Chittagong University of Engineering & Technology

Department of Electrical & Electronic Engineering

Course No. : EEE 460
Course Title: Electrical Services Design
Group No.:

Submitted by-

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Student ID: 1902154

Project Title: Electrical Service Design for a Residential Space

Project Profile	
NAME	Residential Building
LOCATION	Betagi, Rangunia
CLIENT	
Property Type	Private
DESIGNER (ELECTRICAL)	Susmita Barua, Nishat Anjumane Salsabila
TITLE	Electrical System Drawing
PROJECT SIZE	
ESTIMATED COST	BDT
DATE	21 April, 2024.

General Notes	Important Notes
Electrical Design Method is Used According to the Bangladesh National Building Code (BNBC) 2020.	1. LIGHT/FAN POINT USE 3/4" DIA PVC PIPE. 2. FOR Q/M NOS USE 3/4"DIA PVC PIPE DIRECT FROM SDB. 3. FOR TV,TELEPHONE USE 1"DIA PVC PIPE DIRECT FROM TJB. 4. ALL THE SWITCH BOARD BOTTOM SHOULD BE 4'-0" HEIGHT FROM FINISH FLOOR. 5. ALL THE WALL LIGHT BOTTOM SHOULD BE 7'-6" HEIGHT FROM FINISH FLOOR. 6. ALL THE SDB BOARD BOTTOM SHOULD BE 6'-0" HEIGHT FROM FINISH FLOOR. 7. FOR TELEPHONE & INTERCOM CABLE USE TO 2 PAIR TELEPHONE CABLE/RJ-11. 8. FOR TV & DISH ANTENNA CABLE USE TO RJ-6 . 9. FOR INTERNET CABLE USE TO CAT-6/RJ-45. 10. FOR CC CAMERA CABLE USE TO RG-59(IT'S RECOMMENDED)/PnP(IT'S RECOMMENDED ONLY WHEN AUDIO NEEDED). 11. LIFT'S & PUMP'S LOAD ARE APPROXIMATE. 12. ALL SDB, MDB, LT PANEL SHOULD BE PROPERLY EARTHED. 13. ALL STEEL BOX AND 3 PIN SOCKET MUST BE CONNECTED WITH EARTHING POINT BY THE EARTHING CABLE. 14. LEAVING SPACE AT SDB & MDB FOR FUTURE LOADS..

Abstract:

Our project proposal calls for designing the floor plan and electrical services, which comprise conduit, cabling, and electrical fittings for a residential home that is privately owned. The ground floor electrical systems of a residential structure are the main focus of this project's design and implementation. The goal is to design an electrical plan that satisfies each ground floor room or compartment's lighting, fan, and electrical requirements while still being safe and compliant. The project intends to create a complex electrical design, starting with a thorough examination of the bottom floor's architectural layout. The distribution units, switchboards, conduits, wiring networks, and fixtures will all be strategically installed as part of this scheme. Every component will be positioned with care to blend in with each room's unique design, creating a unified and useful electrical system.

The objectives of our project are:

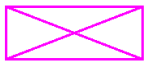
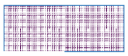
1. To use AutoCAD software to create a 2 D floor layout and electrical services for a home.
2. To create an economical wiring and lighting system with the right placement and wiring route.
3. To reduce the amount of electricity needed by accurately calculating the cables' sizes, the load, and the protection devices' nominal ratings.
4. To lower expenses while maintaining dependable electricity systems.
5. To create a diagram with just one line.

Installation Schedule:

- Installation will be carried out according to the following phases:

Phase	Activity
Phase-I: Preparatory Work	1. Planning and Site Inspection • Verify the electrical layout specifications with the architect and other relevant parties. 2. Purchasing Materials 3. Estimating the cost
Phase-II: Ground Floor Electrical Installation	4. Planning for Layout and Conduit 5. Fittings and Fixtures Installation • As per the plan, install fans, outlets, switches, light fixtures, and other electrical fixtures in the appropriate compartments. 6. Cabling and Wiring • Using the conduit plan as a guide, lay and connect cables and circuits. 7. Installation of the Distribution Board and Switchboard 8. Installing a Lightning Protection System
Phase-III: Finalization & Testing	9. Examination and Verification • Test and confirm that every fitting, fixture, and switchboard is operating as intended. 10. Certification and Documentation 11. Handover and Commissioning • Verify that every electrical system is functional and complies with safety regulations. • Turn over the finished electrical installations to the client or building owner.

Legends:

SYMBOL	CAPTION	HEIGHT	DESCRIPTION
	MDB	Mid Wall	MAIN DISTRIBUTION BORD
	SDB	Lintel	SUB DISTRIBUTION BOARD
	SB	Mid Wall	SWITCH BOARD
	TB	Lintel	TUBE LIGHT
	L	Lintel	WALL LIGHT
	LC	Ceiling	CELLING LIGHT
	F	Ceiling	CELLING FAN
	SS	Mid Wall	SOCKET (2 PIN 5A)
	P	Lower Wall	POWER SOCKET FOR PC
	Q	Lower Wall	POWER SOCKET FOR AC, HEATER, TV ETC
	EX	Lintel	EXHAUST FAN
	CB	Lintel	CALLING BELL

Detailed Plan Drawing:

The dimension of the house will be 40' X 32'-8" + 22' X 15' which is around 1700 sqft. This will include:

Table-1: Dimensions of the different rooms of the house.

Unit	Room	Height (ft)	Length (ft)	Width (ft)	Area (m2)	Room Index	Utilization Factor
A	Bed Room 1	10	12’- 7”	10’- 6”	12.27	0.57	0.48
	Bed Room 2		12’	12’	13.38	0.60	0.50
	Attached Toilet		7’	3’-6”	2.28	0.23	0.35
	Drawing Room		12’-10”	8’6”	10.13	0.51	0.46
	Dining Room		10’-11”	9’	9.13	0.49	0.45
	Common Toilet		8’	4’	2.97	0.27	0.38
	Kitchen		7’	7’	4.55	0.35	0.40
	Verandah		10’-6”	2’-8”	2.60	0.21	0.33
B	Bed Room 1	10	12’- 7”	10’- 6”	12.27	0.57	0.48
	Bed Room 2		12’	12’	13.38	0.60	0.50
	Attached Toilet		7’	3’-6”	2.28	0.23	0.35
	Drawing Room		12’-10”	8’6”	10.13	0.51	0.46
	Dining Room		10’-11”	9’	9.13	0.49	0.45
	Common Toilet		8’	4’	2.97	0.27	0.38
	Kitchen		7’	7’	4.55	0.35	0.40
	Verandah		10’-6”	2’-8”	2.60	0.21	0.33

Table-2: Data table of no. of lamps needed in different rooms for recommended lux.

Unit	Room	Recommended values of lux	Min Lux (lumens)	Max Lux (lumens)	No of Lights	No of Fans	No of 2 Pin Socket	No of 3 Pin Socket	No. of switch board
A	Bed Room 1	150-250	1840	3070	3 (2B,1T)	1	1	1	2
	Bed Room 2	150-250	2007	3345	3 (2B,1T)	1	1	2	2
	Attached Toilet	100-150	228	342	1	-	-	-	1
	Drawing Room	200-300	2026	3039	3 (2B,1T)	1	1	2	2
	Dining Room	200-300	1826	2739	2 (1B,1T)	1	1	1	2
	Common Toilet	100-150	297	446	1	-	-	-	1
	Kitchen	250-500	1137	2275	2	1(Exhaust Fan)	1	1	1
	Verandah	100-150	260	390	1	-		1	1
B	Bed Room 1	150-250	1840	3070	3 (2B,1T)	1	1	1	2
	Bed Room 2	150-250	2007	3345	3 (2B,1T)	1	1	2	2
	Attached Toilet	100-150	228	342	1	-	-	-	1
	Drawing Room	200-300	2026	3039	3 (2B,1T)	1	1	2	2
	Dining Room	200-300	1826	2739	2 (1B,1T)	1	1	1	2
	Common Toilet	100-150	297	446	1	-	-	-	1
	Kitchen	250-500	1137	2275	2	1(Exhaust Fan)	1	1	1
	Verandah	100-150	260	390	1	-		1	1

Drawing With Fitting and Fixtures:

Luminaire Calculation:

For Bed Room 1:

Step-1: According to BNBC 2020, 250 lux is the recommended amount of light for a bed head with a dressing table.

Step-2: Room Index = $\frac{L \times W}{H_m \times (L+W)}$;

Where, L = Length of the room = 12’ 7” = 12’ + 712' = 12.58’

W = Width of the room = 10’ 6”= 10’ + 612' = 10.5’

H_m = The mounting height above the work plane = 10’

Area = 10’6” x 12’7” = (10.5’*12.58’) sq ft = (10.5*×0.3048×12.58×0.3048) m^2= 12.28 m^2

For Bedroom-1, Room Index = $\frac{12.58 \times 10.5}{10 \times (12.58+10.5)}$ = 0.57

Number of lights= $\frac{(E \times A)}{F \times UF \times LF}$

Step-3: As

The Utilization Factor (UF) depends on the type of room and its lighting efficiency. It is determined by:

- Room Index (RI)
- Reflectance of walls, ceiling, and floor
- Type of lighting used

For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises.

Using this and room index the utilization factor is, UF = 0.48

Step-4: We know Lumen = Lux × Area (m²)

$Lumen_{min}$ = 150 ×12.27 = 1840, $Lumen_{max}$ = 250×12.27 = 3070.

Let, One LED bulb provides ~800 lumens .

Number of bulbs, N = $\frac{\boldsymbol{Lumen}}{\mathbf{800}}$ = $\frac{\mathbf{1840 \sim 3070}}{\mathbf{800}}$ = 2.3 ~3.8 ≈3

For the luminaire calculation we know that,

$$N = \frac{E \times A}{f \times UF \times MF};$$

Where, N = no. of lamps required; E = Illuminance level required (Lux); A = area; f =avg. luminous flux from each lamp (lm); UF = Utilization factor; MF = Maintenance factor

Let, MF = 0.95

Now, for the 3 lamps, luminous flux needed from each lamp is:

$$f = \frac{E \times A}{N \times UF \times MF} = \frac{185 \times 12.27}{3 \times 0.49 \times 0.95} = 1758 \text{ lumen}$$

We know, Power (W) = $\frac{Luminous\ Flux\ (lm)}{Luminous\ Efficacy\ (\frac{lm}{W})}$;

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

So, P = $\frac{1625.45 \text{ lm}}{80 \text{ lm/W}}$ = 20.31≈ 20

For that we will use 2 wall lights and 1 tube light of 20 W.

For Bed Room 2:

Step-1: According to BNBC 2020, 250 lux is the recommended amount of light for a bed head with a dressing table.
Step-2: L = Length of the room = 12'
W = Width of the room = 12'
H_m = The mounting height above the work plane = 10'
For Bedroom-2, Room Index = $\frac{12 \times 12}{10 \times (12+12)}$ = 0.60

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.50

Step-4: $Lumen_{min}$ = 150 ×13.38 = 2007, $Lumen_{max}$ = 250×13.38 = 3345,

Let, One LED bulb provides ~800 lumens.

$$\text{Number of bulbs, N} = \frac{\boldsymbol{Lumen}}{\mathbf{800}} = \frac{\mathbf{2007 \sim 3345}}{\mathbf{800}} = 2.5 \sim 4.18 \approx 3$$

Let, MF = 0.95

Now, for the 3 lamps, luminous flux needed from each lamp is:

$$f = \frac{E \times A}{N \times UF \times MF} = \frac{273 \times 13{,}38}{3 \times 0.50 \times 0.95} = 1624.38 \text{ lumen}$$

We know, Power (W) = $\frac{Luminous\ Flux\ (lm)}{Luminous\ Efficacy\ (\frac{lm}{W})}$;

So, P = $\frac{1625.45\ \text{lm}}{80\ \text{lm/W}}$ = 20.31≈ 20

For that we will use 2 wall lights and 1 tube light of 20 W.

For Attached Toilet:

Step-1: According to BNBC 2020, 150 lux is the recommended amount of light for a bedroom attached toilet,
Step-2: L = Length of the room = 7’
W = Width of the room = 3’6” = 3’ + 6’/12’ = 3.5’
H_m = The mounting height above the work plane = 10’
For Bedroom-2, Room Index = $\frac{7\times3.5}{10\times(7+3.5)}$ = 0.23

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.35

Step-4:$Lumen_{min}$ = 100 × 2.28 = 228, $Lumen_{max}$ = 150×2.28 = 342,

Let, One LED bulb provides ~800 lumens.

$$\text{Number of bulbs, N} = \frac{\boldsymbol{Lumen}}{\mathbf{800}} = \frac{\mathbf{228\sim342}}{\mathbf{800}} = 0.285 \sim 0.4275 \approx 1$$

Let, MF = 0.95

Now, for the 3 lamps, luminous flux needed from each lamp is:

$$\text{f} = \frac{E\times A}{N\times UF\times MF} = \frac{174\times2.28}{1\times0.35\times0.95} = 1188.8\ \text{lumen}$$

So, P = $\frac{1188.8\ \text{lm}}{80\ \text{lm/W}}$ = 14.86 ≈ 15

For that we will use 1 LED wall light of 15 W.

Drawing Room:

Step-1: According to BNBC 2020, 300 lux is the recommended amount of light for the Drawing room.
Step-2: L = Length of the room = 12’10” = 12’ + 10’/12' = 12.83’
W = Width of the room = 8’6” = 8’+ 6’/12’= 8.5’
H_m = The mounting height above the work plane = 10’
For Drawing Room, Room Index = $\frac{12.83\times8.5}{10\times(12.83+8.5)}$= 0.51

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.46

Step-4: $Lumen_{min}$= 200×10.13 = 2026, $Lumen_{max}$ = 300×10.13 = 3039

Let, One LED bulb provides ~800 lumens.

$$\text{Number of bulbs, N} = \frac{2026 \sim 3039}{800} = 2.5 \sim 3.7 \approx 3$$

Let, MF = 0.95

Now, for the 3 lamps, luminous flux needed from each lamp is:

$$f = \frac{204 \times 10.133}{3 \times 0.46 \times 0.95} = 1576.3 \text{ lumen}$$

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

So, $P = \frac{1576.3 \text{ lm}}{80 \text{ lm/W}} = 19.7 \approx 20W$

For that we will use 2 LED wall light and 1 Tube light of 20W.

Dining Room:

Step-1: According to BNBC 2020, 300 lux is the recommended amount of light for the Dining Room.

Step-2: L = Length of the room = 10'11" = 10' + 11'/12' = 10.91'

W = Width of the room = 9'

H_m = The mounting height above the work plane = 10'

For Dining Room, Room Index $= \frac{10.91 \times 9}{10 \times (10.91+9)} = 0.49$

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.45

Step-4: $Lumen_{min}$ = 200×9.13 = 1826, $Lumen_{max}$ = 300×9.13 = 2739

Let, One bulb provides ~ 800 lumens.

$$\text{Number of bulbs, N} = \frac{1826 \sim 2739}{800} = 2.3 \sim 3.42 \approx 2$$

Let, MF = 0.95

Now, for the 2 lamps, luminous flux needed from each lamp is:

$$f = \frac{150 \times 9.13}{2 \times 0.45 \times 0.95} = 1601.75 \text{ lumen}$$

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

So, P = P = $\frac{1601.75 \text{ lm}}{80 \text{ lm/W}} = 20.02 \approx 20$

For that we will use 1 LED wall light and Tube light of 20W.

For Common Toilet:

Step-1: According to BNBC 2020, 150 lux is the recommended amount of light for Common toilets.

Step-2: Here, L = Length of the room = 8'

W = Width of the room = 4'

H_m = The mounting height above the work plane = 10'

For Common toilet, Room Index = $\frac{8 \times 4}{10 \times (8+4)} = 0.27$

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.38

Step-4: $Lumen_{min}$ = 100×2.97 = 297, $Lumen_{max}$ = 150×2.97 = 446

Let, One LED bulb provides ~800 lumens.

Number of bulbs, N = $\frac{\mathbf{297 \sim 446}}{\mathbf{800}}$ = 0.37~0.56≈1

Let, MF = 0.95

Now, for the 1 lamp, luminous flux needed from each lamp is:

$$f = \frac{150 \times 2.97}{1 \times 0.38 \times 0.95} = 1208.63 \text{ lumen}$$

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

So, P = P = $\frac{1208.63 \text{ lm}}{80 \text{ lm/W}} = 15.11 \approx 15$

For that we will use 1 LED wall light of 15 W.

For Kitchen:

Step-1: According to BNBC 2020, 500 lux is the recommended amount of light for Kitchen.

Step-2: Here, L = Length of the room = 7’
W = Width of the room = 7’
H_m = The mounting height above the work plane = 10’
For Kitchen, Room Index = $\frac{7\times7}{10\times(7+7)}$ = 0.35

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.40

Step-4: $Lumen_{min}$ = 250×4.55 = 1137, $Lumen_{max}$ = 500×4.55 = 2275

Let, One LED bulb provides ~800 lumens.

$$\text{Number of bulbs, N} = \frac{\mathbf{1137\sim2275}}{\mathbf{800}} = 1.4\sim2.84\approx2$$

Let, MF = 0.95

Now, for the 2 lamps, luminous flux needed from each lamp is:

$$f = \frac{266.6\times4.55}{2\times0.40\times0.95} = \quad 1596 \text{ lumen}$$

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

So, P = P = $\frac{1596 \text{ lm}}{80 \text{ lm/W}}$ = 19.95≈20 W

For that we will use 2 LED wall lights of 20 W.

For Verandah:

Step-1: According to BNBC 2020, 150 lux is the recommended amount of light for Verandah.
Step-2: Here, L = Length of the room = 10’ 6” = 10’ + 612' = 10.5’
W = Width of the room = 2’ 8” = 2’ + 812' = 2.67
H_m = The mounting height above the work plane = 10’

For Verandah, Room Index = $\frac{10.5\times2.67}{10\times(10.5+2.67)}$ = 0.21

Step-3: For general lighting standards, assuming typical reflectance values the triplet 0.7/0.5/0.1 (Ceiling: 70%, Walls: 50%, Floor: 20%), shall be used for other premises. Using this and room index the utilization factor is, UF = 0.33

Step-4: $Lumen_{min}$ = 100×2.6 = 260, $Lumen_{max}$ = 150×2.6 = 390

Let, One LED bulb provides ~800 lumens.

$$\text{Number of bulbs, N} = \frac{260 \sim 390}{800} = 0.3 \sim 0.49 \approx 1$$

Let, MF = 0.95

Now, for the 1 lamp, luminous flux needed from each lamp is:

$$f = \frac{150 \times 2.6}{1 \times 0.33 \times 0.95} = 1244.02 \text{ lumen}$$

As typical values range of Luminous Efficacy is from 70 lm/W to over 100 lm/W for good quality LEDs. So we assume the value 80 lm/W as a middle-ground estimate.

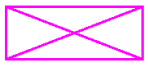
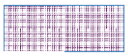
So, $P = P = \frac{1244.02 \text{ lm}}{80 \text{ lm/W}} = 15.45 \approx 15$

For that we will use LED wall light of 15 W.

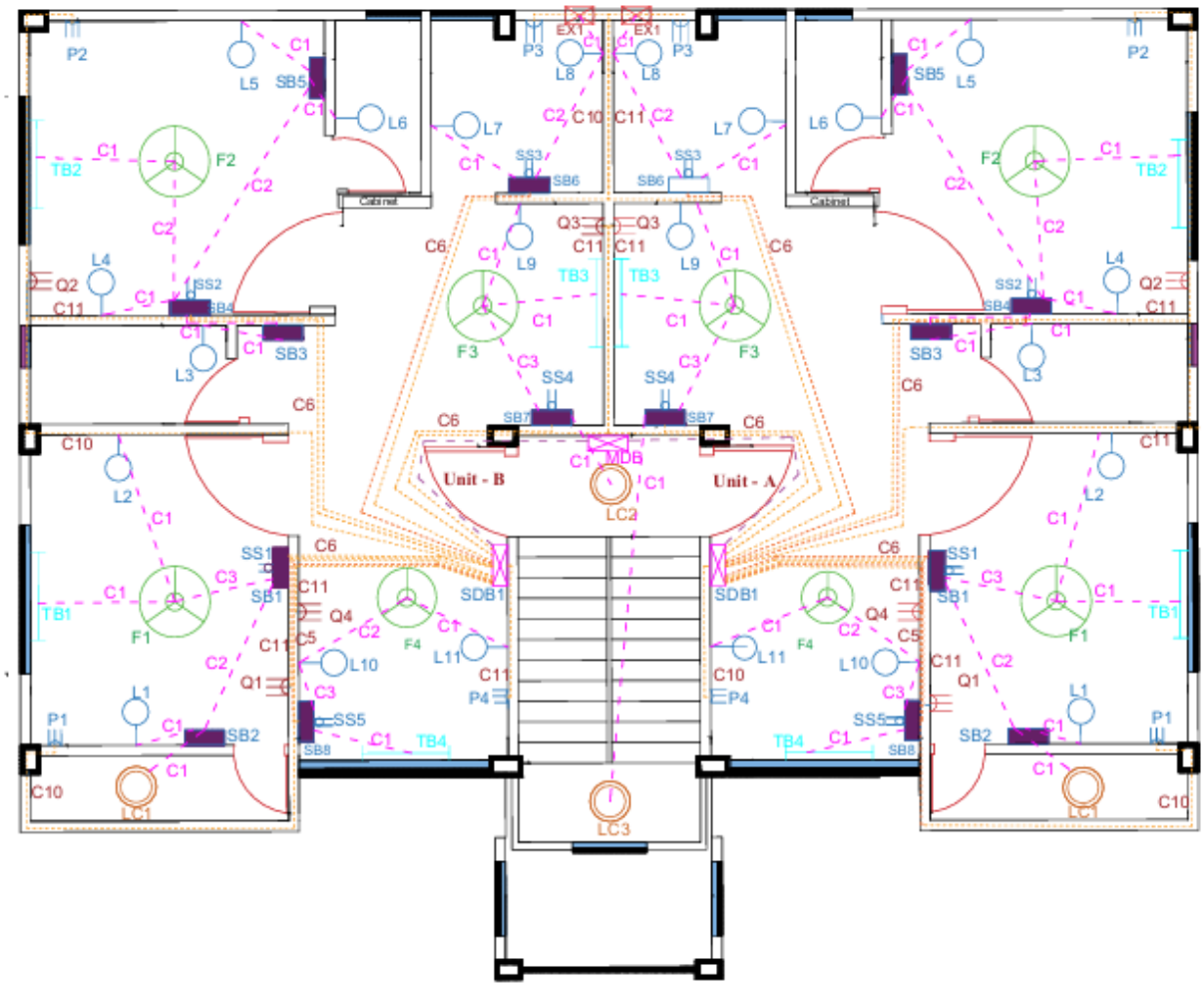
For Corridor: We will use 1 LED ceiling light of 20 W.

For Stair and In Front of House: We will use 1 LED wall light of 20 W.

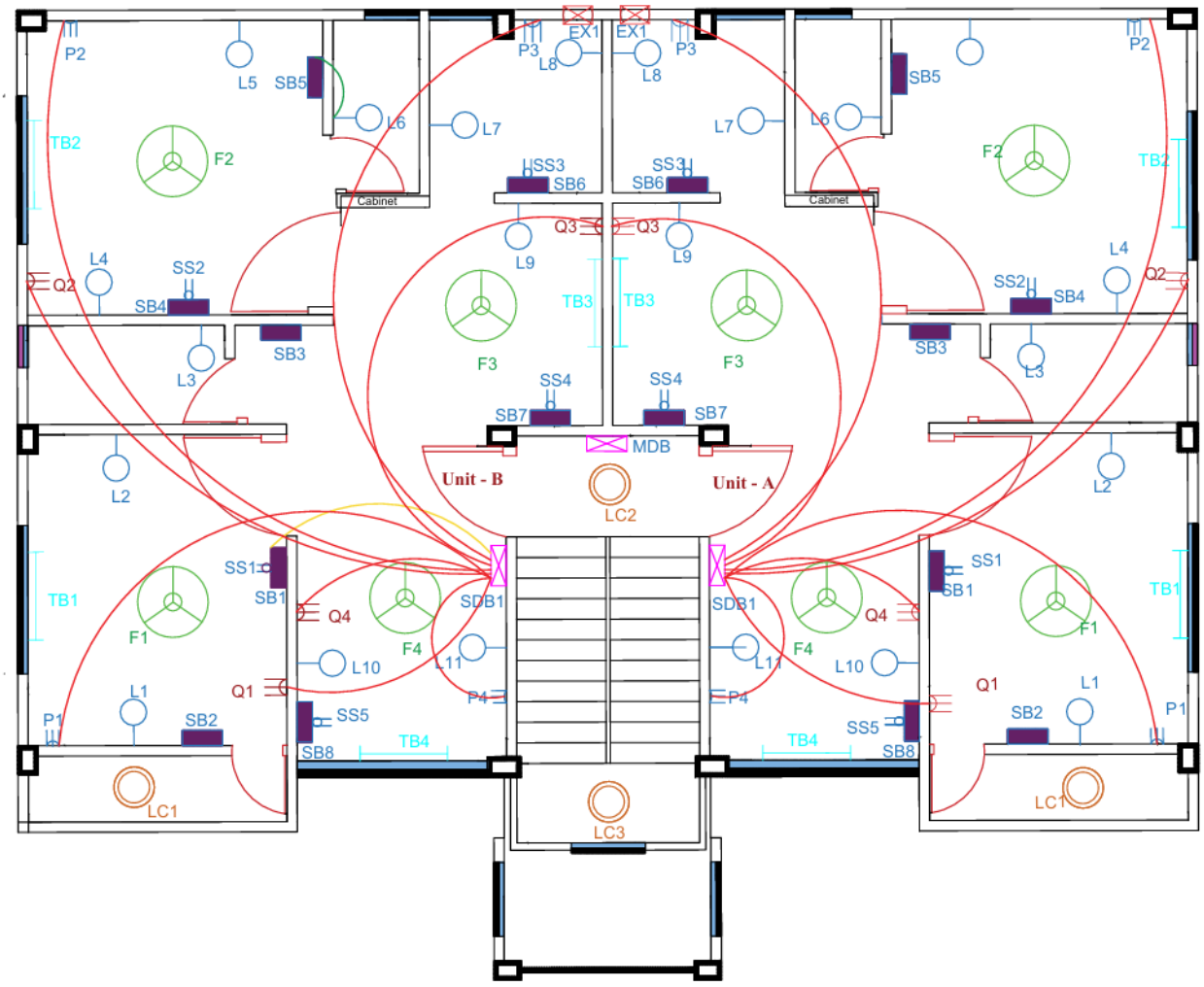
Legends:

SYMBOL	CAPTION	HEIGHT	DESCRIPTION
	MDB	Mid Wall	MAIN DISTRIBUTION BORD
	SDB	Lintel	SUB DISTRIBUTION BOARD
	SB	Mid Wall	SWITCH BOARD
	TB	Lintel	TUBE LIGHT
	L	Lintel	WALL LIGHT
	LC	Ceiling	CELLING LIGHT
	F	Ceiling	CELLING FAN
	SS	Mid Wall	SOCKET (2 PIN 5A)
	P	Lower Wall	POWER SOCKET FOR PC
	Q	Lower Wall	POWER SOCKET FOR AC, HEATER, TV ETC
	EX	Lintel	EXHAUST FAN
	CB	Lintel	CALLING BELL

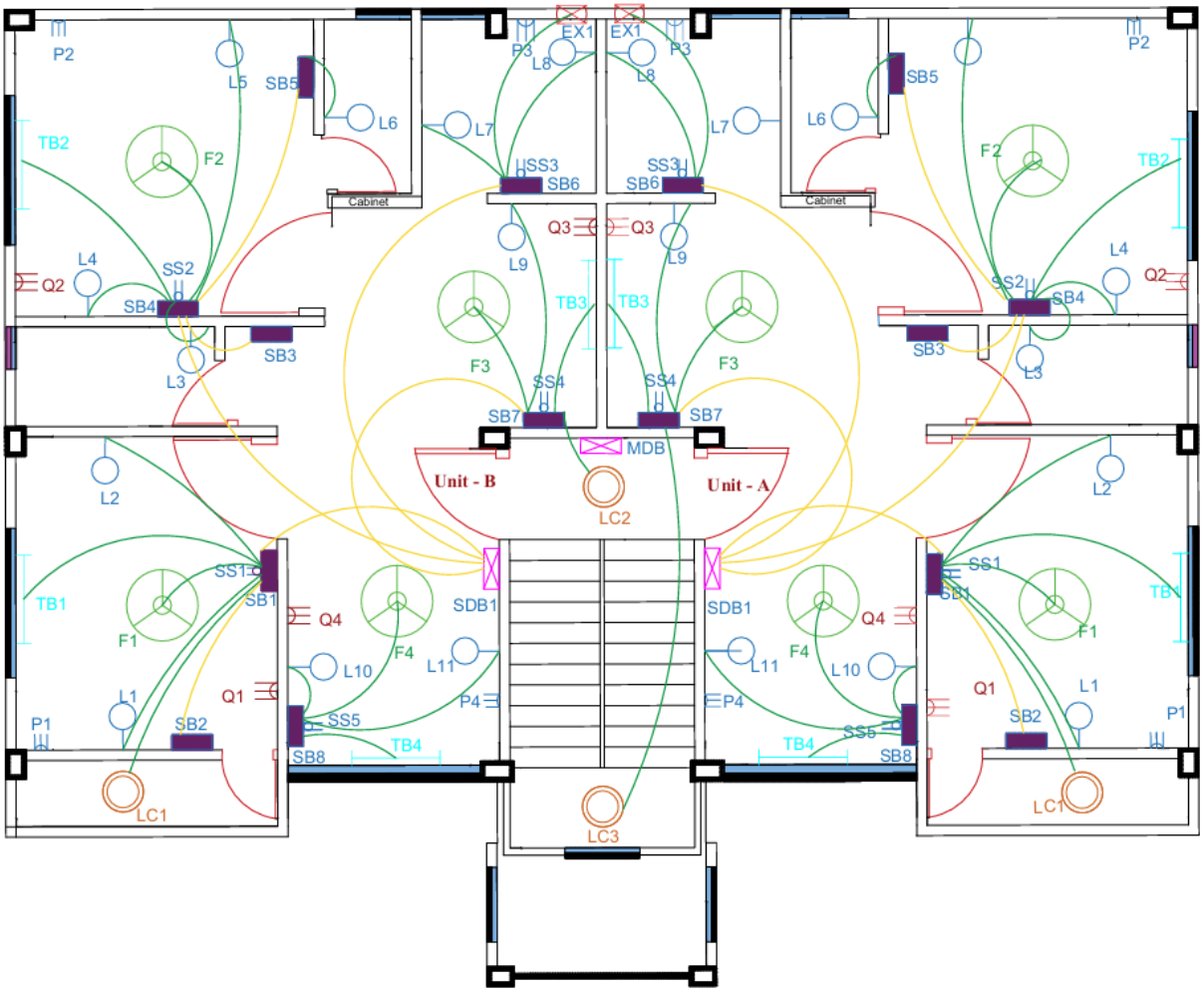
CONDUIT LAYOUTS



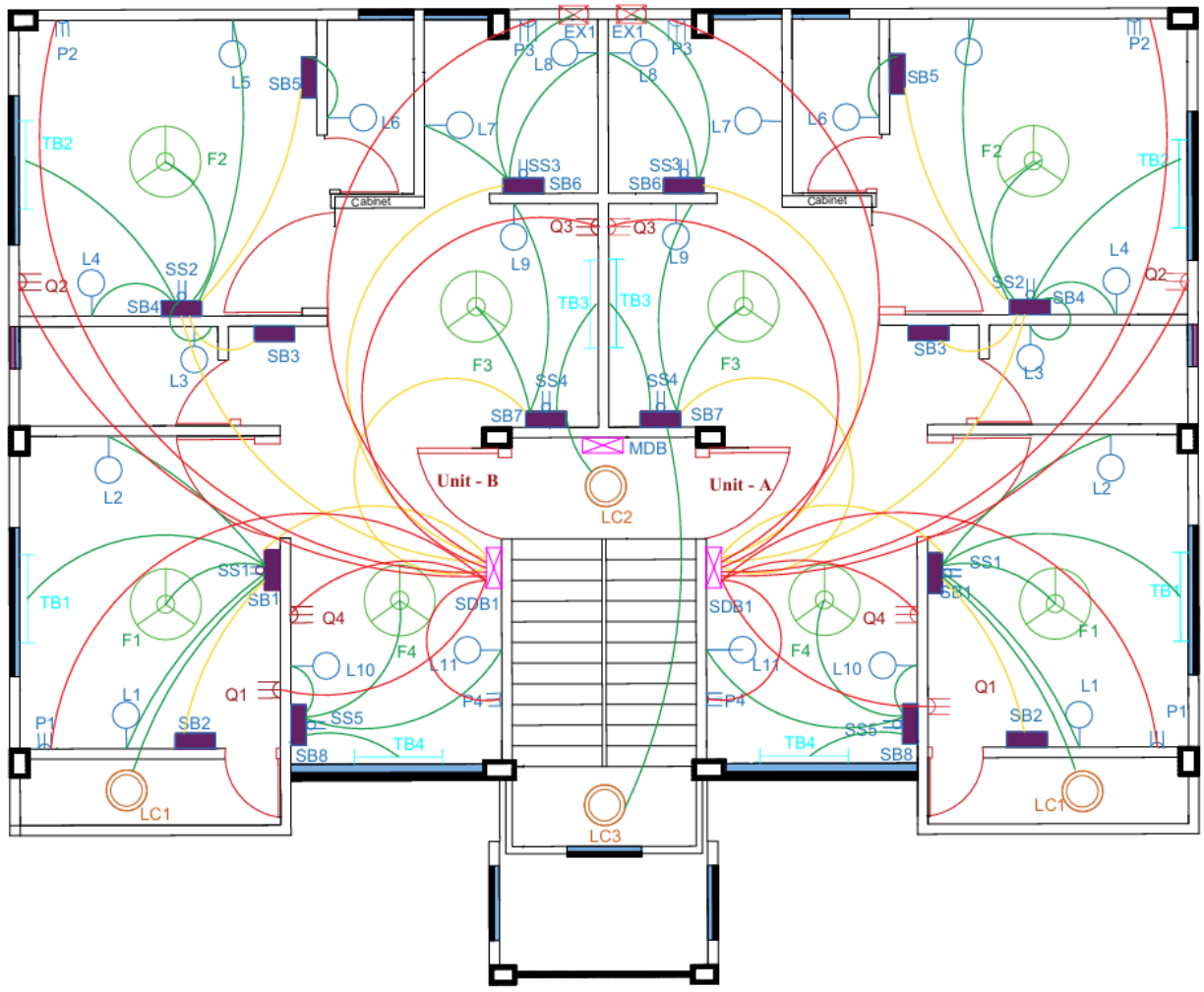
CABLING LAYOUT OF 1ST & 2ND FLOOR (POWER SOCKETS) :



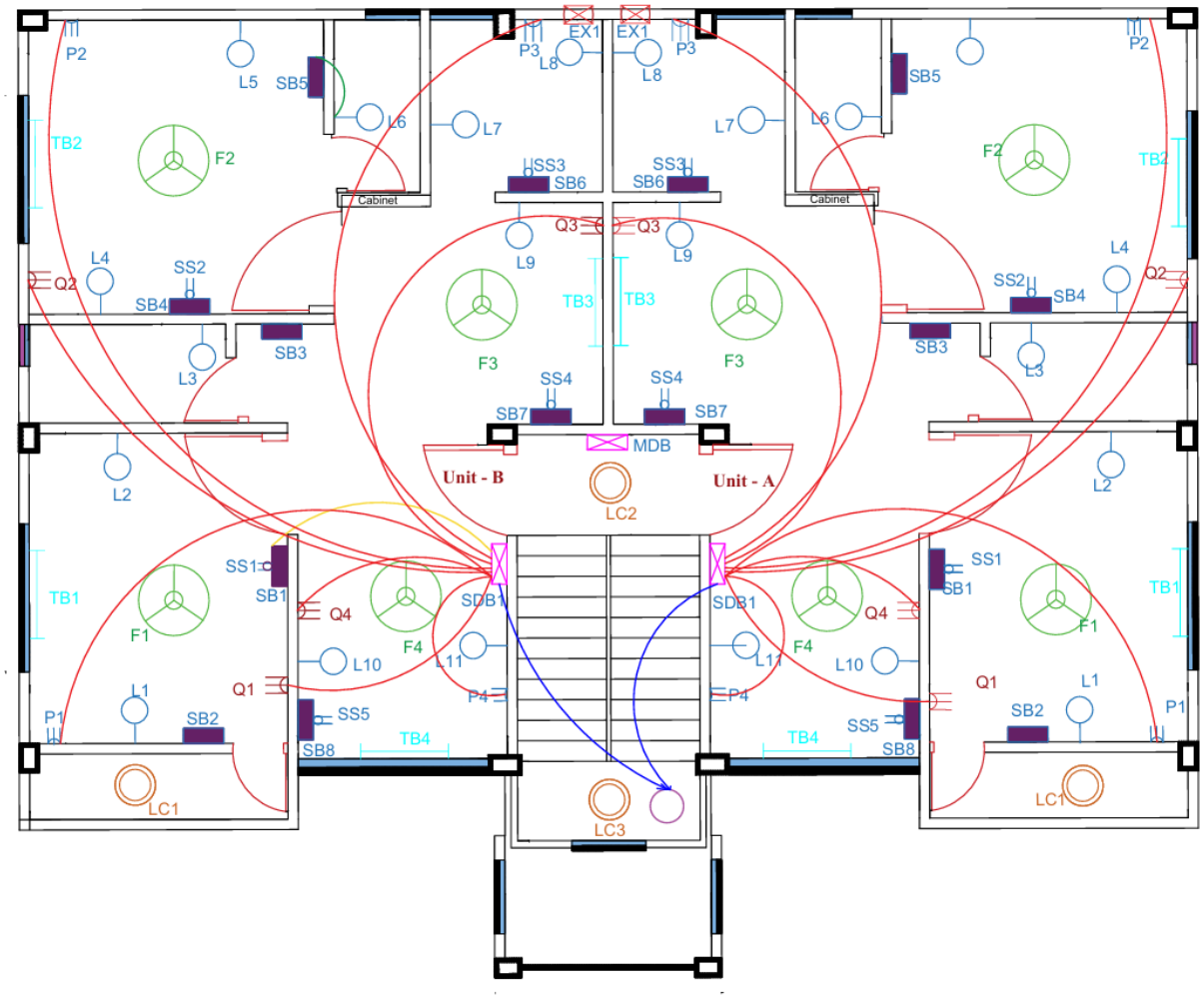
CABLING LAYOUT OF 1ST & 2ND FLOOR (SB, LIGHT, FAN)



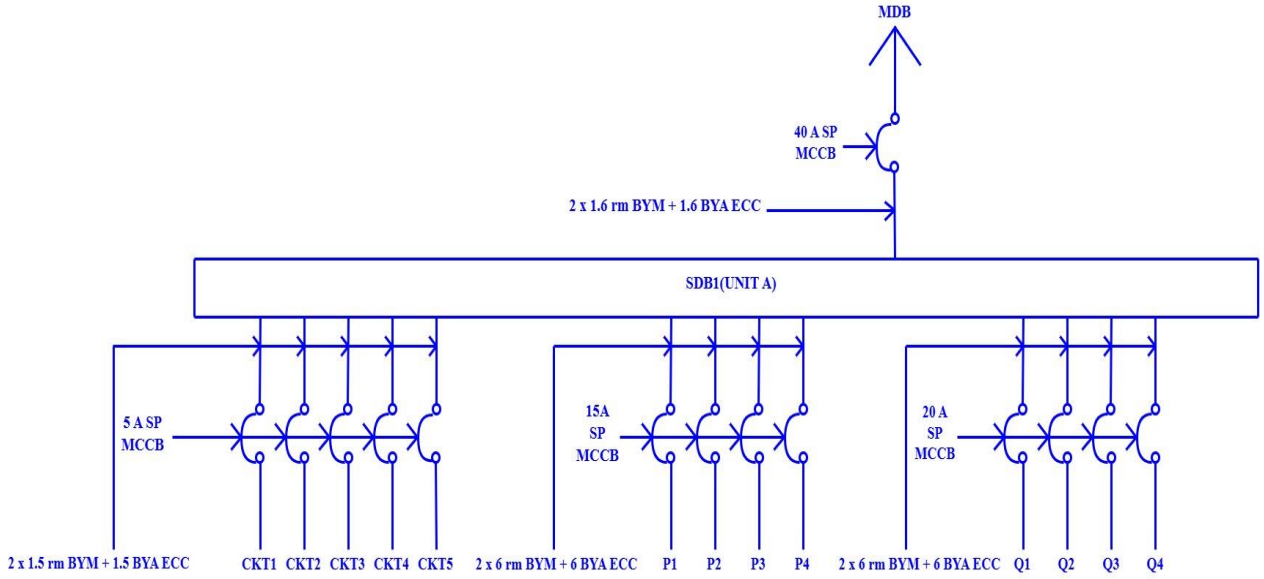
CABLING LAYOUT OF 1ST & 2ND FLOOR (OVERALL)



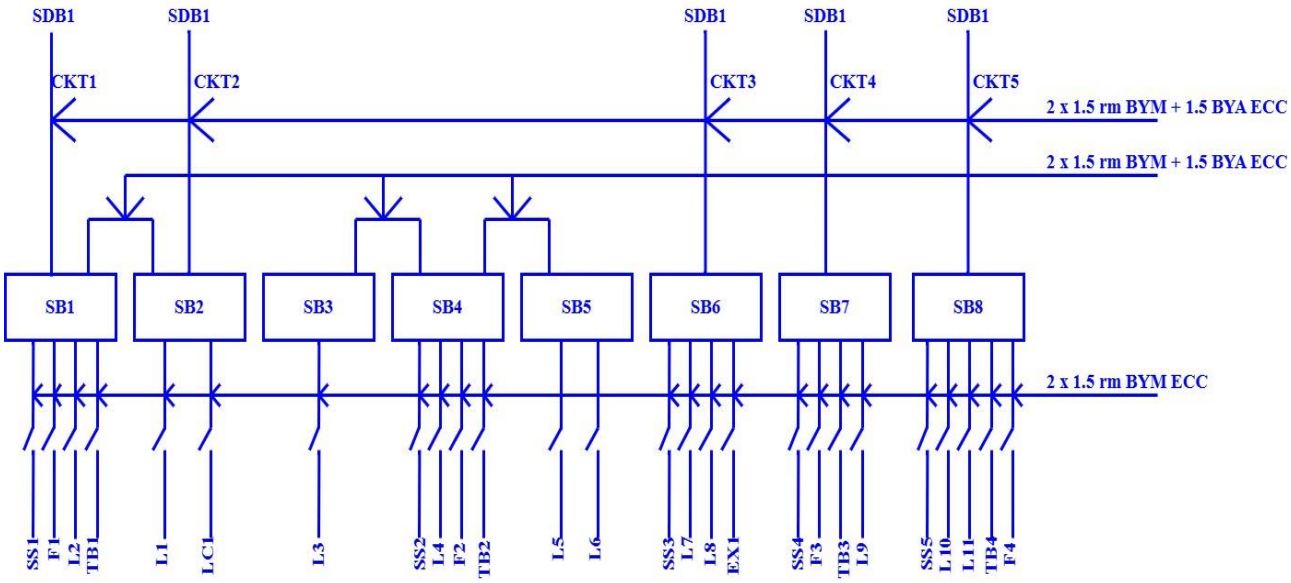
GROUNDING TECHNIQUES FOR 1ST AND 2ND FLOOR



SUB-DISTRIBUTION BOARD DIAGRAM (1ST & 2ND FLOOR):



SWITCH BOARD DIAGRAM (1ST & 2ND FLOOR):



Load Study Analysis:

For bedroom-1(SB1-SB2)

Wall Light – 20 Watt (2), P.F = 0.5

Tube Light – 20 Watt (1), P.F = 0.65

Fan – 90 Watt (1), P.F = 0.994

2 pin Socket – 1000 Watt (1)

3 pin Socket – 2000 Watt (1)

Verandah light - 15 Watt (1), P.F = 0.5

3 pin Socket – 2000 Watt (1)

For Wall Light, Current Rating = $\frac{20}{220\times0.5}$ = 0.181 A

So, for total 2 Lights = (0.181×2) = 0.363 A

For Tube Light, Current Rating = $\frac{20}{220\times0.65}$ = 0.140 A

So, for 1 Light = (0.140×1) = 0.140 A

For Fan, Current Rating = $\frac{90}{220\times0.994}$ = 0.412 A

For Verandah Light, Current rating = $\frac{15}{220\times0.5}$ = 0.136 A

For 2 pin Socket, Current Rating = 5A

For 3 pin Socket, Current Rating = 13A

Therefore, Total Current = 6.051 A (except 3 pin)

For bedroom-2 (SB4-SB5):

Wall Light – 20 Watt (2), P.F = 0.5

Tube Light – 20 Watt (1), P.F = 0.65

Fan – 90 Watt (1), P.F = 0.994

2 pin Socket – 1000 Watt (1)

3 pin Socket – 2000 Watt (2)

Attached Toilet Light – 15 Watt (1), P.F = 0.5

For Wall Light, Current Rating = $\frac{20}{220\times 0.5}$ = 0.181 A

So, for total 2 Lights = (0.181×2) = 0.363 A

For Tube Light, Current Rating = $\frac{20}{220\times 0.65}$ = 0.140 A

So, for 1 Light = (0.140×1) = 0.140 A

For Fan, Current Rating = $\frac{90}{220\times 0.994}$ = 0.411 A

So, for total 1 Fan = (0.411× 1) = 0.411 A

For Toilet Light, Current Rating = $\frac{15}{220\times 0.5}$ = 0.136 A

So, for total 1 Light = (0.136×1) = 0.136 A

For 2 pin Socket, Current Rating = 5A

For 3 pin Socket, Current Rating = 13A

Therefore, Total Current = 6.05 A (except 3 pin)

Kitchen (SB13-SB14)

Wall Light – 20 Watt (2), P.F = 0.5

Exhaust Fan – 40 Watt, P.F = 0.95

2 pin Socket – 1000 Watt (1)

3 pin Socket – 2000 Watt (1)

For Wall Light, Current Rating = $\frac{20}{220\times 0.5}$ = 0.181A

So, for total 2 Light = (0.181× 2) = 0.363 A

For Exhaust Fan, Current Rating = $\frac{40}{220\times 0.95}$ = 0.191A

For 2 pin Socket, Current Rating = 5A

For 3 pin Socket, Current Rating = 13A

Therefore, Total Current = 5.372 A (except 3 pin)

Dining Room (SB7)

Wall Light – 20 Watt (1), P.F = 0.5

Tube Light – 20 Watt (1), P.F = 0.65

Fan – 90 Watt (1), P.F = 0.994

2 pin Socket – 1000 Watt (1)

3 pin Socket – 2000 Watt (1)

Common Toilet Light –15 Watt (1), P.F = 0.5

For Wall Light, Current Rating = $\frac{20}{220 \times 0.5}$ = 0.181 A

So, for total 2 Light = (0.181 ×2) = 0.352 A

For tube Light, Current Rating = $\frac{20}{220 \times 0.65}$ = 0.140 A

For Fan, Current Rating = $\frac{90}{220 \times 0.994}$ = 0.412 A

So, for total 1 Fan = 0.412 A

For toilet Light, Current rating = $\frac{15}{220 \times 0.5}$ = 0.136 A

For 2 pin Socket, Current Rating = 5A

For 3 pin Socket, Current Rating = 13A

Therefore, Total Current = 5.90 A (except 3 pin)

Drawing Room (SB2)

Wall Light – 20 Watt (2), P.F = 0.5

Tube Light – 20 Watt (1), P.F = 0.65

Fan – 90 Watt (1), P.F = 0.994

2 pin Socket – 1000 Watt (1)

3 pin Socket – 2000 Watt (2)

For Light, Current Rating = $\frac{20}{220 \times 0.5}$= 0.181 A

So, for total 2 Light = (0.181 × 2) = 0.362 A

For tube Light, Current Rating = $\frac{20}{220 \times 0.65}$= 0.140 A

So, for total 1 Light = 0.140 A

For Fan, Current Rating = $\frac{90}{220 \times 0.994}$ = 0.411A

For 2 pin Socket, Current Rating = 5A

For 3 pin Socket, Current Rating = 13A

Therefore, Total Current = 5.954 A (except 3 pin)

Stairs

Ceiling Light – 20 Watt (1), P.F = 0.5

2 pin Socket – 1000 Watt (1)

For Ceiling Light, Current Rating =$\frac{20}{220 \times 0.5}$ = 0.181A

For 2 pin Socket, Current Rating = 5A

Therefore, Total Current = 5.181A

Corridor (SB10)

Ceiling Light – 20 Watt (1), P.F = 0.5

For Ceiling Light, Current Rating = $\frac{20}{220 \times 0.5}$ = 0.181A

So, for total 1 Light = 0.181 A

Motor

Motor – 1 H.P (746 Watt)

For Motor, Current Rating = $\frac{746}{220 \times 0.8}$ = 4.24A

TOTAL LOAD CALCULATION:

Appliance	Unit Power (W)	Quantity	Power of Equipment (W)	Diversity Factor	Total Power
Ceiling Fan	90	8	720	0.7	15693
Exhaust Fan	40	2	80	0.7	
Fluorescent Wall Light	20	22	440	0.7	
Fluorescent Tube Light	20	8	160	0.9	
Fluorescent Tube Light	15	6	90	0.9	
3 PIN Power Socket (PC)	1000	10	10000	0.5	
3 PIN Power Socket (AC, Fridge)	2000	4	8000	1	
2 PIN Power Socket	100	10	1000	0.5	
Motor	746	1	7468 ; ;	1.1	

Bill of Quantity for the floor:

Appliance	Description	Quantity	Per Unit Price (TK)	Net Unit Price (TK)	TOTAL (TK)
Ceiling Fan	Product Name - Walton Comfort BLDC 48";Rated voltage 300V;Speed-370rpm;Power Consumption 30W;Power Factor 0.994; Air Delivery 222m^3 /min.	8 (42)	4000	32000	
Exhaust Fan	Product Name- Walton 6" 40W(WEF0601N); Current-0.16A; Speed- 1350rpm; Input Power 40W;Power factor 0.95; Type of motor- Single Phase	2 (12)	1000	6000	

	Shaded Pole Motor.			
Daylight Bulb(wall light)	Product Name- Super Star Mega Lux 20W Daylight Bulb; Rated Voltage 240V(AC);Input Power 20W;Total Luminous Flux 1900 Lumen; CCT 6500K; Power factor 0.5; Lifespan 25000H.	22(11 2)	530	9540
Fluorescent Tube Light	Product Name- **4' 20W Wall-Mounted Fluorescent Tube Light;** Rated Voltage 240V; Input Power 20W; Total Luminous Flux 1900 Lumen; CCT 6500K; Power factor 0.5; Lifespan 10,000H.	8 (42)	800	6400
15W Fluorescent Light(Super Star Orlee 15W Daylight Bulb)	Product Name- Super Star Orlee 15W Daylight LED Bulb; Rated Voltage 265V; Input Power 15W; Total Luminous Flux 1125 Lumen; CCT 6500K; Power factor 0.5; Lifespan 20,000H.	6 (32)	300	1800
3-Pin Power Socket(1000W) (Walton Classic Series)	Product Name- Walton Classic Series 3-Pin Power Socket with Switch; Rated Voltage 250V; Maximum Operating Current: 13A AC; Dimension: 86 x 90 x 35 mm.	10 (52)	270	2700
3-Pin Power Socket (2000W)(Walton Trust Series)	Product Name - Walton Trust Series 3-Pin Round Socket with Switch (WT3PRSW); Maximum Operating Voltage: 250V AC - Maximum Operating Current: 16A AC' - Dimension: 86 x 89 x 35mm	4 (22)	365	1460
2-Pin Power Socket(Walton Classic Series)	Product Name - (WT2PS); Maximum Operating Voltage: 250V AC; Maximum Operating Current: 10A AC'; Dimension: 86 x 86 x 35mm	10 (52)	215	2150
Switch Board with Switches(Walton Classic Series)	Walton Classic Series Switch Board with Switches; **Material**: Flame-retardant, UV-stabilized, unbreakable polycarbonate (PC); **Type**:	24 (122)	245	5880

	Gang Switch Board; **Voltage Rating**: 250V AC; **Current Rating**: Up to 16A				
Bulb Light Holder (Super Star)	Super Star Bulb Light Holder;Maximum Operating Voltage: 240V - Maximum Wattage: 60 Watt	20	66	1320	
Tube Light Fixture (Walton→WLED-FLEX-FIX-4F)	Walton WLED-FLEX-FIX-4F Tube Light Fixture;Material: Aluzinc Sheet;**Dimensions**: 1200 mm × 35 mm × 17 mm	8	90	720	
Fan point (Hook)	Material: Metal · Ceiling installation · Suitable ceiling fans · Package includes 1 Ceiling Mount Hook	8	60	480	
Fan Regulator with switch (Super Star)	**Super Star Fan Regulator with** 1 Way Switch ; Maximum Operating Voltage: 250V AC;**Current**: 13A; **Frequency**: 50/60Hz	8	250	2000	
Door Bell(Super Star)		2	342	684	
Motor(Walton)	Model: RYC 90L-4 HP: 1 KW: 0.75 VOLTAGE: 220 RPM: 1450 SHAFT DIA(mm): 24	1	8000	8000	

For Unit A

To Sub Distribution Board (SDB1) of the floor:

CKT1 Rating (SB1, SB2):

$$I = \frac{100(SS1) + 90(F1) + 20(L2) + 20(TB1) + 15(LC1) + 20(L1)}{220 \times 0.7} A = 1.72 \text{ A}$$

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT2 Rating (SB3, SB4, SB5):

$$I = \frac{15\,(L3) + 100(SS2) + 20\,(L4) + 90(F2) + 20(L2) + 20(TB2) + 20(L5) + 15(L6)}{220 \times 0.7} = 1.948 \text{ A}$$

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT3 Rating (SB6):

$$I = \frac{100\ (SS3) + + 20\ (L7) + 15\ (L8) + 40\ (EX1)}{220 \times 0.7} = 1.14\ A$$

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT4 Rating (SB7):

$$I = \frac{100(SS4) + 90(F3) + 20(TB3\ ) + 20(L9) + 20(LC2)}{220 \times 0.7} = 1.62\ A$$

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

CKT5 Rating (SB8):

$$I = \frac{100(SS5) + 90(F4) + 20(L10) + 20(TB4) + 20(L11)}{220 \times 0.7} = 1.72\ A$$

So, 2 x 1.5 rm BYM + 1.5 BYA ECC are used.

To Sub Distribution Board (SDB1):

P load= 1000 W, Q load= 2000 W,

Voltage = 220 V

Power factor, pf= 0.7

CKT1 load = 100 + 90 + 20 + 20 + 15 + 20 = 265 W

CKT2 load = 15 + 100 + 20 + 90 + 20 + 20 + 20 + 15 = 300 W

CKT3 load = 100 + 20 + 15 + 40= 175 W

CKT4 load = 100 + 90 + 20 + 20 = 230 W

CKT5 load = 100 + 90 + 20 + 20 + 20 = 250 W

Total CKT load= 265 + 300 + 175 + 230 + 250= 1220 W

SDB1 load = 1220 + 4×1000×0.2 + 4×2000×0.4 = 5220 W // P1, P2, P3, P4//Q1,Q2,Q3,Q4

SDB1 (ground floor) current $= \frac{5220}{220 \times 0.7} = 33.90\ A$

So, 40 A SP MCCB is needed from SDB1 to MDB

Calculations for MDB

MDB load = Total SDB load × 0.7 + Water Pump×0.7

Total SDB Load = $2 \times SDB\ Load$

MDB Current = $\frac{MDB\ Load}{\sqrt{3} \times line\ Voltage \times pf}$

Phase Voltage = 220V

Line Voltage = $\sqrt{3}\ \times 220V = 381.05$

Power Factor, pf = 0.95 (Due to PFI Plant)

SDB Load = 5220 W

Pump Load = 5000W

EMDB Load = $2\times 5220 \times 0.7 + 5000 \times 0.7 = 10.808KW$

EMDB Current = $\frac{10.808}{381.05\times0.7}$ =$40.52A \approx 41A$

So, 50A TP MCCB is needed from MDB to Main Line

Calculations for PFI Plant

$cos\theta = 0.7;\ sin\theta = \sqrt{1-(cos\theta)^2}$ = 0.714;

Q = 3VI $sin\theta$ = P $cos\theta$ = 7.566 KVAR

After Pf improvement $sin\theta = 1$

I = $\frac{Q}{3\times V\times sin\theta}$ = $\frac{7566}{3\times220\times1}$ = 11.46 A

So, 16A TP MCCB is needed from PFI to MDB

BOQ FOR CONDUIT:

Appliance	Quantity	Per Unit Price (TK)	Net Unit Price (TK)	Total Cost (TK)
3/4 ” PVC Conduit Pipe	371	12	4452	27895
1” PVC Conduit Pipe	938	15	9570	
1.5 rm BYE	270	33.45	931	
2.5 rm BYE	152	53.35	8109	
2 ×4 rm BYE	11	259	2849	
1.5 rm BYE ECC	62	32	1984	

COST ESTIMATION:

Items	
Transportation Cost	
Permitting and Inspection Fees	
Overhead and Administrative Costs(rent/utilities)	

Contingency (unexpected costs)	
Total residue cost	

Total Cost:

Items	Cost in TK
Cost for Floor	
Cost for conduits	
Cost for cables	
Total residue cost	
Total Estimated Cost	

The estimated cost of the building of 2000-square-feet residential construction is 242505 Bangladeshi Taka (TK). Several elements that are essential to the project's success are included in this comprehensive figure. One of the main factors influencing the whole cost is the cost of installing fixtures, which includes the acquisition and setup of fittings like windows, doors, and other essential parts. Furthermore, because they take into consideration the assessment and calculation of the labor and materials required, the estimated costs are crucial to the overall budget.

To ensure that safety standards and laws are adhered to during the building process, the cost analysis also accounts for expert advice and experience consultation fees. In essence, the comprehensive financial analysis emphasizes the importance of the multifaceted residential construction development process.

INSTALLATION SCHEDULE

- Installation schedule can BE defined as:
- Install conduit pipe first.
- Run wiring to each part unit and connect it to the appropriate panel and unit.
- Install lighting fixtures, switches, and outlets.
- Set up a lightning arrestor
- Attach the Earthine rod.
- Set up the metering.

EARTHING ROD:

A 40 mm (1.5") dia c.l. pipe (ground electrode) with a 6.35 mm dia hole across the pipe at 305 mm intervals will be used to earth the electrical system. Soldering two No-2 SWG HDBC earth leads (at the top of the electrode) and covering them with 20 mm will firmly attach the earth electrode. To keep earth resistance within 1 ohm, a 3/4-inch dia. G.I. pipe should be run up to the main board at a depth of 609.6 mm (2 feet) below the G.I. All required connecting copper sockets, bolts, nuts, and other components should be acquired. At 6858 mm of electrode, the bottom of the primary electrode is 20 feet deep.

MAIN DISTRIBUTION BOARD:

- 50A TP MCCB
- Connect with 11/0.415KV , 50KHz, DYN 11, Oil Immersed transformer.

GANG TYPE SOCKET:

- 15A, 240V, 50Hz, Fire Resistant Virgin Polycarbonate Material
- At dining room attached to wall,2 feet above from floor

CEILING FAN:

- At bedroom, at ceiling, center of the room
- At drawing room, at ceiling, center of the room
- At dining room, at ceiling, center of the room
- At bedroom2,at ceiling, the center of the room

WALL LIGHT FITTING:

- Light Material: SS/MS Sheet, Brass Alloy, Glass-D 260mm H-135mm, GLORIA cat. no. GCLF-640
- 8 feet above from floor

TUBE LIGHT FITTING:

➢ Material: MS Sheet, GLORIA cat. no. GTF(LED)-888x lx 20W, Enegy+EPTL-1025

➢ 9 feet above from floor

EXHAUST FAN:

➢ Capacity:100 cfm, ESP 30 Pa, 40W

➢ At kitchen, at west side wall and above window

METER BOARD:

➢220V. 50Hz single phase l0-40 Amps electric energy meter (KWH meter) steel body

➢Outer side of the main gate and 5 feet above from floor

SWITCHBOARD:

➢ At bedroom 1, just 5.5 feet above from floor at sided wall

➢ Outer wall of toilet 1, 5.5 feet above from floor

➢ At dining room, 5.5 feet above from floor

➢ At bedroom 2, 5 feet above from floor

CONCLUDING REMARKS

It seems that the report's power layout and lighting arrangement were thoughtfully planned and executed using the conventional power table and lumen technique, respectively. Using the right protective device ratings and providing flexibility for future growth shows that safety and scalability have been carefully considered. It is admirable that calculations were incorporated into the design process since they aid in the important decisions that must be made about the ratings of protective devices, cable sizes, and luminaries for each circuit and the total installation.

The proposed building is guaranteed to be designed in accordance with safety and quality requirements by following IEEE standards and regulations as well as those of other regulatory bodies. It is a proactive step to propose a rule requiring builders to submit an approved standard electrical service drawing prior to starting any electrical installation. This can help guarantee that all electrical installations adhere to set guidelines and standards, improving dependability and safety. In conclusion, the paper shows a thorough and deliberate approach to electrical design, emphasizing safety, standard compliance, and growth considerations.

We have created a single-story house plan for this project, in addition to the conduit and electrical fixture arrangement. Next, we created a switchboard connection diagram and a single line diagram that illustrate how the incoming electric power is dispersed around the apartment complex. We also displayed the various cables. The number of lights needed in a given space to provide consistent illumination is determined by the luminance calculation.

The number of lights needed in a given space to provide consistent illumination is determined by the luminance calculation.

We calculated the bill of quantities and estimated the cost of the electrical service design after all the calculations were completed. Our anticipated cost is roughly 10% of the authorized Fire Extinguisher House's overall cost.

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Reference:

[1] BNBC Table 8.1.5 (Recommended Values of Illumination for Residential Buildings

[2] BNBC Table 8.1.27 (Index Figures Associated with Lightning Protection Design)

[3] Electrical Building Load Calculation Study, Muraryspotty, Scribd

[4] Load Calculation and Sizing of Electrical Equipment for a Multi-Story Residential Building, Abdul Alim, Scribd

[5] BNBC Table 8.1.16, BNBC 2020 (Uploaded by Compliance Bangladesh.com)

[6] CABLES AS PER BDS-900 & BS-6004, TECHNICAL INFORMATION FOR PVC INSULATED NON-ARMOURED CABLE