

University of Wales (Trinity Saint David)

Swansea Gower collage

HNC/HND Electrical and Electronic Engineering

Module: Design of Electrical Installations

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Introduction:

The main reasons of this model are to be understanding and applying of IEE wiring regulation for electrical installation for building. Electrical installation requires to follow the IEE regulation, and this assessment illustrate the correct procedure for basic designs of installations. (1)

Lighting systems design:

In order to design the lighting installation for a sheltered accommodation extension block some calculations needs to be done included:

Calculate the number of light bulbs requires in the A new sheltered accommodation extension block.

To calculate the number of lights, the brightness of the area needs to be calculated, and this can be done by calculate the area, light bulbs power where can be obtained from light bulbs manufactures. (2)

Area calculation, from the given draw of the graph a sheltered accommodation extension block. The scale given 1:125 that means every 1cm centimetre from the graph equal 125 cm in the really design.

Area = width * length

Overall Area calculations:

Ground floor

Total area for room1 = $15 \times 7.5 = 112.5 \text{ m}^2$

Area of bed in room1 $12.25 \times 3.75 = 45.9 \text{ m}^2$

Area of toilet in room1 $5 \times 2.5 = 12.5 \text{ m}^2$

The space in the room1 = (Total area for room1 - Area of bed in room1+ Area of toilet in room1) = $(112.5 - 45.9 + 12.5) = 54 \text{ m}^2$

Same calculations for all the areas. See the enclosed work sheet. **Appendix 1**

Lumens calculations:

To calculate the number of lights, the luminous flux output (lumens) or the brightness of each lamp needs to be known. Usually the illuminance is already specified in hand out materials, for example, office 500 lux. *Handout 9 (Illumination)*

The equation for the calculations as shown below: (3)

$$N = \frac{E * A}{F * UF * MF}$$

Where: N = number of lamps required

E = Illuminance level required (lux)

A = area at working plane height (m²)

F = average luminous flux from each lamp (lumens)

UF = utilisation factor, allowance for light distribution and room surfaces

MF = maintenance factor

Number of lighting in room1 can be calculated as:

For room1

From the table

E for general lighting given =200L. *Handout 9 (Illumination)*

A area of bed in room1 = 49m²

F =2600 see appendix 4

UF=0.4

MF= 0.75 (4)

These factors were taken from references (5)

Number of light bulbs $N = \frac{200*49}{2600*0.4*0.75} = 2$ lamps

The calculation of the number of lamps in the whole building has been obtained as shown in appendix 2 and 3.

Total number of lights in ground floor:

from table below that's shows approximately the number of lamps needs to be insulating in the ground floor and first floor as mentioned all these calculations are applied according to the IEE regulations and specification of the lamps manufacturing, calculation carried out as

taking LED lamps as examples because they are very economic ones however others can be used as well.

Table 1

Rooms in ground floor	Number of lamps	Power watts
Room1		
Bed in room1	6	18
Toilet in room1	2	18
Corridor in room1	3	45
Room2		
Bed in room2	6	18
Toilet in room2	2	18
Corridor in room2	3	45
Room3		
Bed in room3	6	18
Toilet in room3	2	18
Corridor in room3	3	45
Dining room		
Corridor in dining room	16	18
kitchen in dining room	2	18
toilet in dining room	2	18
left in dining room	1	45
Stairs in dining room	2	45
Corridor		
Space in corridor	11	18
Utilities room	7	18
Area in utilities room	1	18
Total	75	

From table 1 after the calculations the number of light bulbs requires in ground floor will be 75 with different powers between (18 and 45 W) approximately.

Total number of lights in first floor

Table 2

Rooms in first floor	Number of lamps	Power watts
Room1		
Bed in room1	6	18
Toilet in room1	2	18
Corridor in room1	3	45
Room2		
Bed in room2	6	18
Toilet in room2	2	18
Corridor in room2	3	45
Room3		
Bed in room3	6	18
Toilet in room3	2	18
Corridor in room3	3	45
Room4		
space in room4	13	18
Lift room4	2	18
toilet in room4	2	18
Bed1 in room4	1	45
Bed2 in room4	2	45
Stairs1	2	45
Stair2	2	45
Corridor	11	18
Utilities room	8	18
Total	76	

From table 2 after the calculations the number of light bulbs requires in first floor will be 76 with different powers between (18 and 45 W) approximately. The lights distribution diagram can be seen in attached files.

Power distribution:

Power distribution can be calculated as shown below:

Table 3

Number of lamps in room1	Power Watts per lamp	Total watts
8	18	144
3	45	135

The total power lighting for room1 equal 279W, and the ground floor has 3 rooms so the total power for all rooms equal $279 \times 3 = 837\text{W}$. Power for dining room, left and stairs equal $20 \times 18 + 3 \times 45 = 495\text{W}$. Power for corridor equal $11 \times 18 = 198\text{W}$. Power for Utilities room $8 \times 18 = 144\text{W}$.

Total lighting power for ground floor $1674\text{W} = 1674\text{W}/230 = 7.27\text{A}$

Total power of cookers in the 3 rooms and all they are three phases = $3 \times 4000\text{W} = 12000\text{W}/380 = 31.58\text{A}$.

Power of the cooker in the main kitchen = $1 \times 7000 = 7000\text{W}/380\text{W} = 18.42\text{A}$

Total power sockets 3 off 13 A in the main kitchen = 39A

Total power of socket in 3 rooms assuming 6 off 13A = 78A

Power of socket in Utility room 2 off 13 A = 26A

Power of Washing machine $3600\text{W}/230 = 16.65\text{A}$

Power of Dryer $6400\text{W}/380 = 16.84\text{A}$

Power of Lift $6900/380 = 18.16\text{A}$

Power of socket in lift 1 off 13A = 13A

Power of socket in corridor assuming needs 4 off 13A = 42A.

So final power in the ground floor will be (lighting power + power of cooker in rooms + power of cooker in the main kitchen + power of dryer + power of washing machine + power of the lift).

Total power = $(7.27+31.58+18.42+39+17+26+16.65+16.84+18.16+13+42) = 246.01\text{A}$

Total power in the first floor:

The total power for room 1 for lighting equal 279W, and the first floor has 3 rooms so the total power for all rooms equal $279*3=837\text{W} = 837/230 = 3.64\text{A}$. Power for room 4 $621\text{W}=621/230=2.7\text{A}$.

Power for corridor equal $11*18=198\text{W} = 198/230 = 0.86\text{A}$.

Power for Utilities room $8*18= 144\text{W}= 144/230=0.63\text{A}$.

Total lighting power for first floor = 7.83A .

Total power of cookers in the 4 rooms = $4*4000\text{W} = 16000\text{W}/380=42.11\text{A}$. Power of the cooker in

Total power of main kitchen socket assuming 4 off 13 A = 52A .

Total power of socket in 4 rooms assuming 10 off 13A = 130A

Power of socket in Utility room 2 off 13 A = 26A .

Power of socket in corridor 4 off 13A = 42A .

So final power in the first floor will be $(7.83+42.11+52+130+26+42) = 299.94\text{A}$.

Diversity calculations:

considered the Percentage Diversity for all power included lights and cookers and sockets.

The references for diversity can be found in (1).

For lighting = 66% so for ground floor and ground floor. $7.25*66/100=4.25\text{A}$

For lighting = 66% so for first floor and first floor. $7.83*66/100=5.17\text{A}$

So the assumed demand after applying diversity for cookers would be the first 10 A of the cooker load 30% of the remainder 5 A if the cooker unit has a socket outlet.

So demand after applying diversity for the ground floor for cookers $10+30\%$ of $(50-10)+5 = 10+0.3(40)+5=10+15+5=30\text{A}$. For cookers in the first floor = $10+30\%$ of $(42.11-10)+5 = 10+0.3(32.11)+5=10+9.6+5=24.6\text{A}$.

Cable size calculations:

According to the references (6) they are two basic wiring systems used in domestic premises:

1. Flat twin and three-core cable (6242 Y and 6243 Y), clipped to the building structure, run in the floor, wall and ceiling.
2. Single-core cables (6491 X), enclosed in steel or rigid PVC conduit or in skirting and/or architrave trunking.

Cable selection there are some factors should be considered while selected the cables and this included: the design current I_b and that means the cable should carry the full load current

Type of cable as they are different cables included PVC, MIMS, copper...ect. Handout2

Installed conditions and this included clipped or installed with other cables in trunking

Take in the account the temperature, and thermal insulation

Types of protection and this included the current fault.

Ground floor

First calculate the design current $I_b = \frac{\text{Watts}}{\text{volts}}$

For cooker = $4000/230 = 17.4$, Size of BS 3036 fuse required = 20 amps (I_n),

Tabulated current, $I_t = \frac{I_n}{C_g * C_a * C_r}$

Where C_g is grouping factor, C_a Ambient temperature and, C_r Rewireable fuse (BS 3036) factor. (7)

$I_b = 17.4$, $I_t = 45.14$, $C_g = 0.65$, $C_a = 0.94$, $C_r = 0.725$.

As the I_b is equal 17.4 so the I_n have been chosen to be = 20A.

$$I_t = \frac{20}{0.65 * 0.94 * 0.725} = 45.14A$$

$$\text{volt drop} = \frac{\left(\frac{mV}{Am}\right) * I_b * L}{1000}$$

Assuming the length of cable will be 6 m.

$volt\ drop = \frac{(7.3) \times 17.4 \times 6}{1000} = 0.76$ according to the regulations the voltage drop is in the range that acceptable. (1)

Check volts drop from Table 4D2B (column 3) Volt drop = 0.76 (8)

From the table 4D5A select 6 mm² cable which takes 47 amps.

From the calculations of the **cable size for cookers in all rooms will be 6mm².**

In the same way the calculation of cable size for lighting will be 1mm².

In the same way the calculation of cable size for lift and dryer will be 6mm².

Calculation of the minimum cross-sectional area of protective conductor for the cooker in the communal kitchen.

Minimum cross-sectional area can be determined as shown below:

$$S = \frac{\sqrt{I^2 \cdot t}}{k} \quad \text{Reference (1)}$$

Where: S is the nominal cross-sectional area of the conductor in mm²

I is the value in amperes of fault current.

t is the operating time of the disconnecting device in seconds corresponding to the fault current I amperes.

k is a factor taking account of the resistivity, temperature coefficient and heat capacity of the conductor material, and the appropriate initial and final temperatures.

$$\text{Earth fault current } I_f = \frac{V}{Z}$$

Considering the earth fault loop impedance Z of 2.3Ω

From equation the $I_f = 380/2.3 = 165.2$

Disconnect in 0.7 seconds

$$S = \frac{\sqrt{165.2^2 \times 0.7}}{115} = 1.2$$

CHECK STANDARD CABLE SIZES!!

In this situation, the minimum cross-sectional area is 1.2mm², which can be rounded to 3 mm². So, the 3mm² conductor is suitable under fault conditions. (1)

Emergency lighting design

The meaning of the terms emergency lighting that the light will be operates automatically in case of the power cutting off. (9)

The reason for the emergency lighting to show and guide the people the right path were it will be safe to escape and ensure safe evacuation of a building in case of any risk or dangers for example fire or any other risks. The question now where these emergency lighting can be placed or fitted? Every easy answer should be positioned to be free from disability glare. As the brightness of the luminaire dazzles people. (9)

For a sheltered accommodation extension block. The areas that require emergency lighting:

Corridor and the type of emergency lighting called escape route. However, this requires the link between all rooms, very good lighting level and it should be very clearly escape route, direction exist signs. (9)

Toilet considered open area in generally requires emergency luminaires fitted in clear space.

From the emergency lighting data table for two-meter escape route, lighting require 1 LUX along the centre line and 0.5 LUX for 0.5 meters either side of the centre line.

All these emergency lighting should be inspected regularly to make sure they are working probably, and they will be operating when required. (9)

Cable support systems used throughout the installation

Different types of cable support systems applied for electrical insulations according BS 7671 Regulation 132.7, and they are several factors should be considered during selected the appreciate type of support.

Steel trunking they are three types of this kind of support included metal, PVC and mini trunking, however the specification requires included it should be has very good mechanical protection, and very adaptable to the system, easy to added and remove circuits, it can be carry different types of cables and very safe as it considered as a fire protective.

Other type is a PVC trunking it has the same advantage of the steel trunking maybe added some other advantage this kind is light in weight, easy to cut, acid and corrosion resistant and

prefabricated. However according to the IET Regulation 521.6 requires that all trunking complies with BS EN 50085.

All these supported are available with different sizes, as shows in table below, this table from

Electrical systems design (handout 12: Trunking).

Table 4 Cable factors for trunking

Type of conductor	Conductor CSR mm ²	PVC BS6004 Cable factor	Thermosetting BS7211 Cable factor
solid	1.5	8.0	8.6
	2.5	11.9	11.9
standard	1.5	8.6	9.6
	2.5	12.6	13.9
	4	16.6	18.1
	6	21.2	22.9
	10	35.3	36.3
	16	47.8	50.3
	25	73.9	75.4

Appendix1 area calculations

ground floor

Room1				Room2				Room3				Dining Room			
	length m	width m	area m^2		length m	width m	area m^2		length m	width m	area m^2		length m	width m	area m^2
Room1	15	7.5	112.5	Room2	15	7.5	112.5	Room3	15	7.5	112.5	Room	15	9	126.42
bed in roc	12.25	3.75	45.9375	bed in roc	12.25	3.75	45.9375	bed in roc	12.25	3.75	45.9375	kitchen	5	3.12	15.6
toilet in rc	5	2.5	12.5	toilet in rc	5	2.5	12.5	toilet in rc	5	2.5	12.5	toilet in rc	3.75	3.12	11.7
loung in room 1			54.0625	loung in room 2			54.0625	loung in room 3			54.0625	left	3.12	2.75	8.58
												stairs	6.62	3.12	20.6544

corridor

	length m	width m	area m^2
corridor	35	2.5	87.5

uitlites room

	length m	width m	area m^2
Room	10	6.25	62.5
utilties	4.38	1.88	8.2344
area in utilties			54.2656

first floor

Room1				Room2				Room3				Room4			
	length m	width m	area m^2		length m	width m	area m^2		length m	width m	area m^2		length m	width m	area m^2
Room1	15	7.5	112.5	Room2	15	7.5	112.5	Room3	15	7.5	112.5	Room	15	12.5	102.3656
bed in roc	12.25	3.75	45.9375	bed in roc	12.25	3.75	45.9375	bed in roc	12.25	3.75	45.9375	toilet in rc	3.75	3.12	11.7
toilet in rc	5	2.5	12.5	toilet in rc	5	2.5	12.5	toilet in rc	5	2.5	12.5	left	3.12	2.75	8.58
loung in room 1			54.0625	loung in room 2			54.0625	loung in room 3			54.0625	bed 1	5.2	5	26
												bed 2	5.2	3.5	18.2
												stairs1	6.62	3.12	20.6544
												stairs2	6	1.25	7.5

corridor

	length m	width m	area m^2
corridor	35	2.5	87.5

uitlites room

	length m	width m	area m^2
Room	10	6.25	62.5

Appendix 2 number of lamps calculations (ground floor)

lemuns

ground floor

room1	area	number of lamps
bed	45.9	5.884615
toilet	12.5	1.602564
corridor	54.1	3.109195

room2	area	number of lamps
bed	45.9	5.884615
toilet	12.5	1.602564
corridor	54.1	3.109195

room3	area	number of lamps
bed	45.9	5.884615
toilet	12.5	1.602564
corridor	54.1	3.109195

Dining Room	area	number of lamps
corridor	126.4	16.20513
kitchen	15.6	2
toilet in room	11.7	1.5
left	8.58	0.493103
stairs	20.65	1.186782

corridor	area	number of lamps
corridor	87.5	11.21795

uitlites room

	area	number of lamps
utilties	8.23	6.957179
area in uti	54.266	1.055128

totla lamps 72.4

number of lampes

room1	area	f	UF	MF	E	number of lamps
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

room2	area	f	UF	MF	E	number of lamps
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

room3	area	f	UF	MF	E	number of lamps
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

Dining room	area	f	UF	MF	E	number of lamps
corridor	126.4	2600	0.4	0.75	100	16.20513
kitchen	15.6	2600	0.4	0.75	100	2
toilet in room	11.7	2600	0.4	0.75	100	1.5
left	8.58	5800	0.4	0.75	100	0.493103
stairs	20.65	5800	0.4	0.75	100	1.186782

corridor	area	f	UF	MF	E	number of lamps
corridor	87.5	2600	0.4	0.75	100	11.21795

uitlites room

	area	f	UF	MF	E	number of lamps
room	54.266	2600	0.4	0.75	100	6.957179
utilites	8.23	2600	0.4	0.75	100	1.055128

Appendix 3 number of lamps calculations (first floor)

lemuns

first floor

room1	area	number of lamps
bed	45.9	5.884615
toilet	12.5	1.602564
corridor	54.1	3.109195

room2	area	number of lamps
bed	45.9	5.884615
toilet	12.5	3.109195
corridor	54.1	3.109195

room3	area	number of lamps
bed	45.9	5.884615
toilet	12.5	3.109195
corridor	54.1	3.109195

Room4	area	number of lamps
space in rc	102.36	13.12308
toilet in rc	11.7	1.5
left	8.58	1.1
bed 1	26	1.494253
bed 2	18.2	1.045977
stairs1	20.6544	1.187034
stairs2	7.5	0.431034

corridor	area	number of lamps
corridor	87.5	11.21795

uitlites room

	area	number of lamps
room	62.5	8.012821

totla lamps

73.91

room1	area	f	UF	MF	E	number of lampes
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

room2	area	f	UF	MF	E	number of lamps
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

room3	area	f	UF	MF	E	number of lamps
bed	45.9	2600	0.4	0.75	100	5.884615
toilet	12.5	2600	0.4	0.75	100	1.602564
corridor	54.1	5800	0.4	0.75	100	3.109195

room4	area	f	UF	MF	E	number of lamps
space in rc	102.36	2600	0.4	0.75	100	13.12308
toilet in rc	11.7	2600	0.4	0.75	100	1.5
left	8.58	2600	0.4	0.75	100	1.1
bed 1	26	5800	0.4	0.75	100	1.494253
bed 2	18.2	5800	0.4	0.75	100	1.045977
stairs1	20.6544	5800	0.4	0.75	100	1.187034
stairs2	7.5	5800	0.4	0.75	100	0.431034

corridor	area	f	UF	MF	E	number of lamps
corridor	87.5	2600	0.4	0.75	100	11.21795

uitlites room

	area	f	UF	MF	E	number of lamps
room	62.5	2600	0.4	0.75	100	8.012821

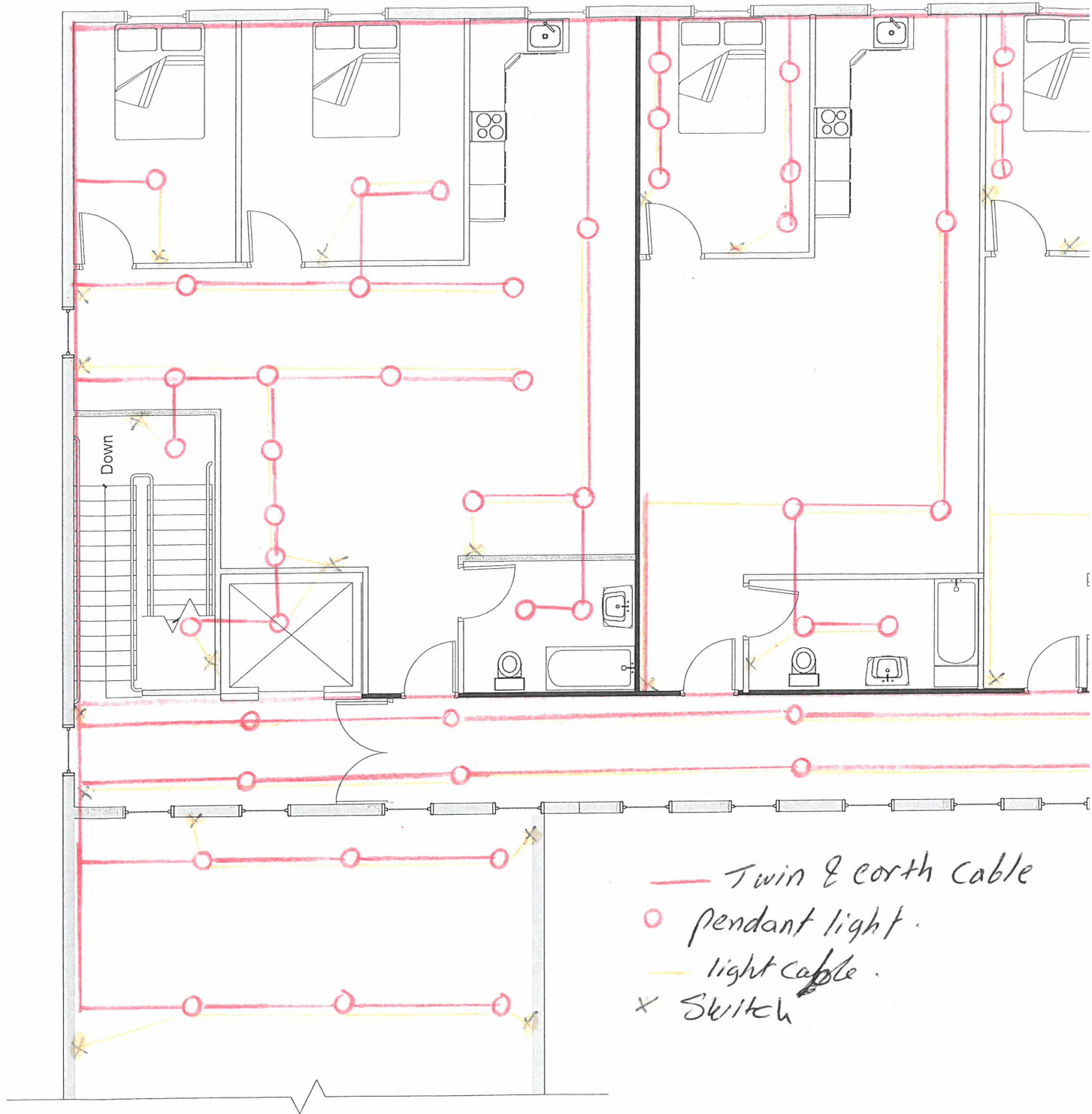
Appendix 4

BRIGHTNESS		450 lumens	800 lumens	1100 lumens	1600 lumens	2600 lumens	5800 lumens
BULB							
 LED		6W	9-10W	13W	16-18W	24W special high voltage lamps	45W
							25W
							
 Halogen		29W	43W	55W	72W	150W	300W

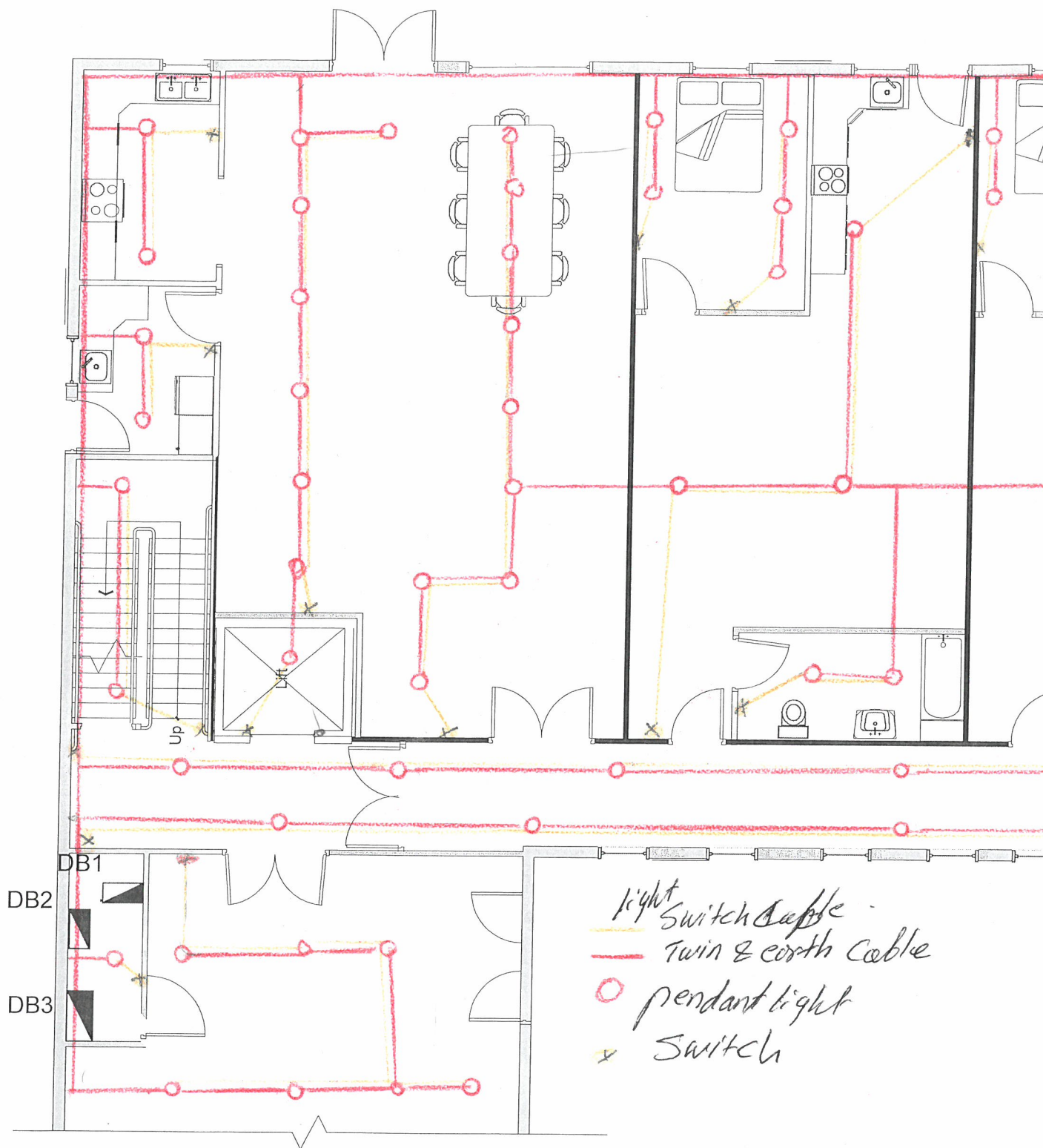
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Sheltered accommodation First Floor
 Scale 1:125



Sheltered accommodation Ground Floor
Scale 1:125