Khulna University of Engineering & Technology (KUET) Khulna- 9203.

Department of Electrical and Electronic Engineering

Project on: Electrical and Electronic Shop Practice (EE 2200)
Project Title: House Wiring Design

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INTRODUCTION:

House electrical wiring is a process of connecting different accessories for the distribution of electrical energy from the supplier to various appliances and equipment at home. It also involves the proper installation and operation of the electrical outlets, switches, breakers, meter base and different electrical circuits. After receiving the blue prints from the architect, estimation need to be done. Estimating defines the determination of the quantity for electrical accessories and their costs.

The main steps that are involved:

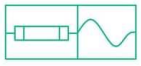
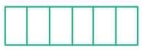
1. Collect the layout of a typical housing floor.
2. Make an AutoCAD floor design of the layout.
3. Draw the Electrical layout of the floor plan.
4. Calculate the required illumination.
5. Calculate the wattage & rated current for both the lighting and power circuit.
6. Calculate the required conduit length and total wire for the whole plan.
7. Final Estimating of conduit size & cables.
8. Estimating the total cost.

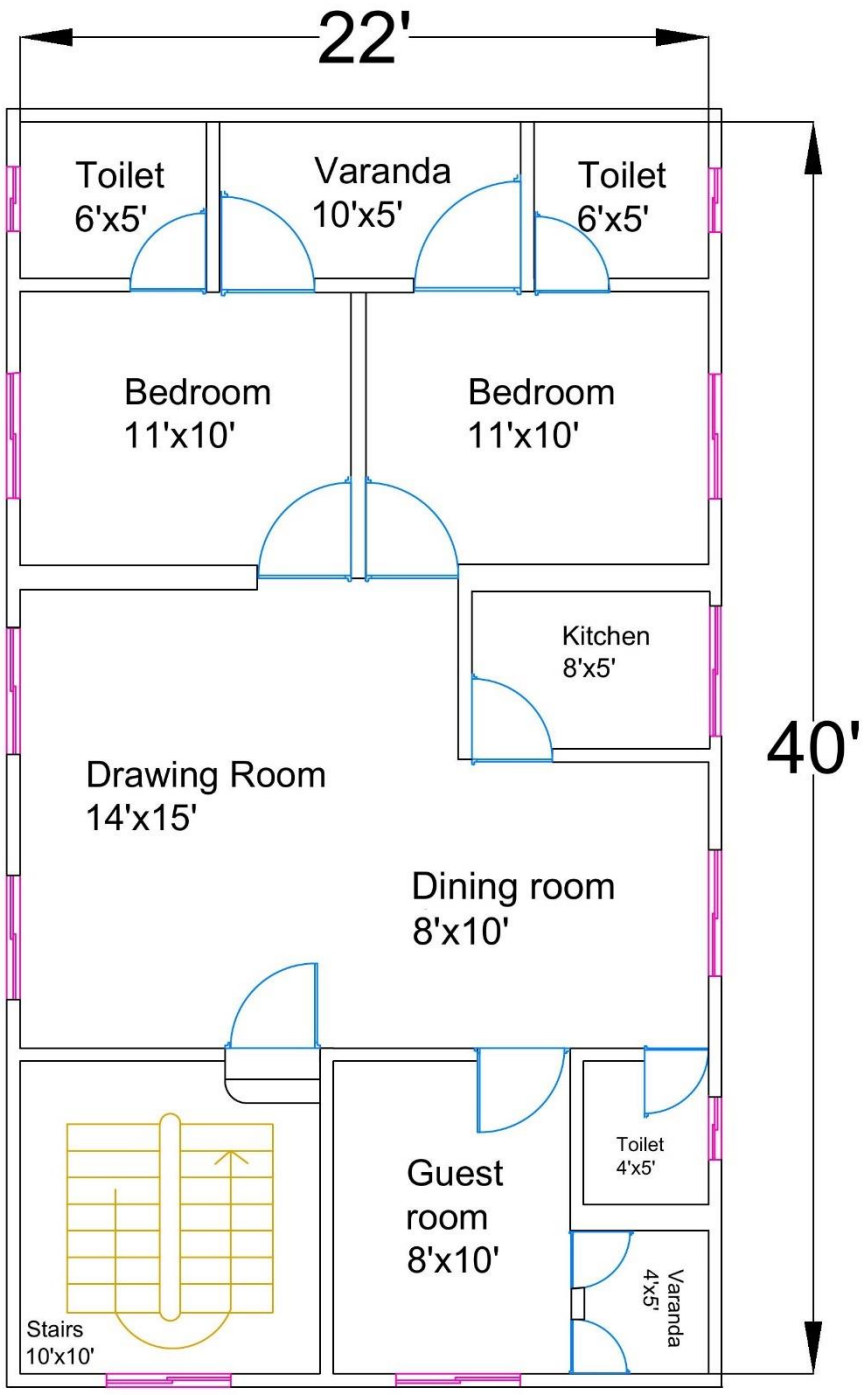
Wiring Design Representation

About the design:

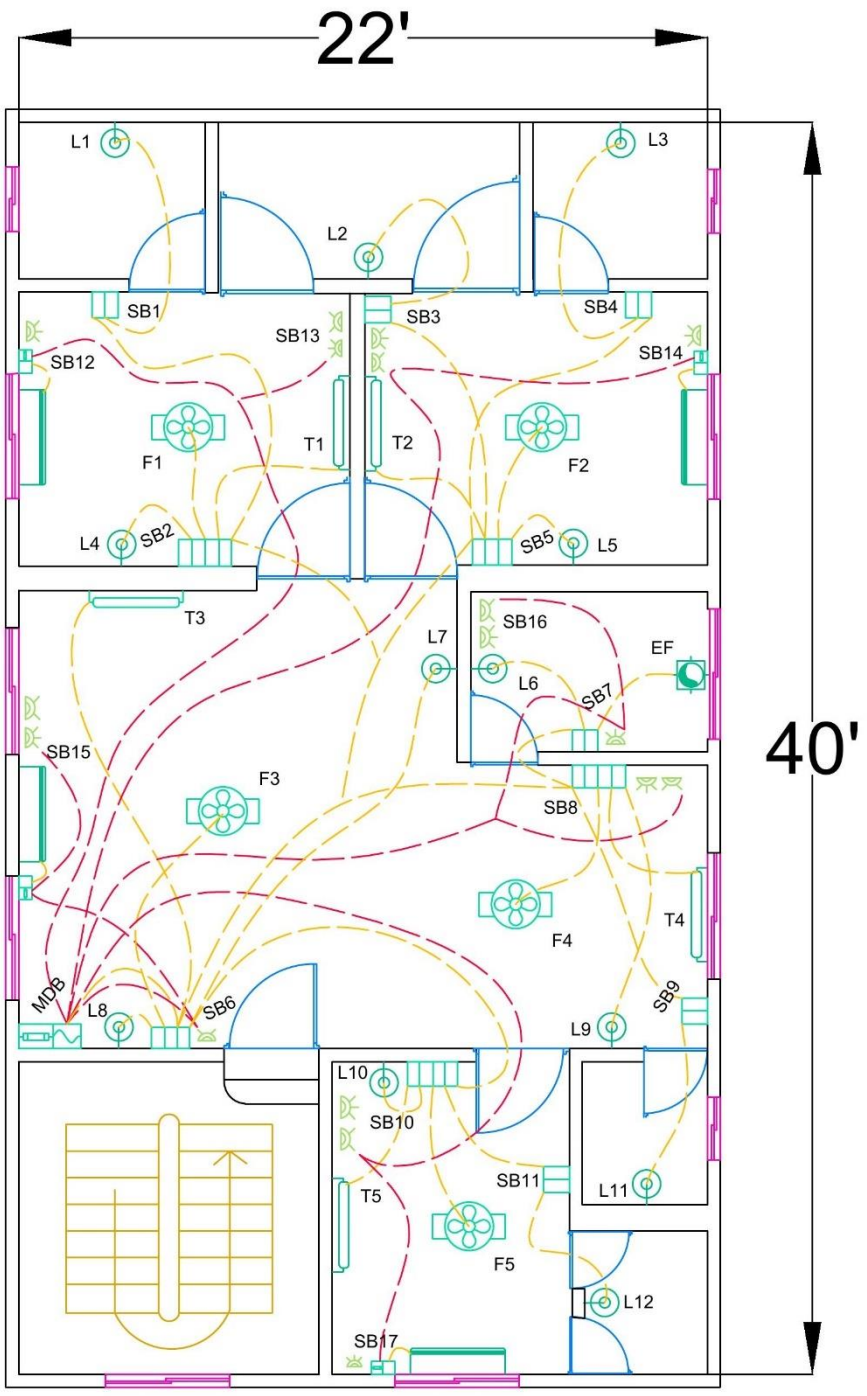
The whole wiring design is done sequentially. Initially, the electrical symbol used in the design is shown. The symbol represents the electrical equipment and appliances. Then we made a floor plan ourself. The Electrical layout is done based on this floor plan. We have used some electrical conventional symbols to complete the layout. The red conduit represents the power circuit connection and the yellow conduit represents the lighting circuit connection. All the wiring connections are supplied from the main distribution board. The conduit runs from main distribution board to each and every switch board. The sub-ware conduit then fulfills the Electrical appliances individually. To ease the calculation, we have done the lighting and power circuit connection design individually. The lighting circuit connections are shown by using the yellow dot line conduit wiring and for the Power circuit connections the red dot line conduit wiring is used. The overall design was done with the help of drawing software AutoCAD.

Symbol Specifications

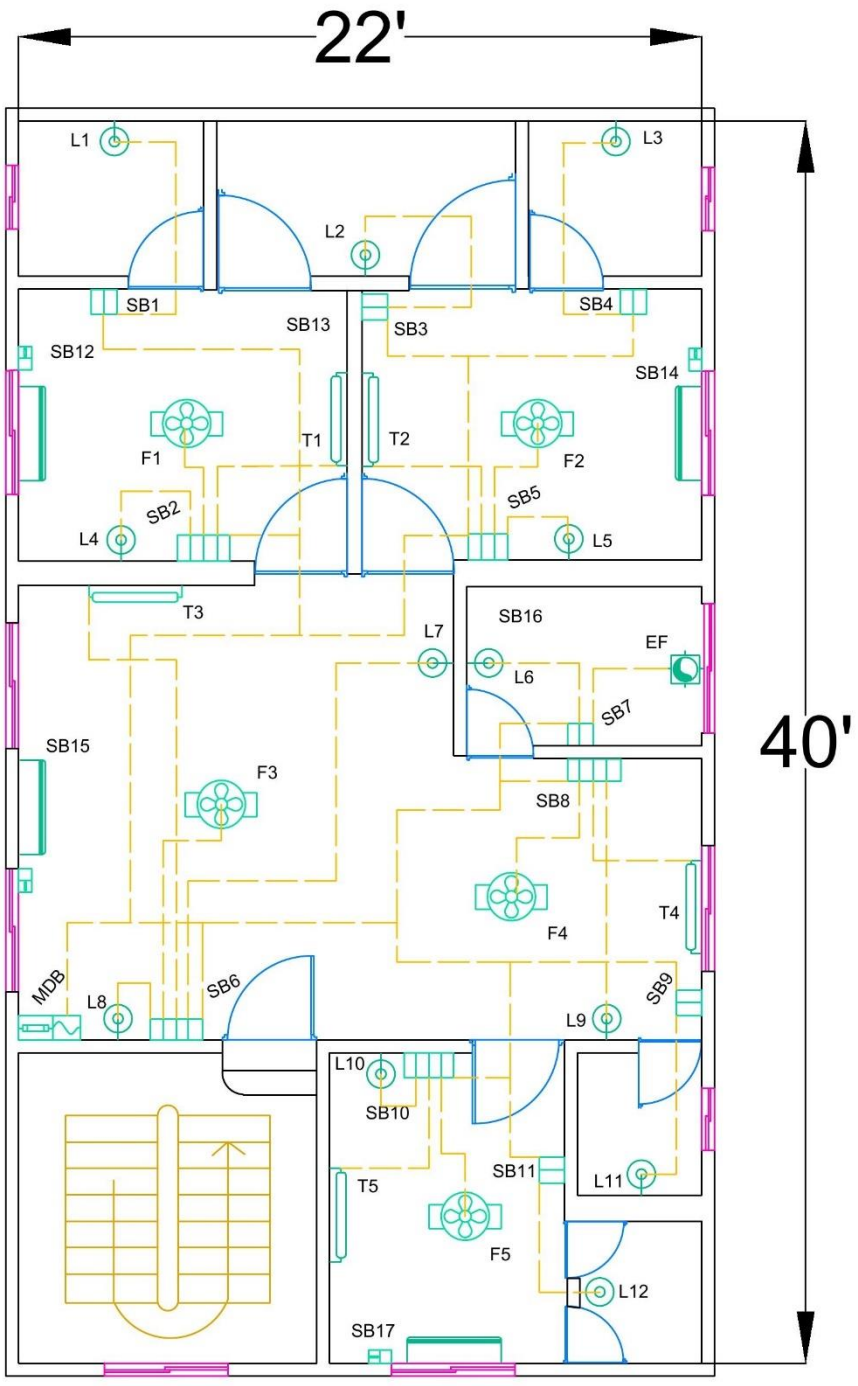
Symbol	Specification
	Tube light
	Fan
	Main Distribution Board
	Air Conditioner
	Circuit Breaker
	Led Light
	Switch Board
	Conduit Wire
	Exhaust Fan
	Two pin socket
	Three pin socket


22'
Toilet
6'x5'
Varanda
10'x5'
Toilet
6'x5'
Bedroom
11'x10'
Bedroom
11'x10'
Kitchen
8'x5'
40'
Drawing Room
14'x15'
Dining room
8'x10'
Guest
room
8'x10'
Toilet
4'x5'
Varanda
4'x5'
Stairs
10'x10'

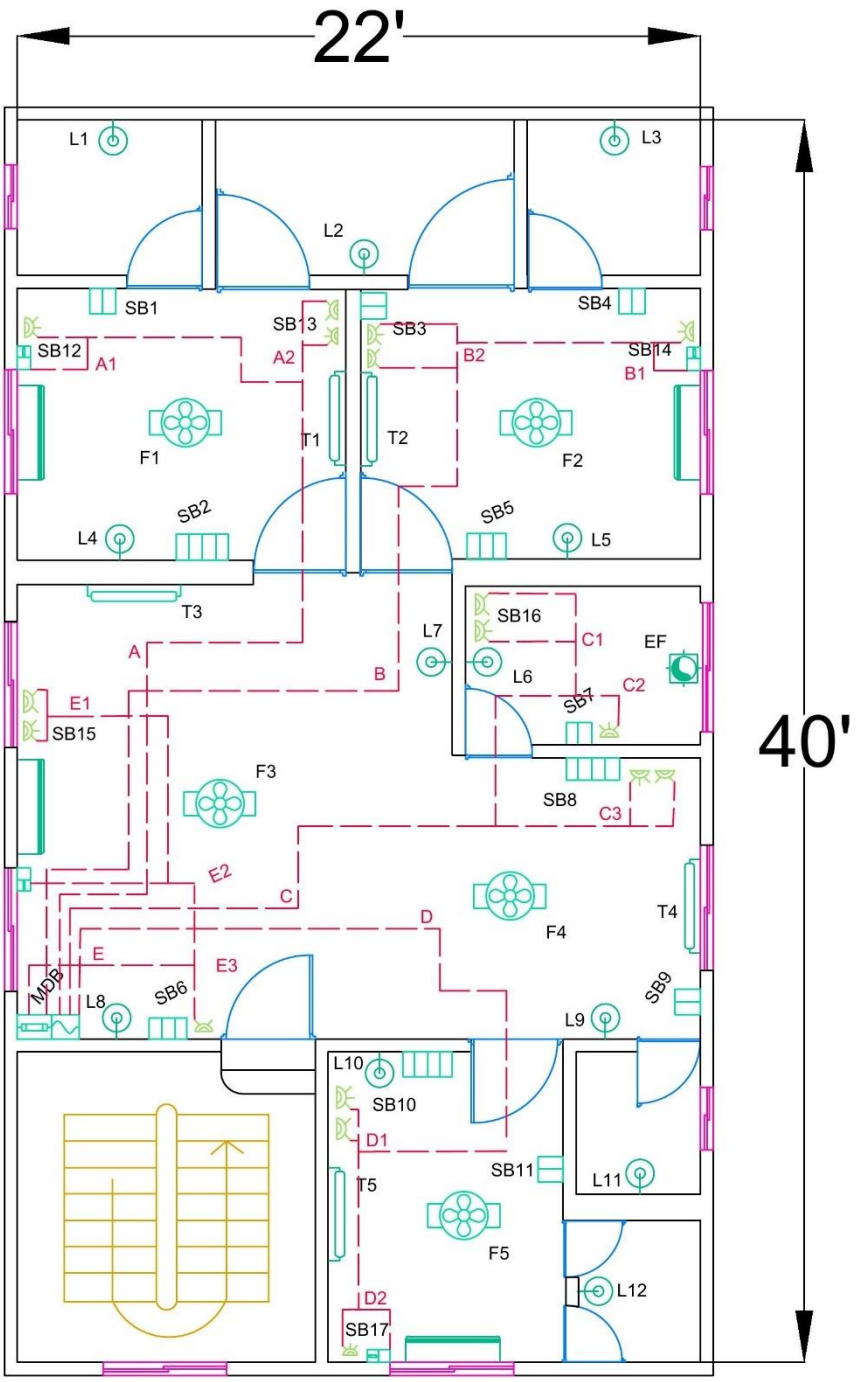
Floor plan



Electrical layout



Lighting Circuit



Power Circuit

Illumination

Calculation of Illumination:

Formula:

$$\textbf{Required Lumen} = \frac{\textbf{Area} \times \textbf{Standard illumination}}{\textbf{Depreciation factor} \times \textbf{Utilization factor}}$$

Depreciation factor varies from 0.6 to 0.8.

Utilization factor varies from 0.4 to 0.6.

For Bedrooms:

Let, the standard illumination = 20 Ft-candle
Area = (11*10) ft^2
=110 ft^2

So, Total lumen required = (110*20) / (0.5*0.8)
= 5500 lumen

Required light for Bedroom 1:

Name	*Ratting*	*Illumination (Lm)*	*Quantity*
LED Tube-Light	40 W	3000	1
LED Bulb	24 W	2600	1

Required light for Bedroom 2:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Tube-Light	40 W	3000	1
LED Bulb	24 W	2600	1

For Guest Room:

Let, the standard illumination = 20 Ft-candle
Area = (8*10) ft^2
=80 ft^2

So, Total lumen required = (80*20) / (0.5*0.8)
=4000 Lumen

Required light:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Tube-Light	24 W	2400	1
LED Bulb	20 W	1600	1

For Dining:

Let, the standard illumination = 15 Ft-candle
Area = (8*10) ft^2
=80 ft^2

So, Total lumen required = (80*15) / (0.5*0.8)
=3000 Lumen

Required light:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Tube-Light	18 W	1800	1
LED Bulb	18 W	1200	1

For Drawing:

Let, the standard illumination = 20 Ft-candle
Area = (15*14) ft^2
= 210 ft^2

So, Total lumen required = (20*210) / (0.5*0.8)
=10500 Lumen

Required light:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Tube-Light	24 W	2400	1
LED Bulb	45 W	5800	1
LED Bulb	24 W	2600	1

For Kitchen:

Let, the standard illumination = 30 Ft-candle
Area = (8*5) ft^2
= 40 ft^2

So, Total lumen required = (40*30) / (0.5*0.8)
=3000 Lumen

Required light:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	36 W	3000	1

For Toilet:

Let, the standard illumination = 10 Ft-candle

Toilet-1:

Area = (6*5) ft^2 = 30 ft^2

So, Total lumen required = (30*10) / (0.5*0.8)
=750 Lumen

Required light for Toilet-1:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	10 W	750	1

Toilet-2:

Area = (6*5) ft^2 = 30 ft^2

So, Total lumen required = (30*10) / (0.5*0.8)
=750 Lumen

Required light for Toilet-2:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	10 W	750	1

Toilet-3:

Area = (4*5) ft^2 = 20 ft^2
So, Total lumen required = (20*10) / (0.5*0.8)
=500 Lumen

Required light for Toilet-3:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	6 W	500	1

For Veranda:

Let, the standard illumination = 10 Ft-candle

Veranda-1:

Area= (10*5) ft^2 =50 ft^2

So, total lumen required = (50*6)/ (0.5*0.8) =750 Lumen

Required light for Veranda-1:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	10 W	750	1

Veranda-2:

Area= (4*5) ft^2 =20 ft^2

So, total lumen required = (20*6)/ (0.5*0.8) =300 Lumen

Required light for Veranda-2:

Name	*Rating*	*Illumination (Lm)*	*Quantity*
LED Bulb	4 W	300	1

Calculation of rated current

Lighting Circuit Current

SWITCH BOARD 1 (SB1): (Toilet-1)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	10 W	10 W

Current = 10/220 = 0.045 A

SWITCH BOARD 2 (SB2): (Bedroom-1)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	24 W	24 W
2.	LED Tube-Light	1	40 W	40 W
3.	Ceiling Fan	1	65W	65 W
			Total=	129 W

Current = 129/220 = 0.586 A

SWITCH BOARD 3 (SB3): (Veranda-1)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	10 W	10 W

Current = 10/220 = 0.045 A

SWITCH BOARD 4 (SB4): (Toilet-2)

SL. No.	*Name*	*Quantity*	*watt*	*Total wattage*
1.	LED Bulb	1	10 W	10 W

Current = 10/220 = 0.045 A

SWITCH BOARD 5 (SB5): (Bedroom-2)

SL. No.	*Name*	*Quantity*	*watt*	*Total wattage*
1.	LED Bulb	1	24 W	24 W
2.	LED Tube-Light	1	40 W	40 W
3.	Ceiling Fan	1	65W	65 W
			Total=	129 W

Current = 129/220 = 0.586 A

SWITCH BOARD 6 (SB6): (Drawing Room)

SL. No.	*Name*	*Quantity*	*watt*	*Total wattage*
1.	LED Bulb	1	24 W	24 W
2.	LED Bulb	1	24 W	24 W
3.	LED Tube-Light	1	45 W	45 W
4.	Ceiling Fan	1	65W	65 W
			Total=	158 W

Current = 158/220 = 0.718 A

SWITCH BOARD 7 (SB7): (Kitchen)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	36 W	36 W
2.	Exhaust Fan	1	50 W	50 W
			Total=	86 W

Current = 86/220 = 0.4 A

SWITCH BOARD 8 (SB8): (Dining Room)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	18 W	18 W
2.	LED Tube-Light	1	18 W	18 W
3.	Ceiling Fan	1	65W	65 W
			Total=	101 W

Current = 101/220 = 0.46 A

SWITCH BOARD 9 (SB9): (Guest Room)

SL. No.	***Name***	***Quantity***	***watt***	***Total wattage***
1.	LED Bulb	1	20 W	20 W
2.	LED Tube-Light	1	24 W	24 W
3.	Ceiling Fan	1	65W	65 W
			Total=	109 W

Current = 109/220 = 0.495 A

SWITCH BOARD 10 (SB10): (Toilet-3)

SL. No.	*Name*	*Quantity*	*watt*	*Total wattage*
1.	LED Bulb	1	6 W	6 W

Current = 6/220 = 0.027 A

SWITCH BOARD 11 (SB11): (Veranda-2)

SL. No.	*Name*	*Quantity*	*watt*	*Total wattage*
1.	LED Bulb	1	4 W	4 W

Current = 4/220 = 0.018 A

- ✓ ***Total Lighting Load= 752 W***
- ✓ ***Total Current (Lighting Circuit) = (0.045 + 0.586 + 0.045 + 0.586 + 0.718 + 0.4 + 0.46 + 0.495 + 0.027 + 0.018) A***
  =3.38 A
- ✓ ***Total Current = 752/220 = 3.4 A***
- ✓ ***Short Current = (3.4 *1.65) =5.64 A***

Power Circuit Current

Circuit 1: (Bedroom-1)

SL. No.	***Specification***	***Number of points***	***Wattage per unit***	***Wattage***
1.	Air conditioner	1	1000 W	1000 W
2.	3 pin socket	2	1000 W	2000 W
3.	2 pin socket	1	100 W	100 W
			Total=	3100 W

Current = 3100/220 = 14.09 A

Circuit 2: (Bedroom-2)

SL. No.	***Specification***	***Number of points***	***Wattage per unit***	***Wattage***
1.	Air conditioner	1	1000 W	1000 W
2.	3 pin socket	2	1000 W	2000 W
3.	2 pin socket	1	100 W	100 W
			Total=	3100 W

Current = 3100/220 = 14.09 A

Circuit 3: (Dining Room + Kitchen)

SL. No.	***Specification***	***Number of points***	***Wattage per unit***	***Wattage***
2.	3 pin socket	3	1000 W	3000 W
3.	2 pin socket	2	100 W	200 W
			Total=	3200 W

Current = 3200/220 = 14.54 A

Circuit 4: (Guest Room)

SL. No.	***Specification***	***Number of points***	***Wattage per unit***	***Wattage***
1.	Air conditioner	1	1000 W	1000 W
2.	3 pin socket	2	1000 W	2000 W
3.	2 pin socket	1	100 W	100 W
			Total=	3100 W

Current = 3100/220 = 14.09 A

Circuit 5: (Drawing Room)

SL. No.	***Specification***	***Number of points***	***Wattage per unit***	***Wattage***
1.	Air conditioner	1	1000 W	1000 W
2.	3 pin socket	1	1000 W	1000 W

3.	2 pin socket	2	100 W	200 W
			Total=	2200 W

Current = 2200/220 = 10 A

- ***Total Power Load = 14700 W***
- ***Total Current (Power Circuit) = (3*14.09 + 14.54 + 10) = 66.81 A***
- ***Total Current = 14700/220 = 66.81 A***
- ***Short Current = (66.81*1.65) = 110.2365 A***

Total load current:

From Distribution-Board,

Total Current = Lighting Circuit Current + Power Circuit Current

= (5.64 + 110.2365) A

= 115.87 A

Conduit Length Calculation:

Specification as follows:

- The Height of the Light Bracket from the Floor Level = 8 Feet.
- The Height of the Switch from the Floor Level = 5 Feet.
- The Height of the 3-pin Switch Board from the Floor Level = 2 Feet.
- The Height of the Ceiling Fan from the Floor Level = 10 Feet.
- The Height of the Main Distribution Board from the Floor Level =6 Feet

Lighting Circuit

Switch Board to Load:

SWITCH BOARD 1:

- SB1 to L1 = 5’5’’+5’+2’ = 12’5’’

SWITCH BOARD 2:

- SB2 to L4 = 3’+3’ = 6’
- SB2 to F1 = 4’5’’+5’ = 9’5’’
- SB2 to T1 = 6’11’’+5’+2’ = 13’1’’

SWITCH BOARD 3:

- SB3 to L2 = 1’+3’ = 4

SWITCH BOARD 4:

- SB4 to L3 = 5’5’’+5’+2’ = 12’5’’

SWITCH BOARD 5:

- SB5 to L5= 3’+3’ = 6’
- SB5 to F2 = 4’7’’+5’ = 9’7’’
- SB5 to T2 = 5’9’’+5’+2’ = 12’9’’

SWITCH BOARD 6:

- SB6 to L8 = 2’+3’ = 5’
- SB6 to F3 = 5’3’’+5’ = 10’3’’
- SB6 to T3 = 3’3’’+5’3’’+3’ = 11’6’’
- SB6 to L7 = 14’8’’+5’+2’ = 21’8’’

SWITCH BOARD 7:

- SB7 to EF = 4’10’’+5’+2’ = 11’10’’
- SB7 to L6 = 4’6’’+5’+2’ = 11’6’’

SWITCH BOARD 8:

- SB8 to L9 = 9’6’’+5’+2’ = 16’6’’
- SB8 to F4 = 5’+5’ = 10’
- SB8 to T4= 8’+3’ = 11’

SWITCH BOARD 9:

- SB9 to L11 = 6’1’’+1’11’’+5’+2’ = 15’

SWITCH BOARD 10:

- SB10 to L10 = 2’+3’ = 5’
- SB10 to F5 = 5’3’’+5’ = 10’3’’
- SB10 to T5 = 3’3’’+5’3’’+3’ = 11’6’’

SWITCH BOARD 11:

- SB11 to L12 = 4’+5’+2’ = 11’

Main Distribution Board to Switch Board:

- MDB to SB10 = 12’4’’+5’+4’ = 21’4’’
- SB10 to SB11 = 6’10’’+5’ = 11’10’’
- MDB to SB6 = 4’4’’+5’+4’ = 13’4’’
- SB6 to SB8 = 15’10’’+5’ = 20’10’’
- SB8 to SB7 = 2’+5’ = 7’
- SB8 to SB9 = 8’8’’+5’ = 13’8’’
- MDB to SB2 = 16’3’’+5’+4’ = 25’3’’
- SB2 to SB12 = 9’8’’+5’ = 14’8’’
- MDB to SB5 = 21’+5’+4’ = 30’
- SB5 to SB3 = 8’8’’+5’ = 13’8’’
- SB5 to SB4 = 9’7’’+5’ = 14’7’’

Power Circuit

MDB to D:

- MDB to D = 12’7’’+4’ = 16’7’’
- D to D1 = 7’8’’+8’ = 15’8’’
- D2 to D1 = 5’+8’ = 8’

MDB to C:

- MDB to C(New) = 15’10’’+4’ = 19’10’’
- C(New) to C3 = 4’4’’+8’ = 12’4’’
- C(New) to C2 = 5’10’’+8’ = 13’10’’
- C(New) to C1 = 6’4’’+8’ = 14’4’’

MDB to E3:

- MDB to E3 = 5’10’’
- E3 to 2-pin = 2’+5’ = 7’
- E3 to E2 = 2’10’’
- E2 to AC = 5’+5’ = 10’
- E2 to E1 = 6’8’’+8’ =14’8’’

MDB to A2:

- MDB to A2 = 22’8’’+8’ =30’8’’
- A2 to A1 = 7’+5’ = 12’

MDB to B2:

- MDB to B2 = 25’3’’+8’ =33’3’’
- B2 to B1 = 6’4’’+5’ =11’4’’

- ✓ ***In Lighting Circuit, Total Conduit Size = 446’11’’+ 10%*446’11’’ ≈ 490’8’’***
- ✓ ***In Power Circuit (D), Total Conduit Size =40’6’’+ 10%*40’6’’ ≈ 44’6’’***
- ✓ ***In Power Circuit (C), Total Conduit Size = 60’2’’+ 10%*60’2’’ ≈ 66’2’’***
- ✓ ***In Power Circuit (E), Total Conduit Size = 40’4’’+10%*40’4’’ ≈ 44’5’’***
- ✓ ***In Power Circuit (A), Total Conduit Size = 42’8’’+10%*42’8’’ ≈ 47’***
- ✓ ***In Power Circuit (B), Total Conduit Size = 44’7’’+10%*44’7’’ ≈ 50’***

Wire Length Calculation

Lighting Circuit:

SWITCH BOARD 1:

- SB1 to L1 = 12’5’’*2 = 24’10’’

Total =24’10’’ =24.83’

SWITCH BOARD 2:

- SB2 to L4 = 6’*2 = 12’’
- SB2 to F1 = 9’5’’*2 = 18’10’’
- SB2 to T1 = 13’1’’*2 = 26’2’’

Total =57’

SWITCH BOARD 3:

- SB3 to L2 = 4’*2 = 8’

Total=57’

SWITCH BOARD 4:

- SB4 to L3 = 12’5’’*2 = 24’10’’

  Total= 24’10’’ =24.83’

SWITCH BOARD 5:

- SB5 to L5 = 6’*2 = 12’’
- SB5 to F2 = 9’7’’*2 = 19’2’’
- SB5 to T2 = 12’9’’*2 = 23’6’’

Total =54’8’’ = 54.67’

SWITCH BOARD 6:

- SB6 to L8 = 5’*2 = 10’’
- SB6 to F3 = 10’3’’*2 = 20’6’’

- SB6 to T3 = 11’6’’*2 = 23’
- SB6 to L7 = 21’8’’*2 = 43’4’’

Total =96’10’’ = 96.83’

SWITCH BOARD 7:

- SB7 to EF = 11’10’’*3 = 35’6’’
- SB7 to L6 = 11’6’’*2 = 23’

Total =58’6’’ = 58.5’

SWITCH BOARD 8:

- SB8 to L9 = 16’6’’*2 = 33’
- SB8 to F4 = 10’*2 = 20’
- SB8 to T4= 11’*2 = 22’

Total =75’

SWITCH BOARD 9:

- SB9 to L11 = 15’*2 = 30’

SWITCH BOARD 10:

- SB10 to L10 = 5’*2 =10’
- SB10 to F5 = 10’3’’*2 = 20.5’
- SB10 to T5 = 11’6’’*2 = 23’

Total =53.6’

SWITCH BOARD 11:

- SB11 to L12 = 11’*2 = 22’

Main Distribution Board to Switch Board:

- MDB to SB10 = 21’4’*3 = 62’
- SB10 to SB11 = 11’10’’*3 = 35.5’
- MDB to SB6 = 13’4’’*3= 40’

- SB6 to SB8 = 20’10’’*3 = 62.5’
- SB8 to SB7 = 7’*3 = 21’
- SB8 to SB9 = 13’8’’*3 = 41’
- MDB to SB2 = 25’3’’*3 = 75.75’
- SB2 to SB12 = 14’8’’*3 = 44’
- MDB to SB5 = 30’*3 = 90’
- SB5 to SB3 = 13’8’’*3 = 41’
- SB5 to SB4 =14’7’’*3 = 43.8’

Power Circuit

MDB to D:

- MDB to D = 17.2’*2 = 34.4’
- D to D1 = 16.3’*2 +16.3’*3 = 81.5’
- D2 to D1 = 8’*3= 24’

Total = 140’

MDB to C:

- MDB to C(New) = 19.8’*2 = 39.6’
- C(New) to C3 = 12.3’*5 = 61.5’
- C(New) to C2 = 13.8’*3 = 41.4’
- C(New) to C1 = 14.3’ *5 = 71.5’
- Total = 214’

MDB to E3:

- MDB to E3 = 5.8’
- E3 to 2-pin = 7’*2 = 14’
- E3 to E2 = 2.8’*2 = 5.6’
- E2 to AC = 0.8’*3 = 2.4’
- E2 to E1 = 14.7’*5 = 73.5’

Total = 101’

MDB to A2:

- MDB to A2 = 30.7'*2 = 61.4'
- A2 to A1 = 12' *10 = 120'

Total =181'4''

MDB to B2:

- MDB to B2 = 33.25'*10 = 332.5'
- B2 to B1 = 11.3'*5 = 56.5'

Total = 389'

- ✓ ***In Lighting Circuit, Total Wire Length = 505.16'+505.16'*10% ≈555.68'***
- ✓ ***In power Circuit, Total Wire Length = 1026' +1026'*10% ≈ 1129'***

Conductor Size specification

From Switch Board to Loads = 1.5 mm^2 (1/1.40), 10A (17 Gauge)
From Distribution Board to Switch Board = 6.0 mm^2 (1/2.80), 27A (10 Gauge)
[The calculated short current of power circuit is 110.2365A. This current is divided among 5 branches. Hence the maximum short current is = (14.09*1.65) A = 23.2485A.]

Final Estimating of Conduit & Cables

Conduit:

1. 27 mm diameter---490.7'
2. 50 mm diameter---252.1'

Cables:

1.5mm^2 (1/1.40),10A (17 Gauge) = 555.68'
6.0mm^2 (1/2.80), 27A (10 Gauge) =1129'

Cost Calculation

1. Wiring Material Cost:

Serial no.	*Materials with specification*		*Quantity*	*Rate (Tk)*	*Total cost(Tk)*
01	Conduit (27 mm dia)		490.7’	12/feet	5889/=
02	Conduit (50 mm dia)		252.1’	20/feet	5042/=
03	1.5 mm^2 (1/1.40) ,10 A(17Gauge)		555.68’	8/feet	4446/=
04	6.0 mm^2 (1/2.80),27A (10 Gauge)		1129’	20/feet	22580/=
05	Conduit	Outlet box	30 piece	20/ piece	600/=
		Junction box	25 piece	40/ piece	1000/=
		Inspection box	10 piece	30/ piece	300/=
		Coupler	15 piece	6/ piece	90/=
		Elbow	50 piece	3/ piece	150/=
	Accessories	Tee box	13 piece	8/ piece	104/=
		Rectangular box	10 piece	6/ piece	60/=
06	3 pin 5-amp socket		10 piece	50/ piece	500/=
07	2 pin 5-amp socket		7 piece	20/ piece	140/=
08	Switch (250 v , 15 amp)		40 piece	20/ piece	800/=
09	Switch board		17 piece	40/ piece	680/=
10	Tube light holder		5 piece	250/ piece	1250/=
11	Holder		12 piece	50/ piece	600/=

12	Circuit Breaker	1 piece	260/ piece	250/=
13	Screw	200 piece	0.5/ piece	100/=
Total = 44591/=				

2. Additional Cost:

Serial No.	***Item***	***Price per piece(Tk)***	***Required piece***	***Total price(Tk)***
1	LED Bulb	250/=	12	3000/=
2	LED Tube-Light	350/=	5	1750/=
3	Fan	2500/=	5	12500/=
4	Exhaust Fan	1300/=	1	1300/=
5	2 Pin Plug Point	120/=	7	840/=
6	3 Pin Plug Point	200/=	10	2000/=
Total = 21390 /=				

- ✓ *Total Cost = 44591+21390 = 65981/=*
- ✓ *Labor cost= 20% * 65981 = 13197/=*
- ✓ ***Finally, Total Cost: Total Cost + Labor cost = 65981 + 13197***
  = 79178 /=

Discussion:

In this experiment, First of all we have designed the floor plan ourself. The conduit wiring was done based on this floor plan with the help of AutoCAD. We have calculated the required illumination and designed the electrical appliances based on it. Measuring and calculating all factors such as amperage, wire length, conduit length, cable size and specifications, the amount ***79178 Tk (only***) is found considering all possible cost. As the price of the materials changes time to time, cost may vary. It's performed bearing in mind that it would give maximum satisfactory result with the least cost.

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