribution system Explanation	2M 3M 5M
b)	Any four points indicating importance of earthing	5M 5M
Q 5 a)	Explanation of any two factors for selecting the size of conductor	5M 5M
b)	Definition of voltage drop Derivation of voltage drop	2M 3M 5M
Q 6 a)	Explanation of any two factors in estimation of electrical cost	5M 5M
b)	Calculation of load current and conductor diameter Calculation of conduit and wire length Estimation table	2M 1M 2M 5M

Q7a)	Explanation of advantages of case studies	5M <hr/> 5M
b)	Calculation of load current Calculation of number of sub circuits Estimation table	2M 1M 2M <hr/> 5M
Q8 a)	Diagram Explanation	2M 3M <hr/> 5M
b)	List of any 6 components	5M <hr/> 5M
Q 9 a)	Diagram Explanation	3M 2M <hr/> 5M
Q b)	Diagram Explanation	3M 2M <hr/> 5M
Q10a)	Diagram Either schematic or wiring diagram Explanation	3M 2M <hr/> 5M
b)	Diagram Explanation	3M 2M <hr/> 5M
11 a)	Diagram Explanation	3M 2M <hr/> 5M
11 b)	Diagram Either schematic or wiring diagram Explanation	3M 2M <hr/> 5M


Q 1 a)

Direct current —

Alternating current —  $\sim$

Ceiling fan —  $\infty$

Bracket fan 


Fan regulator 

Lamp X


Group of Three Lamps 3X


Fluorescent lamp 


Switch 

Single pole switch 

Two pole switch 

Two way switch 

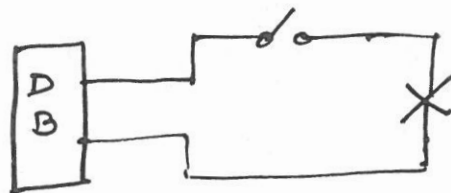
Socket outlet 5A 

Socket outlet 15A 

Switch & socket 

Link 

1 b)



1 c) In the 3 phase, 4-wire power distribution system power is supplied from the substation through 4 wires. Three of these wires are called live or phase or line wires. The fourth wire is usually at zero voltage and is called neutral wire. The neutral wire is earthed at the substation.

1 d) The voltage drop in a cable depends not only upon current and cross-sectional area of the cable, but also upon its length. The amount of voltage drop allowed as per standards is known as permissible voltage drop. Voltage drop between supply point and building and any cut let should be not more than 2.5% of nominal voltage.

1 e)

1. The number of sub circuits
2. Size and rating of main & distribution boards
3. Size of the cable
4. Size of conduits
5. Bus bars and BUS bar chambers.
6. mounting of distribution boards
7. Earthing.

1 f)

- i) motor circuit wiring & Conduit used for wiring
- ii) cable & its rating.
- iii) Starting method of motor & type of starter
- iv) Capacity of main & other & distribution board

1 g)

A sub station is a location in an electric power system where <sup>Electrical</sup> energy is transformed, controlled and distributed.

1 h)

A pole mounted substation is known as an outdoor substation.

Transformers of rating up to 250 KVA mounted on MS channel which are rigidly fastened to two pole structure. mainly used in rural electrification, agriculture loads, domestic & commercial load.

1 i)

1 Normally open contact

1 Normally close contact

Armature, Contactor coil, Auxiliary contacts

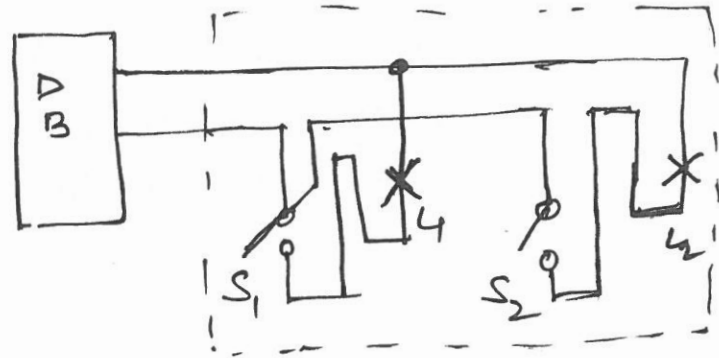
1 j)

The procedure or scheme of safe guarding the motor from abnormal conditions such as over current, over voltage, and short circuit using devices in an economic way.

2a) All electrical appliance like fan, light, heater and air conditioner are connected to supply by means of insulated wire. There are two different modes of wiring. ① joint box system  
② Looping system.

### ① joint box system:-

In this method of wiring an appliance is controlled by switch which is in series, the end of which are connected through T joints to the two lines coming from the main distribution board.



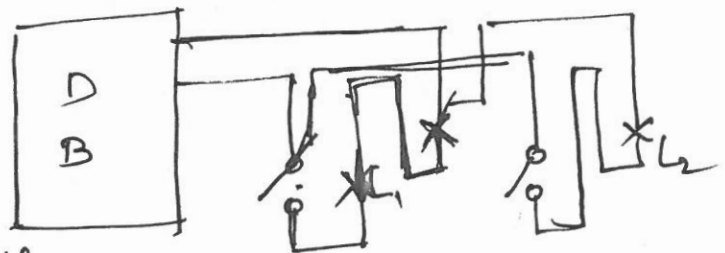
In this method of system are made in joint boxes. When joints boxes are used they must be special joint boxes in which they should be soldered to give proper continuity. It must be realized that a joint is a place where fault can develop due to over heating or due to loose contact.

### Looping system.

main advantage of looping system is that

no tapping is taken directly

from main wire hence no joints are used. The length of wire is reduced a more than in joint box system of wiring.



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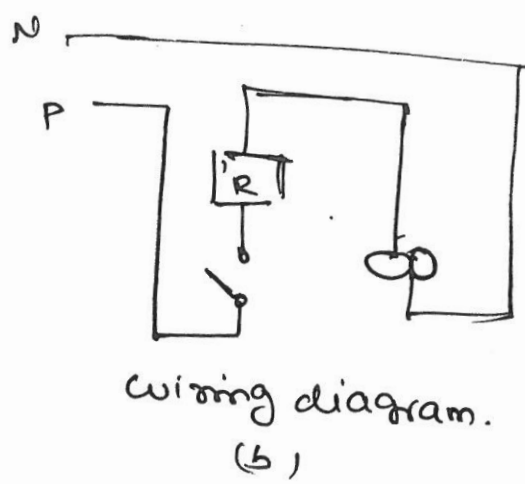
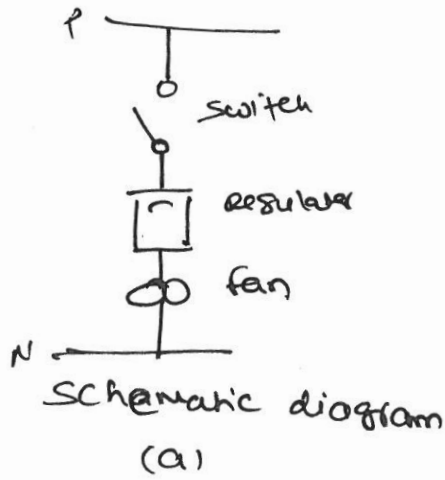
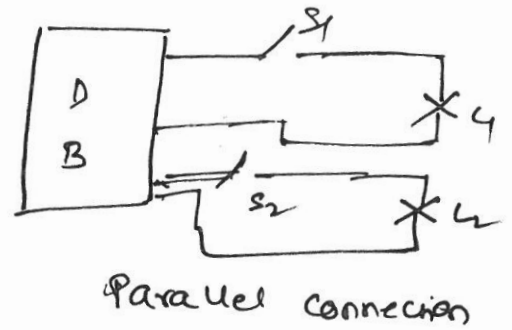
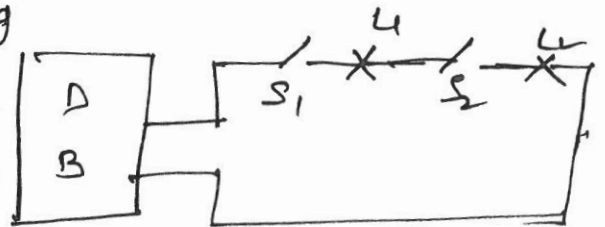


Fig a shows the schematic diagram of fan connected with the regulator. The <sup>single pole</sup> switch is connected in series with fan & regulator to control the speed. Fig (b) shows the wiring diagram in looping method.

3 a) In a series connection all electrical devices are connected in single path so the same current flows through each device while supply voltage gets divided among them. In this type of connection if one device fails the entire circuit is interrupted.



All connected loads stop working. As it leads to unequal voltage distribution causes degradation of life of appliance.

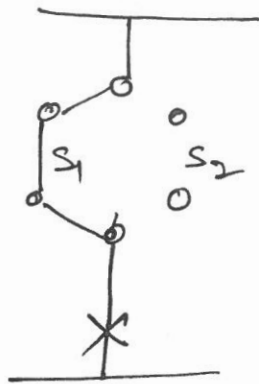


Application: Guit, decorative lights

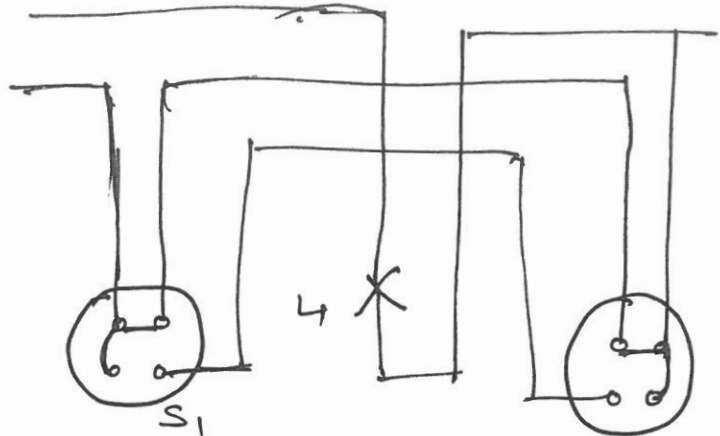
In parallel connection devices are connected across the supply. This connection is widely used in electrical wiring as each appliance connected receive same supply voltage. This connection is more reliable and flexible as continuity of supply maintained though there is fault in any one connected device. It improves safety. Parallel connection require more conductor resulting in

increased cost when compared to series connection.

35)



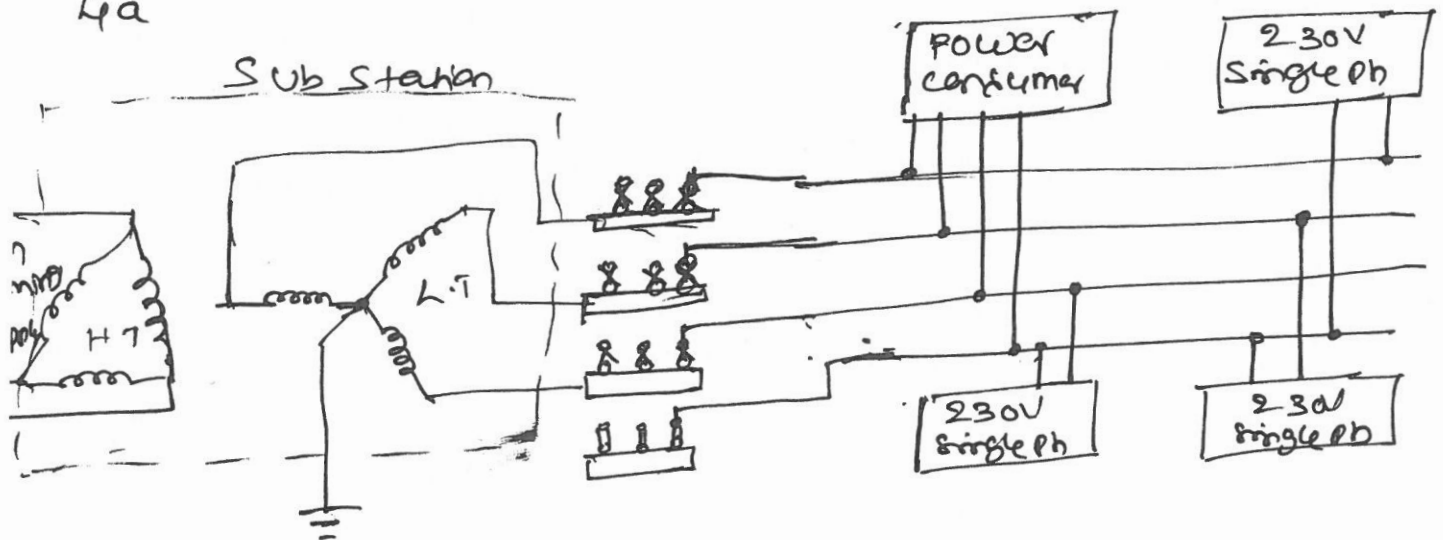
Schematic diagram



wiring diagram

In this circuit two switches  $S_1$  &  $S_2$  of a two way type are located at different points. one at the starting of stair case and other at other end of stair case. when switched at one end make circuit ON by virtue of connection. when switching operation made on next time it will change the state to off.

Q4a



Electric loads of consumers are connected in a such way that all the three phases are equally loaded.

Large consumers particularly those with heavy motor load are provided with 3ph three wire supply.

consumers with load requirement more than 250 kVA are provided with supply at high voltage with substations

installed in Condenser Permisses where voltage is step down to 415/240 V. as show in fig.

In a Three phase four wire power distribution system power is supplied from the substation through 4 wires. Three of these wires are called live or phase wire. The fourth wire is usually at zero voltage and is called neutral wire. The neutral wire is earthed at the substation.

45) Earthing means connection of neutral point of a supply system to the non current carrying part of electrical apparatus such as metallic frame work, metal covering of cables earth terminals of socket to the general mass of earth in such a manner that at all times immediate discharge of electrical energy takes place without danger.

Earthing is provided

- ① TO ensure that no current carrying conductor rises to a potential with respect to general mass of earth than its designed insulation.
- ② TO avoid electric shock to the human being
- ③ TO avoid risk of fire due to earth leakage current through unwanted path.
- ④ Earthing is a fundamental safety feature in any electrical installation as it provides a low resistance path for fault current to flow safely into ground.
- ⑤ It maintain the system voltage at a stable level providing a reference point.
- ⑥ Earthing safely conducts high voltage surges caused by lightning or switching operations to the ground.

⑦ Improves the system reliability.

5a) There are three points which must be taken into account

- ① minimum size mainly for mechanical reason
- ② current carrying capacity
- ③ voltage drop

① minimum size:- The conductor used in domestic wiring must not be less than  $1\frac{1}{2}$  mm in copper or  $1\frac{1}{4}$  mm in aluminium wire. For flexible cord and wire fittings.

② Current carrying capacity:-

The wire should be of sufficient size to carry the maximum current continuously without overheating.

The maximum possible current is not in exact proportion to the sectional area of the conductor. The amount of heat developed due to flow of current is proportional to the resistance of conductor and inversely proportional to cross section area. Temp rise also depends heat dissipation from surface of conductor. When there are several cable bunched together in same conduit the current carrying capacity for same cross section area of conductor is less than that of pair of cable in conduit.

③ Voltage drop:- maximum voltage drop from supply terminals to any point in the installation is not to exceed 2.5% of supply voltage.

5 b) Voltage drop is reduction in voltage along a feeder due to impedance of ( $Z = R + jX$ ) feeder when current flows through the feeder.

A single phase feeder has a phase conductor and Neutral conductor hence the total impedance is twice the impedance of a conductor

Let  $I$  = Load current flowing in feeder  
 $R$  = Resistance of one conductor  
 $X$  = Reactance of one conductor  
 $\phi$  = Power factor angle of load  
 $V_s$  = sending end voltage  
 $V_r$  = receiving end voltage

$$\Delta V = \text{Voltage drop} = V_s - V_r = I Z = V_d$$

$$Z = 2(R + jX)$$

$$\begin{aligned} \text{for a.c circuit} &= I(\cos\phi - j\sin\phi) \times 2(R + jX) \\ &= 2I(R\cos\phi + X\sin\phi) + j(X\cos\phi - R\sin\phi) \end{aligned}$$

$$V_d = 2I(R\cos\phi + X\sin\phi)$$

as voltage drop does not depend on imaginary part.

Q 6a) Estimating and Costing of Electrical installation.

Electrical installation work is a highly competitive business. Estimating is a very important part of running business. To estimate the cost involved following aspects have to be considered.

- ① Price list:- First the quantities of material required are calculated. Second the cost rate or price list of various material is to be known. quotations are collected from different manufacturers in the market to prepare the price list.
- ② Labour charge:- Labour charge is the most difficult variable item to assess. It is affected by factors such as site condition, skill and technical training physical fitness. Labour charge is estimated using system of man hours constant.
- ③ Over head charges:- These include general office expense, rent, rates of lighting and heating, depreciation of furniture and office equipment.

④ Contingencies:-

Contingencies include un expected expenditure due to increase in cost rate of the material, loss due to flood or any other reasons etc.

The total cost is calculated by adding together the cost of material, and cost of labour. To the total cost over head charges and contingencies charges are added. to finalize the cost of installation.

Gb)

Lighting etc	No of light points	-	4	Wattage/Unit	60	Total wattage
	No of fan points	-	2	100		200 W
	No of Sockets	-	2	1000/100		2000
				100 for 5A		200 W
				100 for 15A		

Considering SB socket total load = 640W

$$\text{Full load current } I = \frac{640}{240} = 2.66 \text{ amps.}$$

Assumptions:-

Assuming height of main board & switch board = 1.5m

Height of ceiling cap = 3.0m

Height of bracket light points = 2.4m

Distance from MDB = 0.2m

Length of wire & PVP conduit

meter to main board: 0.2m

Vertical run to ceiling in hall = 0.6m

from MB to SB, = 1.5 + 2 + 1.5 = 5m

run along ceiling in hall = 2.4 + 2.4 + 2.4 = 7.2m

Drop from ceiling to L<sub>1</sub> = 1.2m

L<sub>2</sub> = 1.2m

from SB<sub>2</sub> to L<sub>3</sub> & L<sub>4</sub> = 1.5 + 3 + 1.8 + 1.6 = 7.9m

Vertical run along ceiling in room = 0.6m

Run along ceiling = 27.7 m

Total length =  $0.2 + 5 + 0.6 + 7.2 + 1.2 + 1.2 + 4.2 + 4.2 + 0.6 + 2.7$   
 $\approx 27.1 \text{ mt}$

Waste take =  $27.1 \times 2.7 \approx 30 \text{ mt}$

Length of phase wire =

MB to SB <sub>1</sub> = $1.7 + 2 + 1.5 = 5.2 \text{ mt}$		= 5 mt
SB <sub>1</sub> to fan = $2.4 + 2.4 = 4.8 \text{ mt}$		- 4.5
SB <sub>1</sub> to L <sub>1</sub> = $2.1 + 2.4 + 2.4 + 1.1 + 2.8 = 10.8 \text{ mt}$		- 8.1
L <sub>2</sub>		= 8.1 mt
SB <sub>1</sub> to SB <sub>2</sub> = 0.25 m		.25
SB <sub>2</sub> to L <sub>3</sub> = 4.2 m		4.2
L <sub>4</sub> = 8.1 m		8.1
		42.9 mt
	Waste take 20%	8.6 mt
		51.5 mt

Length of Neutral  $\approx 48 \text{ mt}$

Length of Earth wire = 6 mt.

S.No	Description	Quantity	Rate Per	Amount
1.	240, 16A DPE switch with fuse and neutral link	1 no	800	800
2.	DPE conduit	30 mt	50	1500
3.	1.5 sqmm single core cable	52 + 43 mt $\approx 95 \text{ mt}$	12	1140
4.	Earth wire 14 BSW	0.2 kg	100	20
5	5A, switch	8	50	400
6	Teak wood SB	2	225	450
7	5A socket	2	50	100
8	fan regulator	2	50	100
9	Lamp holders	4	12	48
10	2way DB	1	150	150
11	MCB	1	400	400
	Labour charge @ 50 Per Point			5108 400
	Overheads Contingency 10%			5508 508
	Total cost			Rs 6016

Q. 7)  
a

Case Study analysis is the study of existing or previous installation to improve the short falls that occurred earlier. It helps in understanding the technical requirements like no of lighting ckt, power ckt, location of points, length of conduit, wire and earthing requirements. It help in estimating the cost near to actuals. case studies also reveal the common fault and safety issues, helping to ensure compliance with safety standards and avoid hazards like electric shock. Case studies also help in under estimation or overloading of the system. It also helps in selecting the cost effective and durable components. It help in timely execution of project and enhances the overall system performance.

7b)

Given data		wattage Per ckt	Total wattage
Light Points -	10	60	600
exhaust fan -	4	100	400
3ph Induction motor -	3	$7.5 \times 746$	16785 W

as motor load is more than 1kw it is considered as power circuit and wiring should be done separately.

Here two sub circuits are consider  
1 Lighting circuit and 1 power circuit

Lighting circuit load current =  $\frac{600+400}{240} = 4.16 \text{ amp}$

As total power rating for motor ckt is 16785w.

Three phase supply is used for powering the circuit.

$$I = \frac{16785}{\sqrt{3} \times 415 \times 0.8} = 29.19 \text{ amp.}$$

assuming  $\cos \phi$  or  $\text{PF} = 0.8$

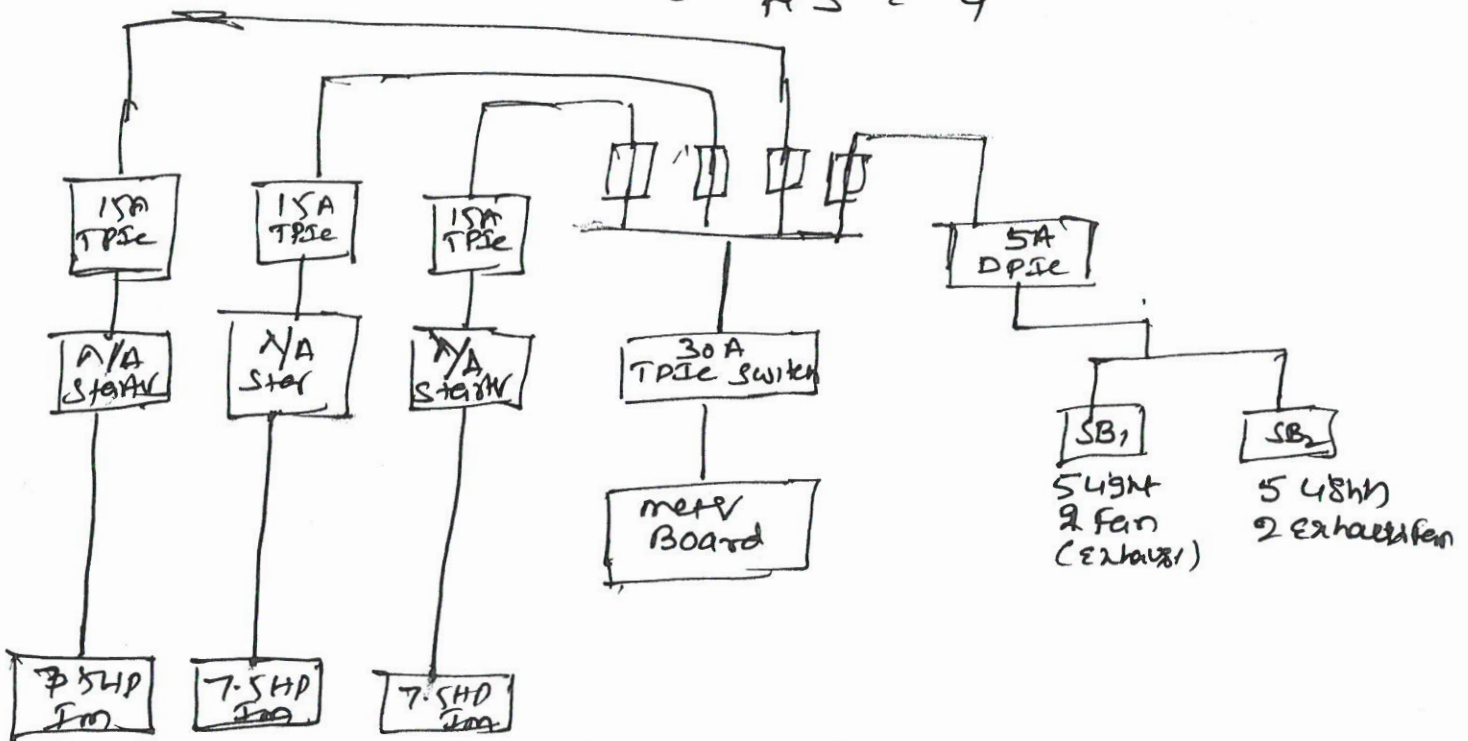
As all loads are not connected at once, assuming a demand factor of 0.8

maximum demand: Connected load  $\times 0.8$   
 $= (1000 + 16785) = 17785 \text{ w}$   
 $= 17785 \times 0.8 = 14.228 \text{ kw}$

$$I = \frac{14.22 \times 10^3}{\sqrt{3} \times 415 \times 0.8} \approx 25 \text{ amp}$$

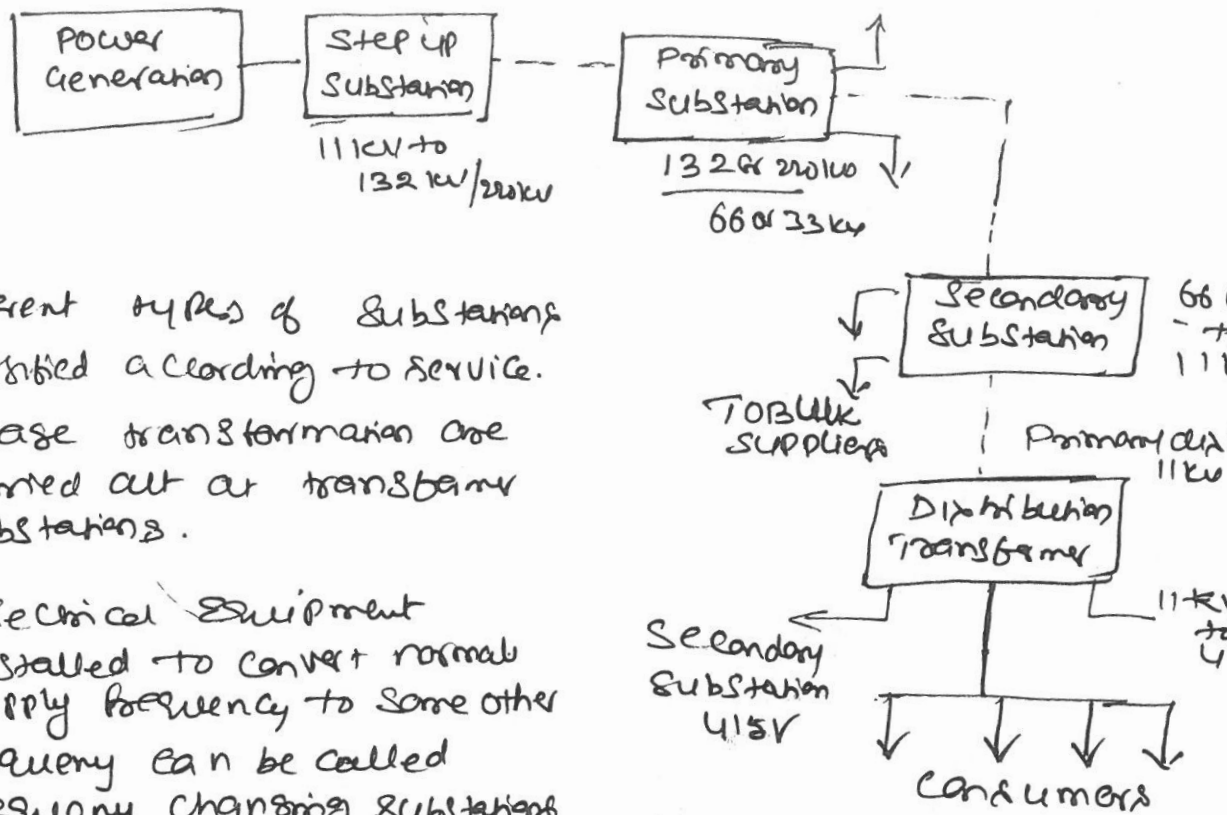
No of sub circuit = Lighting ckt + each one sub ckt of each motor

$$= 4 + 3 = 7$$



Sub circuit arrangement

8a.)



Different types of substations classified according to service.

- ① Voltage transformation are carried out at transformer substations.
- ② Electrical equipment installed to convert normal supply frequency to some other frequency can be called frequency changing substations.
- ③ Power factor correction substations consist of synchronous condenser installed for improving power factor.
- ④ In converting substations equipment like converter or inverter are installed to convert ac supply to dc supply and vice versa.

Figure show the transformer substation.

After primary transmission voltage is stepped down to secondary transmission voltage at primary substation.

At secondary substation the secondary transmission voltage is stepped down to primary distribution (11kV) voltage. HT consumers are directly supplied at 11kV. The secondary distribution voltage is obtained at distribution station.

8b.)

major equipment used in distribution substation are

- ① 11 kV lightning arrester
- ② 11 kV disc insulators
- ③ 11 kV gang operating air break switch

S. NO	Description	Specification	Qty	Rate Per	Total Cost
1	PVC Insulated single core copper cable core	1.5 sqmm	150mt	12	1800
2	PVC insulated 3 core copper cable	4.5 sqmm	200m	25	5000
3	Earth wire	2.5 sqmm	150m	15	2250
4	Conduit pipe - PVC 25mm dia		150m	30	4500
5	switches 5A		15	100	1500
6	30A TPJc switch fuse unit		1	250	250
7	15A TPJc switch fuse		3	150	450
8	15 DPJc switch fuse		1	100	100
9	4 way 15A, 80V DB		1	1000	1000
10	Switch Board		2	100	200
11.	Other accessories		28		1500

Rs 18,550

Labour charge

6,000

24,550

over head & contingencies 10%.

2450

TOTAL

26,950



The Substation building should be constructed providing the necessary accommodation for the transformer and LT switchgear and cable trenches for incoming and outgoing cables. The building for housing the transformer should be spacious and sufficiently high. Adequate clearance between walls and equipment and between different equipment should be provided to ensure safety of personnel. Proper ventilation should be ensured.

9 b)

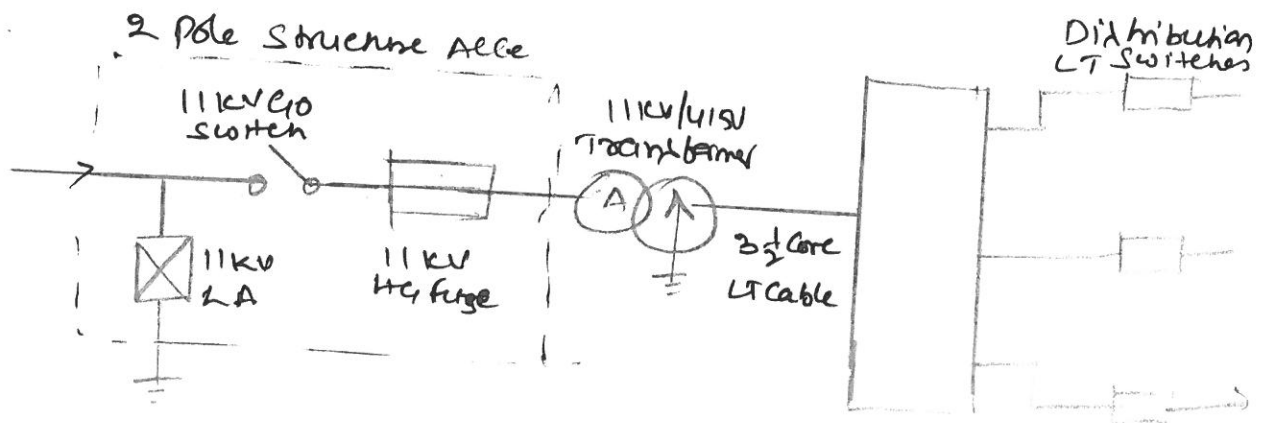
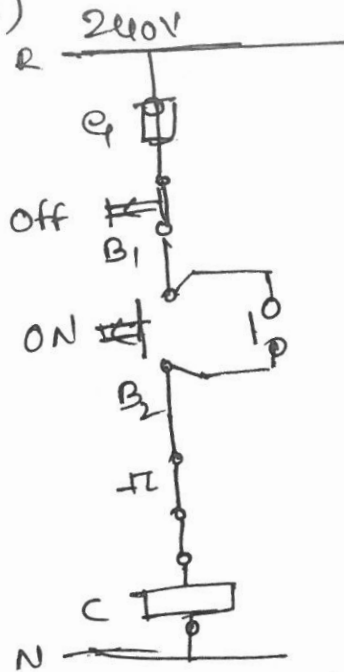


Fig shows the different accessories on a pole mounted distribution substation. The 11kV gang operating switch is installed below 11kV conductor taps the 11kV supply to transformer.

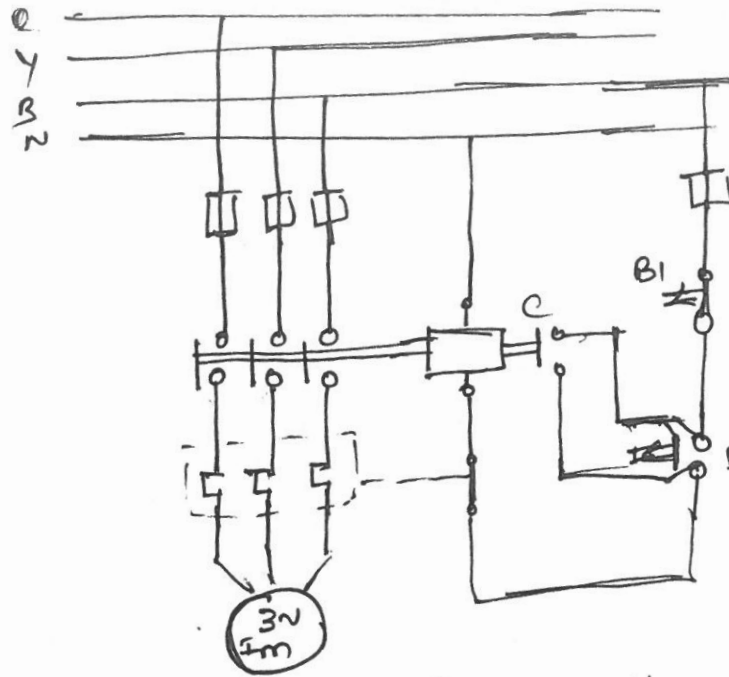
The transformer can be isolated from the 11kV supply when ever necessary. 11kV horn gap fuse installed below G.O switch and transformer tapping. on LT side transformer 3 1/2 core LT cable is taken from LT tapping to LT main switch LT main is connected to LT distribution box. LT cables are selected according to capacity of transformer.

10. a)



Schematic diagram  
control ckt

Three



Complete wiring diagram

Three Phase Im can be started direct on line by supplying the rated phase voltage to motor terminals at the time of starting.

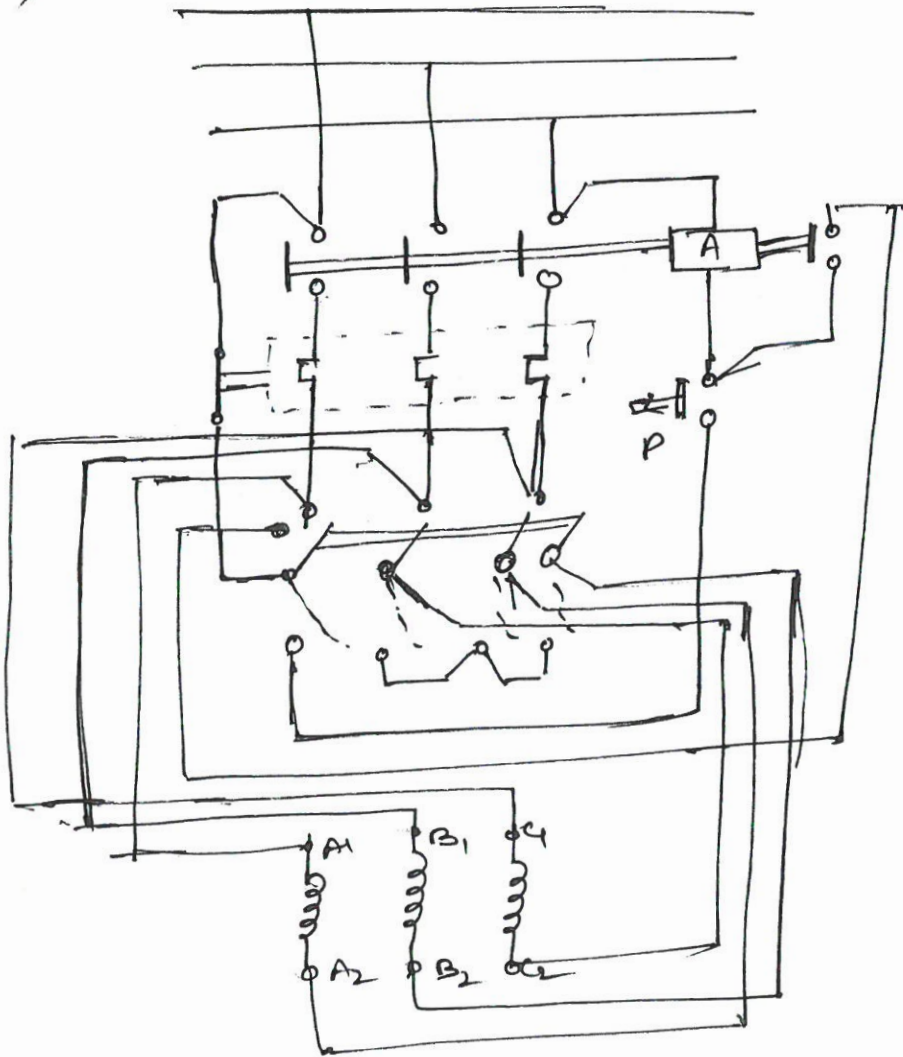
To incorporate motor protection against over load a thermal relay and contactor unit is used instead of tripple pole switch.

The contactor can be energized through separate push button for starting or stopping.

When control ckt is energized by pressing B<sub>2</sub> the motor gets 3 phase supply through the contacts of electromagnetic contactor which are normally open. The motor is protected against over load by a thermal relay which opens the circuit control when over load occurs.

Cartridge fuse are provided on power circuit for protection of motor.

10 b)

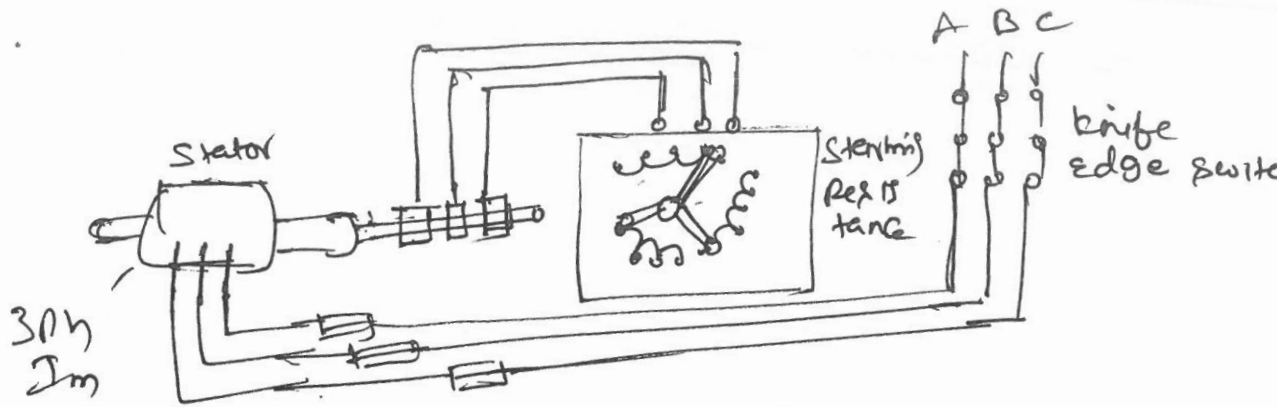


Star delta starters are used where starting current limitation does not permit DOL starter.

In  $\Delta/A$  starting motor is started with starter wdg connected in star. The windings are changed to delta when motor reaches near to the rated speed.

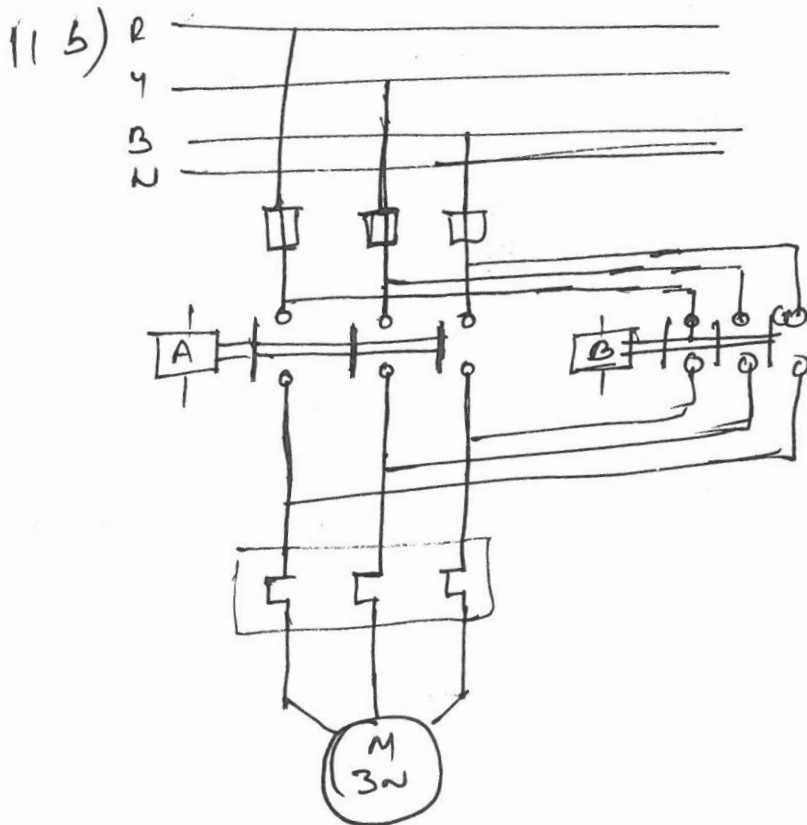
By connecting to star winding during starting the line current drawn by motor reduces to one third. When push button P is pressed the handle of starter S is brought to Y position. The contactor coil A gets energized. The starter winding terminals get star connected. After motor picks up speed the current drawn by motor automatically gets reduced and therefore the winding are connected in delta by turning switch S to A position. The pressure on push button P can now be released. The contactor coil A remains energized by getting supply through hold on contact A. of contactor.

11 a).

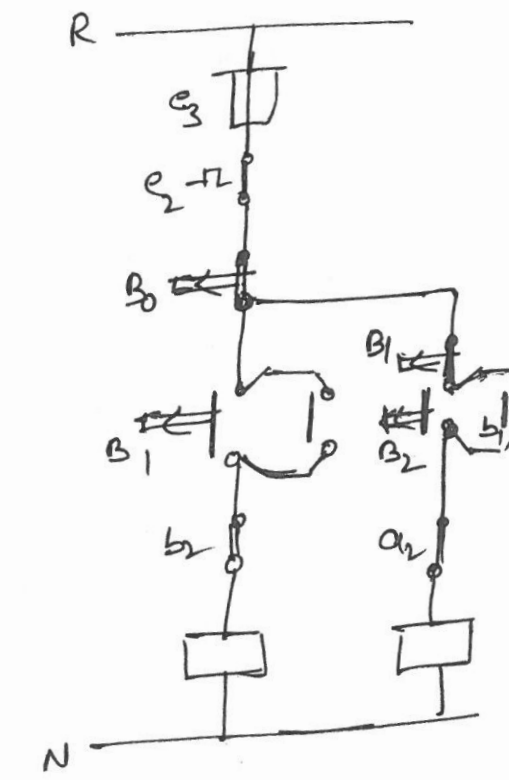


The wound rotor motor is essentially similar to the squirrel cage motor except that it has winding similar to that of stator. Instead of short circuit bars on the rotor.

High starting torque can be obtained by connecting extra resistance in series with rotor circuit at starting. This extra resistance is gradually cut out of the circuit. Under running condition speed of the motor can be controlled by varying the rotor resistance.



wiring diagram



schematic diagram of control ckt

The direction of rotation of 3 $\phi$  IM is reversed if the supply connection of any of the two phases are reversed. In the fig shows the wiring diagram three phase IM having possibility of getting supply through energisation of either contactor A or contactor B. The motor rotate in reverse direction when receive supply through contactor B.

Push button B<sub>1</sub> is for energising the contactor A and there by running motor in clock wise direction where as push button B<sub>2</sub> is for energising contactor B and there by running motor in anticlockwise direction. Contacts are made by one hold on ~~contacts~~ contacts of contactor A & B. An NC contact of a<sub>2</sub> contactor A has been connected in series with contactor coil B where as NC contact b<sub>2</sub> of contactor B has been connected in series with contactor coil A. This provides interlocking of contactors. Push button B<sub>0</sub> is for switching off the motor at any time.