

ELECTRICAL INSTALLATION

Sample design procedures: to be followed:

More or less a given electrical installation should incorporate the following steps:

→ Following the prior steps; discussed in the class; Next is to calculate the area of each room specified in the structural plan. And deduce the illumination level of each room accordingly i.e. to obtained from table.

Then calculate the Number of lamps required:

$$N = \frac{E \times A}{\phi \times CF \times LLF}$$

$E \Rightarrow$ Illumination (Lux)

$A \Rightarrow$ Area (m^2)

$\phi \Rightarrow$ Luminous flux (lm)

$CF \Rightarrow M.F \times U.F$
 0.8×0.6

$\swarrow$
In your case
 LLF : Light loss factor
take 0.8

⊗ You Need to Calculate the total no of luminaires required:

Then; according to EEPCO standard; you need to make lighting grouping:

i.e. One CB (10A) rated is supposed to hold (control) up to ~~1000~~ 12 lamps.

If more than 12 lamps are available we need to have an additional Branch Circuit.

* Following this make load (power) calculation for the lighting ckt.

NB: IF the lamps are Incandescent P.f is 1. NO reactive power; only real power we have.

✓ If the lamps are fluorescent lamps we have a P.f deviated from unity; i.e. we have both Real & Reactive powers.

Eg: Lets say we have 18 lamps; 10 are Incandescent lamps and the remaining 8 are fluorescent lamps (40W each) is a P.f of 0.8. So we have:

As the total no of lamps exceed 12 we have two branch ckt for all these lamps:

ONE Branch ckt: Containing 10 Incandescent (10A) lamps.

2nd Branch ckt: Containing 8 Fluorescent (10A) lamps.

⊗ Total power for B.C 1.

✓ To Calculate the total load (power) of this B.C; we need to calculate the following factors first:

$$* \text{ Load Factor} = \frac{\text{Maximum Capacity}}{\text{Installed Capacity}}$$

Where the Maximum Capacity is the Utilization Capacity of the lamps: i.e. $10 \times 60W = 600W$

Acc. to EEPco Standard the installed capacity of each lamp is 100 VA; hence, total installed capacity becomes $100 VA \times 10 = 1000 VA$

$$\therefore L.F_1 = \frac{600W}{1000 VA} = \underline{\underline{0.6}}$$

* Simultaneity Factor: take 0.9 for incandescent lamps.

* Thus, the diversity factor becomes:

$$D.F_1 = S.F_1 \times L.F_1 = 0.9 \times 0.6 = \underline{\underline{0.54}}$$

Now, the total apparent power of these lamps becomes:

$$S_1 = S_{1 \text{ installed}} \times D.F_1 = 1200 VA \times 0.54 = 648 VA$$

But we know that;

$$S_1 = P_1 + jQ_1$$

but since no reactive power

$$S_1 = P_1 + jQ_1^{\circ} = \underline{\underline{648W}}$$

P Total power for B.C2

$$\begin{aligned} * \text{ Load factor}_2 &= \frac{\text{Maximum Cap.}}{\text{Installed cap.}} \\ &= \frac{.8 * 40W}{8 * 100VA} = \underline{\underline{0.4}} \end{aligned}$$

* Simultaneity factor: Let's use 0.5 for fluorescent lamps:

$$\begin{aligned} * \text{ D.F. Diversity factor becomes:} \\ \text{D.F.}_2 &= S.F._2 * L.F._2 = 0.5 * 0.4 \\ &= \underline{\underline{0.2}} \end{aligned}$$

Now, the total power of lamps become:

$$\begin{aligned} S_2 &= S_2 \text{ Installed} * L.F._2 = 800VA * 0.2 \\ &= \underline{\underline{160VA}} \end{aligned}$$

The P.f of these lamps is 0.8 so we decompose the S_2 into P_2 (real) and Q_2 (reactive)

$$S_2 = P_2 + jQ_2$$

$$S_2 = 160 \cdot \angle \cos^{-1}(0.8) = 160 \cdot \angle 36.86^\circ$$

$$\begin{aligned} S_2 &= 160(0.8) + j160(0.6) \\ &= \underline{\underline{128 + j96}} \end{aligned}$$

Assume 12-socket outlets are needed to be installed of each 200W rating.

⇒ Hence, we will have two groups, where each group consists six socket points.

The load factor for socket outlets is calculated as:

$$L.F_1 = \frac{\text{Maximum Capacity}}{\text{Installed capacity}} \quad \left[\begin{array}{l} \text{Subscriber refers} \\ \text{to S.O. group 1} \end{array} \right]$$

✓ The max. capacity for each socket outlet is given 200W, where for all is $(6 \times 200 = 1200W)$

✓ The installed capacity for each socket outlet according to EEPCO recommendation is 400VA, where for all S.O.s is $6 \times 400VA = 2400VA$

$$\therefore L.F_1 = \frac{\text{Max. Cap.}}{\text{Installed cap.}} = \frac{1200W}{2400VA} = \underline{\underline{0.5}}$$

Using the Simultaneity factor 0.5, the diversity factor is calculated as:

$$D.F_1 = S.F_1 \times L.F_1 = 0.5 \times 0.5 = \underline{\underline{0.25}}$$

Now the total apparent power for the socket outlets is:

$$S_1 = S_1(\text{installed}) \times D.F_1 = 2400VA \times$$

$$\Rightarrow \text{The real power becomes ; } P_1 = S_1 \times \text{pf}_1 = 600W$$

* The same procedure can also be made for group 2 socket outlets.

⇒ In our installation if we do have power cts like Mittad, Stove, water heater we follow the pf procedures:

Let's have 3.5kw rated Injera Mittad, 1.2kw rated water heater, and 3.5 kw rated Stove. [w/c are all 1φ] :

Hence the load profile can be tabulated as follows:

Groups	Description	Inst. VA	S.F	L.F	D.F	P.f	Real power P (kw)	Apparent power S (VA)
G ₁	Lighting 1	10 × 100 VA	0.6	0.9	0.54	1	648	648
G ₂	Lighting 2	8 × 100 VA	0.5	0.4	0.20	0.8	128	160
G ₃	Socket 1	6 × 400 VA	0.5	0.5	0.25	1	600	600
G ₄	Socket 2	6 × 400 VA	0.5	0.5	0.25	1	600	600
G ₅	Mittad	3500	1	1	1	1	3500	3500
G ₆	Water heater	1200	1	1	1	1	1200	1200
G ₇	Stove	3500	1	1	1	1	3500	3500

∴ The total apparent and real power consumption on the building is:

$$S_T = (648 + 160 + 600 + 600 + 3500 + 1200 + 3500) \text{ VA}$$

$$= \underline{\underline{10,208 \text{ VA}}}$$

$$P_T = (648 + 128 + 600 + 600 + 3500 + 1200 + 3500)$$

$$= \underline{\underline{10,144 \text{ kW}}}$$

⇒ Design of the distribution board (DB).

- ✓ For lighting the current rating of the protective device (I_n) is 10A. [Acc. to EEPco standard].
 - ✓ For S.O.s the value for I_n is 16A. [w/c is also EEPco standard].
 - ✓ For all the power ckt's we use: [All are 1 ϕ]
- $P = \sqrt{3} I_b \cos \phi$
- but Since all are resistive ckt's $\cos \phi = 1$, then we can deduce the value for I_b , so as to come up to the desired value of I_n .

Now, $P_{mited} = \sqrt{3} I_b$; $V = 220V$

The desired current is then:

$$I_b = \frac{P_{mited}}{\sqrt{3} V} = \frac{3500W}{220V} = \underline{15.91A}$$

but $I_n \geq I_b$ [Value of I_n must not be less than I_b]
 $I_n \geq 15.91A$, Hence, Select the value for I_n
 $I_n = \underline{20A}$ (w/c is based on the standard rating of protective devices.)

Then, to select the cable size we need to calculate the current carrying capacity; w/c is:

$$I \geq \frac{I_n}{CF_s}$$

but here we don't have correction factors. But since the load is power ckt we need to consider the worst scenario.

$$I \geq 20A ; \text{ then } I \geq \underline{25A}.$$

⇒ Then from ~~Watts~~ table we select a cable size of $3 \times 4mm^2$ for the I_{mited} .

By doing the same procedures for the water heater and stove, you can get:

→ $I_n = 16A$ (for water heater) and $3 \times 2.5mm^2$ cable size is being chosen.

→ $I_n = 20A$ (for stove) and $3 \times 4mm^2$ cable is selected.

* Now, we can calculate the feeder cable rating:

$$S_T = \underline{10,208VA} \quad \& \quad P_T = \underline{10,144kW}$$

⇒ But, $P_T = \sqrt{3} \cdot V \cdot I_b \cdot \cos\phi$ (since 3ϕ)

From this we can calculate the designed current (I_b) for the incoming power i.e. 3ϕ :

$$I_b = \frac{P_T}{\sqrt{3} \cdot V \cdot \cos\phi} \quad ; \quad \cos\phi = P.f. = \frac{P_T}{S_T}$$

$$V = 380V (3\phi)$$

$$= \frac{10,144}{10,208}$$

$$= \underline{0.99}$$

$$\text{Hence, } I_b (3\phi) = \frac{10,144kW}{\sqrt{3} (380V) * 0.99} = 15.57A$$

Since, $I_n \geq I_b$, we need to select the value for

$I_n = 20A$: and the current carrying capacity

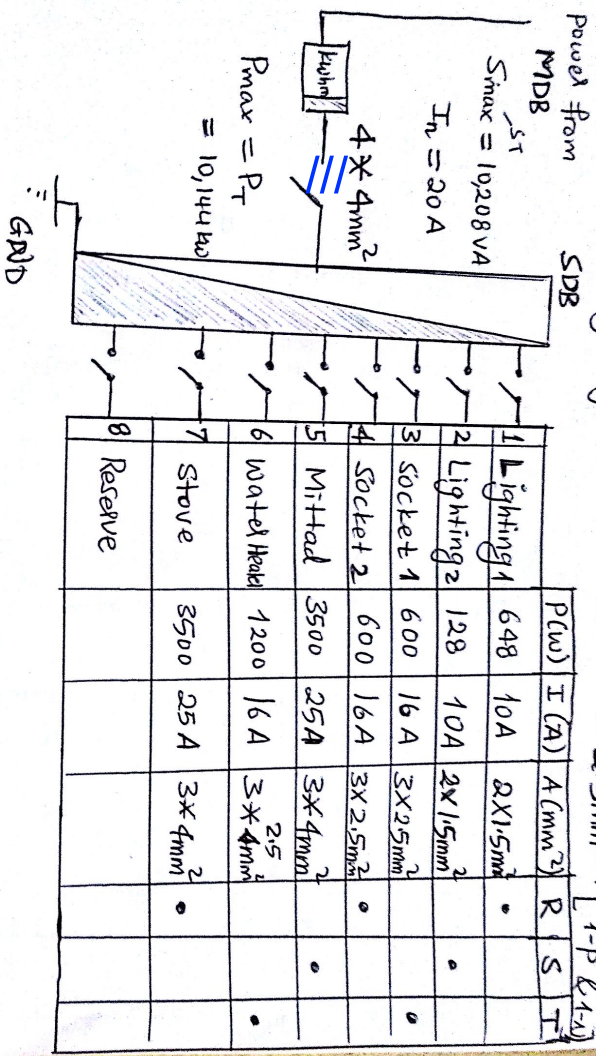
$I_z = \frac{I_n}{CF_s}$; but we need not to consider the CF_s for domestic installation

but we should consider the worst scenario; so:

$$I_z \geq I_n \quad I_z = 20/25 = 8$$

$$I_2 = \underline{20A} \text{ [as per to my design]}$$

Hence; for socket outlets we use $3 \times 2.5 \text{ mm}^2$ [1-phase 1-wire 4-ground]
for lighting we used $2 \times 1.5 \text{ mm}^2$ [1-P & 1-N]



Here, $S_{max} = S_T = 10,208 \text{ VA}$

$$P_{max} = P_T = 10,144 \text{ kW}$$

⇒ This is the design of Sub Distribution, (SDB)^{main}
but you may also design for the MDB