



Benha University

Dr : Mohamed Ahmed Ebrahim



Undergraduate Course

Electric Installation Design

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Lecture (6)



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2nd step

Power Circuits design



Design steps

- Electrical works contains The sockets, which feeds any equipment, as well as any motors, elevators or any other load in the building. In this part, the architect intervenes to determine the sockets places.
- The 2nd step in electrical installation design includes:
 - * Sockets.
 - * HVAC loads.
 - * power loads (Elevators – Escalators – Pumps).








1. Sockets

Sockets Classification as stated in the Egyptian code

م	النوع	العدد	السعة (أمبير)	الجهد (فولت)	عدد الأطراف	الاستخدام
١	مقبس بريزة أحادي	١	١٠	٢٥٠	٣ 1Ph + N+E	الأحمال العادية أباجورة + مكثفة - راديو - تليفزيون - ألخ
٢	مقبس بريزة أحادي	١	١٦	٢٥٠	٣ (1Ph + N+E)	أحمال القوى كالسخان
٣	مقبس بريزة مزدوج	٢	١٠	٢٥٠	٣ (1Ph + N+E)	أحمال الخدمة العادية والتي تتطلب أكثر من مصدر متجاور كالتلفزيون و التليفزيون
٤	مقبس بريزة ثلاثي	١	٢٥ ، ١٦ ، ٦٣ ، ٥٠ ، ٢٥٠ ، ١٢٥	٤٠٠	٥ (3Ph + N+E)	أحمال القوى الخاصة بالصيانة كمنشآر كهربى، مثقاب محمول، .. ألخ

Sockets types

Types	S (VA)	Wattage	Application	C.B	shape
Normal socket	180 VA	1000 : 1500 Watt Single Outlet (5-7) Socket per circuit	General Used	10 A : 16 A	
Double socket	360 VA				
Power socket	2000 : 5000 VA	1500 : 3000 W (one socket per circuit)	-Kitchen -Laundry -Drilling machine	20 A : 32 A	
U.P.S socket	250 VA		Computer	10 A : 16 A	
Weather proof socket	150 : 250 VA		-Corridor -Kitchen -Bathroom -Outdoor -Stores		

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Sockets Mounting

Mounting

Wall mounting

-Rise from the land

- 30cm (offices)
- 120cm (water area)



Floor mounting

-IP must be very high
(IP 67)



Furniture mounting



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Sockets Distribution

- Socket distribution for a given room is dependent on the following factors:
 1. Room application (every (2 – 5) meter on the Room circumference for residential applications).
 2. Room furniture.
 3. Each 3 meters put a single or duplex socket (in case of no furniture DWG).
 4. For kitchens, there must be at least one power socket.

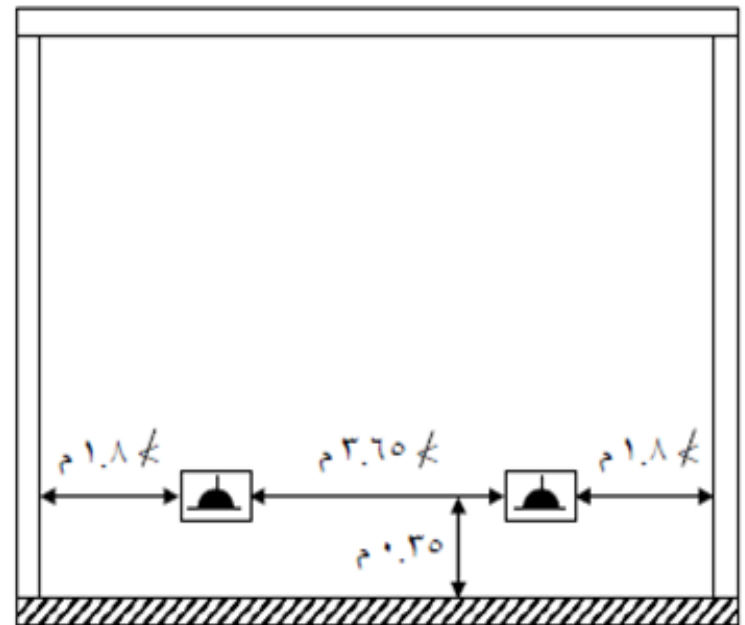
According to the Furniture.

- **For low voltage Applications**








$$I_{line} = I_{ph} = \frac{S_{3\phi}}{KVA} * 1.5$$

- **Or**

$$I_{line} = I_{ph} = \frac{S_{1\phi}}{KVA} * 4.5$$



Sockets legend

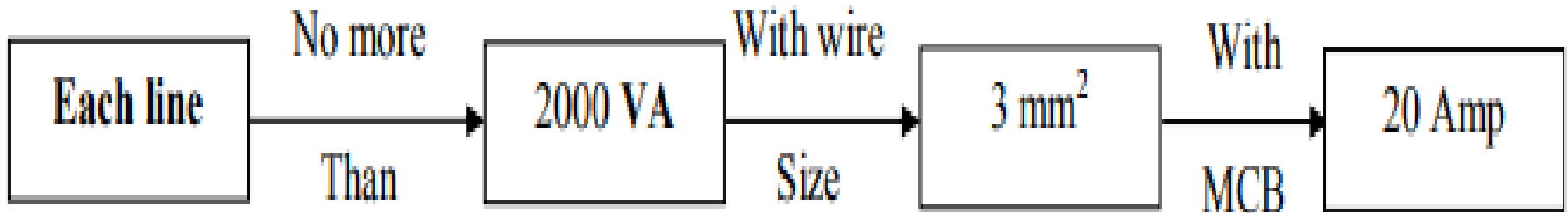
P1		Single Socket –outlet 16A–220V German Type (Schuko)
P2		DUPLEX Socket –outlet 16A–220V German Type (Schuko)
P3		Power Socket –outlet 16A–220V German Type (Schuko) separate Circuit .
P4		Ditto P3 but For Water Heater.
P5		Ditto P3 but With Cover (Weather Proof).
P6		Ditto P1 but With Cover (Weather Proof).
P7		Single Socket –outlet 16A–220V with cover German Type (Schuko)

Wiring for Sockets Circuits

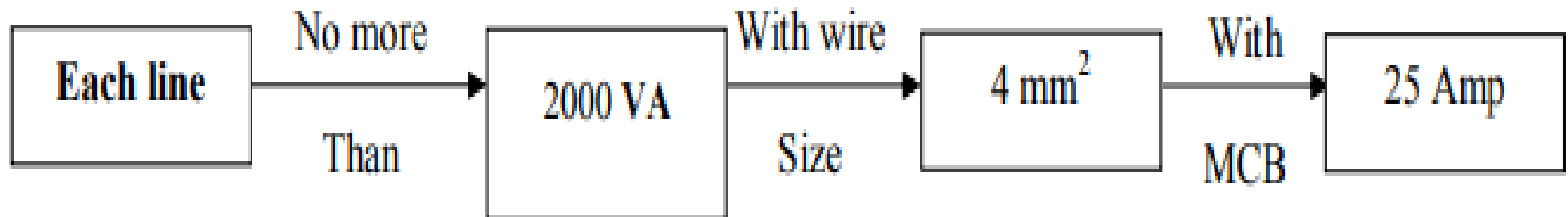
1. Socket circuits connected with a copper cable as cross section area ($3 * 3 \text{ mm}^2$), and circuit breaker 16 or 20 amp.
2. In case of power sockets with 16 amp circuit breaker or 20 amp, each of them directly into the separately circuit of their own circuit breaker.
3. The number of luminaires or outlets used for lighting units that carry one separately circuit shall not exceed ten outlets.

Electric lines calculations for Sockets

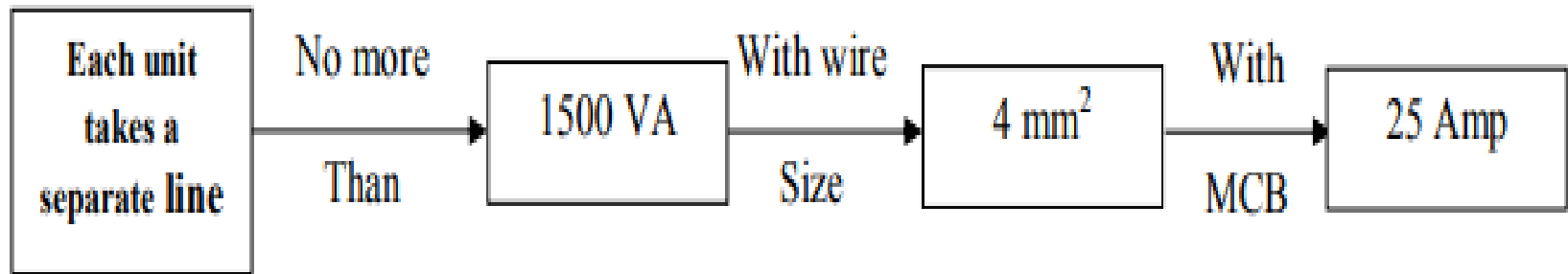
1. For socket lines:



2. For power socket lines:



3. For hand drier:



2. *HVAC*

(heating, ventilation, and air conditioning)

Air conditions (AC)

1. Air conditions (AC)

Air conditioning (often referred to as A/C, AC or air con) is the process of altering the properties of air (primarily temperature and humidity) to more comfortable conditions, typically with the aim of distributing the conditioned air to an occupied space to improve thermal comfort and indoor air quality.



Air conditioning Units

Split Units

- Feeding by an electrical cable connected directly to the panel by MCB circuit breaker.
- The load is calculated as a motor load.
- Used in (open place-lecture hall-Apartment).

Center Units

- This type is used in hotels or large commercial buildings and consists of central air conditioning units that are usually on the roof.
- The air is distributed to the rooms through pipes or the fan cool unit FCU and the air comes out of the diffuser.

Air condition Types

Types

Split & window



Split duct



Split type

- consists of (fan, grill, and compressor)



Window type



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Conditioned Area

Room Area (m ²)	A/C (HP)	Power (watt)	Current (A)
Less than 10	1 $\frac{1}{2}$	1125	6.8
10-20	2 $\frac{1}{4}$	1687.5	10.3
20-30	3	2250	13.6
30-40	4	3000	18.2
40-50	5	3750	22.7
Greater than 50	Select combinations	Σ power combinations	Σ current combinations

Typical Connected Electrical Load for Air Conditioning Only

Type of Building	Conditioned Area VA / M ²
Bank	77.8
Department store	33.33 to 55.56
Hotel	66.7
Office Building	67.7
Telephone equipment building	77.78 to 88.89
Small store (shoe, dress, etc.)	44.44 to 133.33
Restaurant (not including kitchen)	88.9

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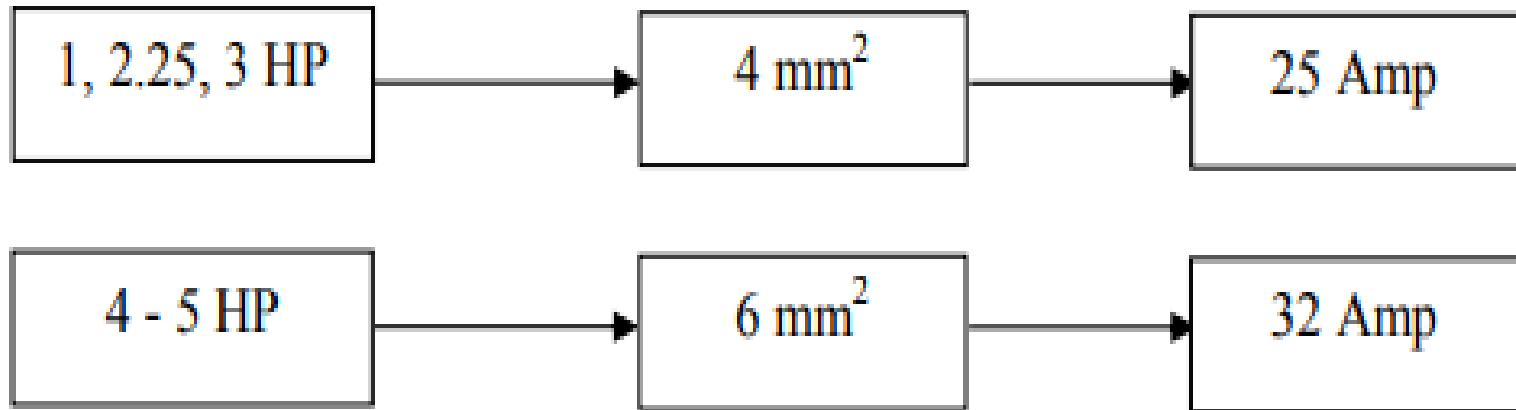
Wiring for Air conditions


- Usually the power loads defined by horse power (HP), when calculation the **HP** transferred to **KW**.
- 1 hp = 746 Watt.
- 1 hp → covered area (9 – 12) m² for average 10 m².
- $hp = A10$ → for height 2.5 meter and for another height.
- $hp = A \times h / 25$
- Is a large unit can feed the whole building and can reach the capacity of chiller to 0.5 mw.

Electric lines calculations for Air Conditioners

1. For Air conditioners lines:

Each unit takes a separate line

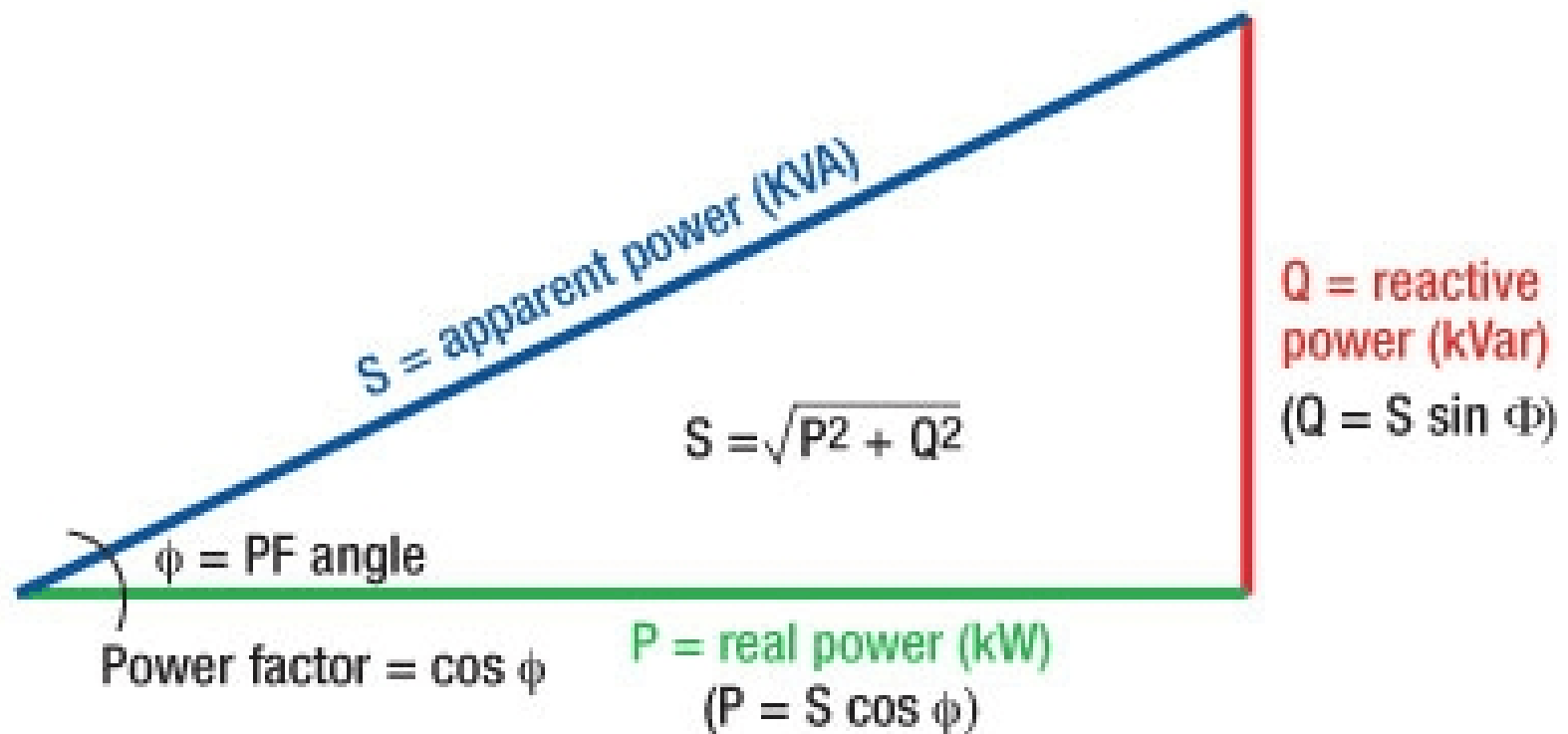




3. *Power & Current
Calculations*

Electrical Power Triangle

- **Electrical Power Triangle:**



- **Power Factor:**

It`s a percentage of used active power.

$$P.F = P / S$$

Where:

* P =Active Power.

* S=Apparent Power.

- **Note**

For fluorescent lamps $PF = 0.45 = 0.6$

For halogen or spots $PF = 1$

kVAR / kW Estimation values when improving the power factor

Before compensation		kvar rating of capacitor bank to install per kW of load, to improve $\cos \phi$ (the power factor) or $\tan \phi$,													
tan ϕ	cos ϕ	to a given value													
		tan ϕ	0.75	0.59	0.48	0.46	0.43	0.40	0.36	0.33	0.29	0.25	0.20	0.14	0.0
	cos ϕ	0.80	0.86	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1	
2.29	0.40	1.557	1.691	1.805	1.832	1.861	1.895	1.924	1.959	1.998	2.037	2.085	2.146	2.288	
2.22	0.41	1.474	1.625	1.742	1.769	1.798	1.831	1.840	1.896	1.935	1.973	2.021	2.082	2.225	
2.16	0.42	1.413	1.561	1.681	1.709	1.738	1.771	1.800	1.836	1.874	1.913	1.961	2.022	2.164	
2.10	0.43	1.356	1.499	1.624	1.651	1.680	1.713	1.742	1.778	1.816	1.855	1.903	1.964	2.107	
2.04	0.44	1.290	1.441	1.558	1.585	1.614	1.647	1.677	1.712	1.751	1.790	1.837	1.899	2.041	
1.98	0.45	1.230	1.384	1.501	1.532	1.561	1.592	1.628	1.659	1.695	1.737	1.784	1.846	1.988	
1.93	0.46	1.179	1.330	1.446	1.473	1.502	1.533	1.567	1.600	1.636	1.677	1.725	1.786	1.929	
1.88	0.47	1.130	1.278	1.397	1.425	1.454	1.485	1.519	1.532	1.588	1.629	1.677	1.758	1.881	
1.83	0.48	1.076	1.228	1.343	1.370	1.400	1.430	1.464	1.497	1.534	1.575	1.623	1.684	1.826	
1.78	0.49	1.030	1.179	1.297	1.326	1.355	1.386	1.420	1.453	1.489	1.530	1.578	1.639	1.782	
1.73	0.50	0.982	1.232	1.248	1.276	1.303	1.337	1.369	1.403	1.441	1.481	1.529	1.590	1.732	
1.69	0.51	0.936	1.087	1.202	1.230	1.257	1.291	1.323	1.357	1.395	1.435	1.483	1.544	1.686	
1.64	0.52	0.894	1.043	1.160	1.188	1.215	1.249	1.281	1.315	1.353	1.393	1.441	1.502	1.644	
1.60	0.53	0.850	1.000	1.116	1.144	1.171	1.205	1.237	1.271	1.309	1.349	1.397	1.458	1.600	
1.56	0.54	0.809	0.959	1.075	1.103	1.130	1.164	1.196	1.230	1.268	1.308	1.356	1.417	1.559	
1.52	0.55	0.769	0.918	1.035	1.063	1.090	1.124	1.156	1.190	1.228	1.268	1.316	1.377	1.519	
1.48	0.56	0.730	0.879	0.996	1.024	1.051	1.085	1.117	1.151	1.189	1.229	1.277	1.338	1.480	
1.44	0.57	0.692	0.841	0.958	0.986	1.013	1.047	1.079	1.113	1.151	1.191	1.239	1.300	1.442	
1.40	0.58	0.665	0.805	0.921	0.949	0.976	1.010	1.042	1.076	1.114	1.154	1.202	1.263	1.405	
1.37	0.59	0.618	0.768	0.884	0.912	0.939	0.973	1.005	1.039	1.077	1.117	1.165	1.226	1.368	
1.33	0.60	0.584	0.733	0.849	0.878	0.905	0.939	0.971	1.005	1.043	1.083	1.131	1.192	1.334	
1.30	0.61	0.549	0.699	0.815	0.843	0.870	0.904	0.936	0.970	1.008	1.048	1.096	1.157	1.299	
1.27	0.62	0.515	0.665	0.781	0.809	0.836	0.870	0.902	0.936	0.974	1.014	1.062	1.123	1.265	
1.23	0.63	0.483	0.633	0.749	0.777	0.804	0.838	0.870	0.904	0.942	0.982	1.030	1.091	1.233	
1.20	0.64	0.450	0.601	0.716	0.744	0.771	0.805	0.837	0.871	0.909	0.949	0.997	1.058	1.200	
1.17	0.65	0.419	0.569	0.685	0.713	0.740	0.774	0.806	0.840	0.878	0.918	0.966	1.007	1.169	
1.14	0.66	0.388	0.538	0.654	0.682	0.709	0.743	0.775	0.809	0.847	0.887	0.935	0.996	1.138	
1.11	0.67	0.358	0.508	0.624	0.652	0.679	0.713	0.745	0.779	0.817	0.857	0.905	0.966	1.108	
1.08	0.68	0.329	0.478	0.595	0.623	0.650	0.684	0.716	0.750	0.788	0.828	0.876	0.937	1.079	
1.05	0.69	0.299	0.449	0.565	0.593	0.620	0.654	0.686	0.720	0.758	0.798	0.840	0.907	1.049	
1.02	0.70	0.270	0.420	0.536	0.564	0.591	0.625	0.657	0.691	0.729	0.769	0.811	0.878	1.020	
0.99	0.71	0.242	0.392	0.508	0.536	0.563	0.597	0.629	0.663	0.701	0.741	0.783	0.850	0.992	
0.96	0.72	0.213	0.364	0.479	0.507	0.534	0.568	0.600	0.634	0.672	0.712	0.754	0.821	0.963	
0.94	0.73	0.186	0.336	0.452	0.480	0.507	0.541	0.573	0.607	0.645	0.685	0.727	0.794	0.936	
0.91	0.74	0.159	0.309	0.425	0.453	0.480	0.514	0.546	0.580	0.618	0.658	0.700	0.767	0.909	

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Power Calculation

1. For lighting:

* Incident & Florescent lamps: Depend on lamp power.

* For chandeliers: $S = 400 \approx 500$ VA.

2. For Electrical Sockets (Outlets):

<i>Electrical Outlet</i>	<i>Power [VA]</i>
Normal Single Socket	200 VA
Normal Duplex Socket	400 VA
Power Socket	From 1500 up to 5000 VA depend on Load
Water Heater	1500 VA For W.H below 80Lt. & 2000 VA For W.H up to 100 Lt.
Hand Drier	1500 VA

Current Calculation

1. **Single phase loads:**

$$I \text{ (Amp)} = 4.5 \text{ Skva}$$

2. **Three phase loads:**

$$I \text{ (Amp)} = 1.5 \text{ Skva}$$

Diversity factor (Df)

- It's the percentage of expected on line loads connected at the same time.

*For lighting $\longrightarrow 0.7 \approx 1$

* For all sockets $\longrightarrow 0.6 \approx 0.9$

* For Air conditioners $\longrightarrow 1$

* For heaters and hand drier $\longrightarrow 1$

Load Schedule

Project Name:				MCB:			
Panel Name:				cable: size:			
Breaking cap.:							
Circuit Number	Type	Cable size	MCCB	Three phase			Notes
				R	Y	B	
R ₁	Lighting	2.5 mm ²	16A	800			
Y ₁	Lighting	2.5 mm ²	16A		600		
B ₁	Lighting	2.5 mm ²	16A			990	
R ₂	Socket	3 mm ²	20A	1600			
Y ₂	Socket	3 mm ²	20A		1800		
B ₂	A.C	4 mm ²	25A			1500	
R ₃	Spare		16A				
Y ₃	Spare		20A				
B ₃	Spare		32A				
Total connected load				2400	2400	2490	

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