



# Design A Lighting Point Calculator System For Residential Houses Using Microsoft Visual Basic

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**Abstract:** Lighting point calculation plays an important feature in developing a new residential house. This enables people inside the house will have enough of light to perform tasks efficiently. Currently, consulting electrical engineers use rules of thumb to forecast the quantity of lighting points, however these rules are inaccurate. It does not take into account the lux required based on Malaysian Standard MS1525. Furthermore, good lighting can save money and provide visual comfort to the occupants. However, numerous parameters such as room index, utilisation factor and illuminance used for each space or room inside the house must be considered when determining the quantity of lighting point for a residential property. Three types of residential houses are considered which are: single storey house, double storey house and condominium house. This paper presents the development of lighting point calculator system for residential houses using Microsoft Visual Basic and comparison of quantity of lighting point using manual calculation using Microsoft Excel and simulation calculation using Microsoft Visual Basic.

**Keywords:** Lighting point calculation, residential houses, microsoft excel, microsoft visual basic

## 1. Introduction

As the world transforms into a highly industrialized and modern era, the evolvement on the lighting calculation of residential houses have to be appreciated. The lighting calculation from manual estimation using Rule's of Thumb, now have been made some improvement that makes the consultant engineer work easier. Focusing on the lighting, it is one of the most important elements in providing good interior design of a residence. This allows people to perform visual tasks efficiently and accurately [1]. Bad lighting will lead many problems such as insufficient light, glare, improper contrast, poor distributed light and flicker [2]. There are many factors contribute to bad lighting, so an appropriate design of quantity of lighting point should precisely calculate in order to not short designed or over designed the quantity while ensuring quality and quantity of illumination in the house.

However, lighting calculation requires many factors related with it. The area of the room, the type of lamp used and the function of the room plays a crucial factor in order to give the proper amount lighting point in the room. This factor is closely related to the lumen method. It also called Photometrical Computation and widely used for interior lighting calculation [3]. In addition, these factors determine the preciseness of the output result. In developing a new system, it is important to have a guideline or standard, while doing this to ensure the reliability of the result. Therefore, Malaysian Standard, MS 1525 is a standard that this project referring to. To sum up, the quality of the lighting ensures coziness of the house as the resident's comfort and satisfaction are always be a priority of a consultant electrical engineer.

## 2. Methodology

This section describes the flowchart of the project, type of lamp used and the procedures in determining the quantity of lighting points for each room or space in the house.

### 2.1 Flowchart Of The Project

This project achievement method was divided into several stages to make the flow of the project more systematic and manageable. Figure 1 shows the flowchart of the project from the beginning until the end of the project. This flowchart is used to guide the process of Microsoft Excel calculation for determining the quantity of lighting point up to designing a calculator system using Microsoft Visual Basic and make a comparison between two calculation methods.

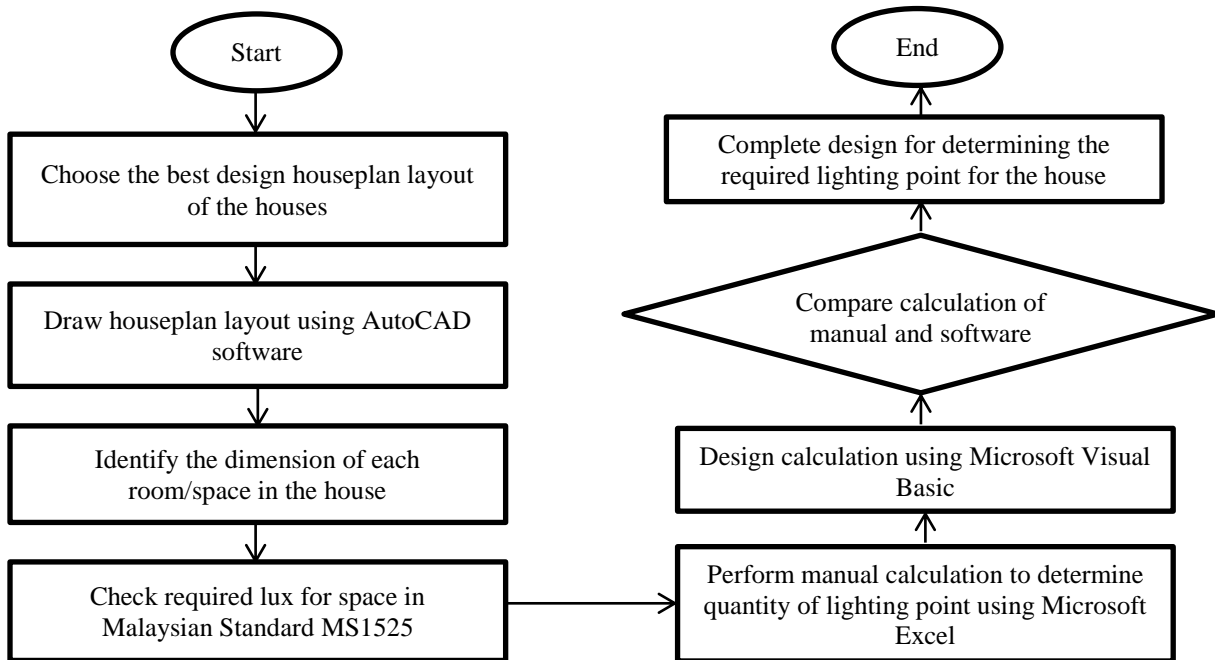


Fig. 1 - Flowchart of overall project

### 2.2 Type of Lamp Used

Figure 2 shows the type of lamp used which is PHILIPS 50W LED TRUEFORCE E27 5000 lumen. This lamp is chosen because it is one of the best lightning as it is known as energy saving lamp. By using using this type of lamp, it can save the budget for electricity bill in the future while having sufficient brightness of the lamp. In this new era technology, lumen knowledge has been wider spread as lumens of the lamp are more accurate when determining the brightness of the lamp especially when it related to LEDs [6]. Besides that, the cost for 1 lamp for this type of lamp is only below RM50. Although this quite expensive but good element from this lamp worth it as it has longer lifespan and energy saving.



Fig. 2 - PHILIPS 50W LED TRUEFORCE E27 5000 lumen

### 2.3 Procedures in Determining Quantity of Lighting Points

The method used to determine the quantity of lighting point is lumen method. Step by step calculation were shown in Figure 3 and these only applicable for one room or space only, so this steps will be repeated according to the number of room to be calculated. While Figure 4 and Figure 5 shows the recommended average illuminance level based on Malaysian Standard, MS 1525:2007 and the utilisation factor table respectively. The average illuminance (lux) value used when determining illuminance (lux) required for the room or space later.

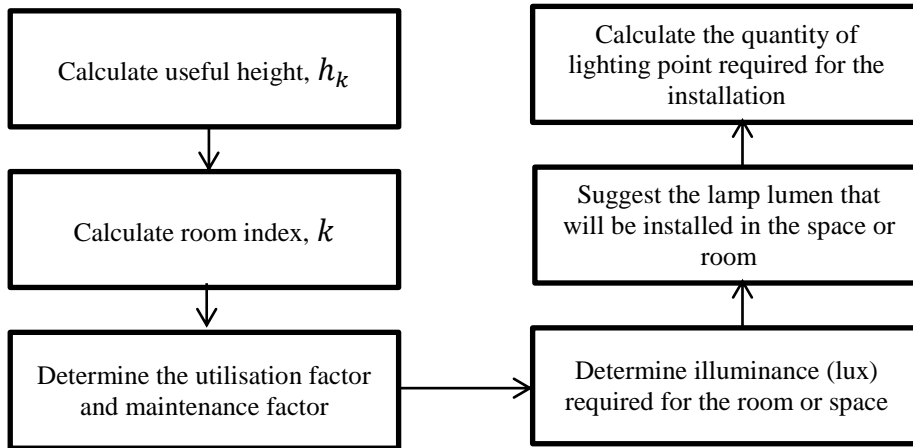


Fig. 3 - Step by step calculation to determine quantity of lighting point for one room or space only

Task	Illuminance (lux)	Example of Applications
Lighting for infrequently used area	20	Minimum service
	100	Interior walkway and carpark
	100	Hotel bedroom
	100	Lift Interior
	100	Corridor, passageways, stairs
	150	Escalator, travellerator
	100	Entrance and exit
	100	Staff changing room, locker and cleaner room, lavatories, stores
	100	Entrance hall, lobbies, waiting room
	300	Inquiry desk
Lighting for working area	200	Gate house
	200	Infrequent reading and writing
	300-400	General offices, shops and stores, reading and writing
	300-400	Drawing office
	150	Restroom
	200	Restaurant, canteen, cafeteria
	150-300	Kitchen
	150	Lounge
	150	Bathroom
	100	Toilet
	100	Bedroom
	300-500	Classroom, library
200-750	Shop/Supermarket/Department store	
300	Museum and gallery	
Localised lighting for exacting task	500	Proof reading
	1000	Exacting drawing
	2000	Detailed and precise work

Fig. 4 - Recommended average illuminance level based on Standards Malaysia 2007

Room Reflection			Room Index								
C	W	F	.75	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
.70	.50	.20	.44	.50	.56	.60	.65	.69	.72	.75	.77
	.30		.38	.44	.50	.54	.60	.64	.68	.72	.74
	.10		.33	.40	.46	.50	.56	.61	.64	.69	.72
.50	.50	.20	.39	.44	.49	.52	.57	.60	.62	.65	.67
	.30		.34	.40	.44	.48	.53	.56	.59	.62	.64
	.10		.30	.36	.41	.44	.50	.53	.56	.60	.62
.30	.50	.20	.34	.39	.42	.45	.49	.51	.53	.55	.57
	.30		.30	.35	.39	.42	.46	.49	.51	.53	.55
	.10		.27	.32	.36	.39	.44	.47	.49	.52	.54
.00	.00	.00	.22	.26	.29	.31	.34	.36	.38	.40	.41
→ UF ←											

Fig. 5 - Utilisation factor table

## 2.4 Formulae And Equations Related

The formula and equations related to determine quantity of lighting point are calculated according to multiple terms which are Room Index, Useful Height, Utilisation Factor, Maintenance Factor and Quantity of Lighting Point [3][4][5].

i. Room Index,  $k$

$$k = \frac{l + w}{h_k(l + w)} \quad (1)$$

where;  $k$  = Room Index  
 $l$  = Length of room/space (in meter)  
 $w$  = Width of room/space (in meter)  
 $h_k$  = Useful height (in meter)

ii. Useful Height,  $h_k$

$$h_k = h - h_d \quad (2)$$

where;  $h_k$  = Useful height (in meter)  
 $h$  = Height from floor to ceiling (in meter)  
 $h_d$  = Height of working area (in meter)

iii. Utilisation Factor [7]

For the value less than 0.75, utilisation factor will be normalized to 0.75. For example, Room Index = 0.68;

$$UF = \frac{0.44[\text{from\_UtilisationFactor\_RI}(0.75)] \times 0.68}{0.75} \quad (3)$$

For the value greater than 0.75, utilisation factor will be read directly from the table and if the value in between two Room Index value, the higher value will be selected. For example, Room Index = 0.84;

$$UF = 0.5[\text{from\_UtilisationFactorTable\_RI}(1.00)] \quad (4)$$

iv. Maintenance Factor

For the residential house, the Maintenance Factor was fixed to 0.85.

v. Quantity of lighting point,  $N$

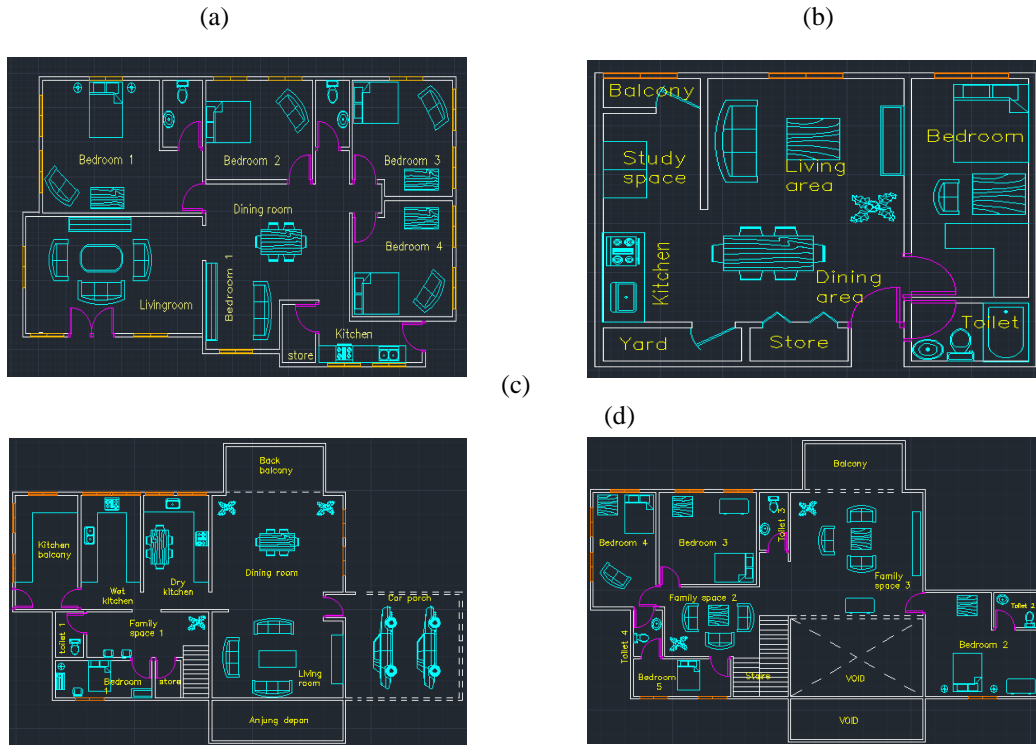
$$N = \frac{E \times A}{\phi \times UF \times MF} \quad (5)$$

where;  $N$  = Quantity of lighting point  
 $E$  = Illuminance required for the room/space (in lux)  
 $A$  = Area of the room (in meter square)  
 $\phi$  = Lumen of the lamp (in lumen)  
 $UF$  &  $MF$  = Utilisation factor and maintenance factor respectively

### 3. Result and Discussion

#### 3.1 Layout Of Residential Houses

There are three case studies were carried out which are single storey house, double storey house and condominium house. These three types of house are designed according to the sample of common design of residential houses. The layout of the residential houses was designed and illustrated using AutoCAD software 2018 version. Figure 6 shows all the three layout of the residential houses.



**Fig. 6 - (a) Layout of single storey house; (b) Layout of condominium house; (c) Layout of ground floor of double storey house; (d) Layout of first floor of double storey house**

#### 3.2 Information of Residential Houses

Table 1 – Table 3 shows the details of each room or space inside the house which are the dimension and room index of the room or space that will be useful to calculate the quantity of lighting point for the residential house.

**Table 1 - Details of each room or space inside single storey house**

Type of room / space	Length (m)	Width (m)	Useful height (m)	Room Index
Living room	7.8	4.7	2.25	1.29
Bedroom 1	7.2	4.1	2.25	1.15
Bedroom 2	4.8	3.6	2.25	0.91
Bedroom 3	4.5	3.6	2.25	0.89
Bedroom 4	4.5	3.6	2.25	0.89
Toilet 1	1.8	2.4	2.25	0.46
Toilet 2	1.5	2.4	2.25	0.41
Family space	6.3	3.6	2.25	1.02
Store	1.5	2.1	2.25	0.39
Kitchen	4.5	1.8	2.25	0.57
Balcony1	5.4	1.5	2.25	0.52
Balcony 2	2.4	2.4	2.25	0.53
Balcony 3	1.2	1.8	2.25	0.32

**Table 2 - Details of each room or space inside condominium house**

Type of room / space	Length (m)	Width (m)	Useful height (m)	Room Index
Balcony	1.9	0.7	2.25	0.24
Study space	1.9	2.5	2.25	0.49
Kitchen	1.9	2.9	2.25	0.52
Yard	2.9	0.9	2.25	0.33
Living area	3.9	3.2	2.25	0.78
Dining area	3.9	2.9	2.25	0.74
Store	1.9	1.0	2.25	0.29
Bedroom	2.4	5.6	2.25	0.74
Toilet	2.4	1.5	2.25	0.40

**Table 3 - Details of each room or space inside double storey house**

Type of room / space	Length (m)	Width (m)	Useful height (m)	Room Index
Bedroom 1	5.1	1.8	2.25	0.59
Toilet 1	1.5	2.4	2.25	0.41
Family space 1	6.3	2.4	2.25	0.77
Store room	1.2	1.8	2.25	0.32
Living room	6.9	3.9	2.25	1.11
Balcony 1	6.9	5.1	2.25	1.30
Kitchen balcony	3.3	6.0	2.25	0.95
Dry kitchen	3.0	6.0	2.25	0.89
Wet kitchen	3.3	6.0	2.25	0.95
Dining room	6.9	2.1	2.25	0.72
Back balcony	5.1	2.4	2.25	0.73
Car porch	6.0	5.4	2.25	1.26
Stairs	1.2	2.7	2.25	0.37
Bedroom 2	6.0	5.4	2.25	1.26
Toilet 2	2.4	1.8	2.25	0.46
Bedroom 3	5.1	4.8	2.25	1.10
Bedroom 4	3.3	6.0	2.25	0.95
Bedroom 5	5.1	1.8	2.25	0.59
Toilet 3	1.5	3.0	2.25	0.44
Family space 2	6.3	3.6	2.25	1.02
Family space 3	6.9	5.1	2.25	1.30
Toilet 4	1.5	2.4	2.25	0.41
Stairs	2.7	4.2	2.25	0.73
Upper balcony	5.1	2.4	2.25	0.73

### 3.3 Lighting Point Calculator Using Microsoft Visual Basic

After the application is designed, the user can calculate the quantity of lighting point by inserting value of length, width, height, illuminance (lux) used and lumen of the lamp. Figure 7 shows the interface of the lighting point calculator application system using Microsoft Visual Basic.

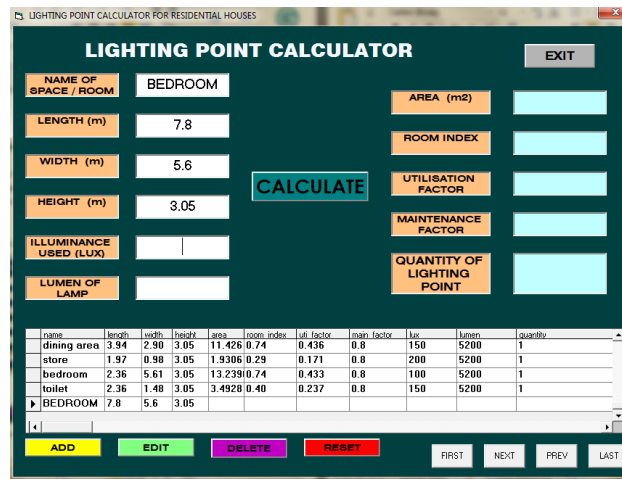


Fig. 7 - User interface of lighting point calculator application system using Microsoft Visual Basic

### 3.4 Comparison Of Results Between Manual Calculation and Simulation Calculation

The comparison of results between manual calculation and simulation calculation was illustrated in **Table 4 – Table 6**. This comparison will determine the reliability of the result from the simulation calculation from Microsoft Visual Basic.

**Table 4 - Results comparison between Microsoft Excel and Microsoft Visual Basic simulation of each room or space inside single storey house**

Type of room / space	Excel calculation			Visual Basic simulation calculation			Differences of utilisation factor (%)
	Room index	Utilisation factor	Quantity of lighting point	Room index	Utilisation factor	Quantity of lighting point	
Living room	1.29	0.516	3	1.29	0.518	3	0.38
Bedroom 1	1.15	0.515	1	1.15	0.516	1	0.19
Bedroom 2	0.91	0.455	1	0.91	0.457	1	0.43
Bedroom 3	0.89	0.445	1	0.89	0.444	1	0.22
Bedroom 4	0.89	0.445	1	0.89	0.444	1	0.22
Toilet 1	0.46	0.270	1	0.46	0.268	1	0.74
Toilet 2	0.41	0.241	1	0.41	0.241	1	0.00
Family space	1.02	0.457	2	1.02	0.456	2	0.22
Store							
Kitchen	0.39	0.229	1	0.39	0.228	1	0.43
Balcony 1	0.57	0.334	2	0.57	0.335	2	0.29
Balcony 2	0.52	0.305	1	0.52	0.306	1	0.33
Balcony 3	0.53	0.311	1	0.53	0.313	1	0.63
	0.32	0.188	1	0.32	0.188	1	0.00

**Table 5 - Results comparison between Microsoft Excel and Microsoft Visual Basic simulation of each room or space inside condominium house**

Type of room / space	Excel calculation			Visual Basic simulation calculation			Differences of utilisation factor (%)
	Room index	Utilisation factor	Quantity of lighting point	Room index	Utilisation factor	Quantity of lighting point	
Balcony	0.24	0.141	1	0.24	0.140	1	0.71
Study space	0.49	0.288	1	0.49	0.285	1	1.05
Kitchen	0.52	0.305	1	0.52	0.306	1	0.33
Yard	0.33	0.194	1	0.33	0.192	1	1.04
Living area	0.78	0.390	2	0.78	0.392	2	0.51
Dining area	0.74	0.434	1	0.74	0.436	1	0.46
Store	0.29	0.170	1	0.29	0.171	1	0.59
Bedroom	0.74	0.434	1	0.74	0.433	1	0.23
Toilet	0.40	0.235	1	0.40	0.237	1	0.85

**Table 6 – Results comparison between Microsoft Excel and Microsoft Visual Basic simulation of each room or space inside double storey house**

Type of room / space	Excel calculation			Visual Basic simulation calculation			Differences of utilisation factor (%)
	Room index	Utilisation factor	Quantity of lighting point	Room index	Utilisation factor	Quantity of lighting point	
Bedroom 1	0.59	0.346	1	0.59	0.347	1	0.28
Toilet 1	0.41	0.241	1	0.41	0.241	1	0.00
Family space 1	0.77	0.385	2	0.77	0.386	2	0.26
Store room	0.32	0.188	1	0.32	0.188	1	0.00
Living room	1.11	0.497	3	1.11	0.496	3	0.20
Balcony 1	1.30	0.520	3	1.30	0.521	3	0.19
Kitchen balcony	0.95	0.475	2	0.95	0.473	2	0.42
Dry kitchen	0.89	0.445	3	0.89	0.444	3	0.23
Wet kitchen	0.95	0.475	3	0.95	0.473	3	0.42
Dining room	0.72	0.422	2	0.72	0.420	2	0.48
Back balcony	0.73	0.428	1	0.73	0.426	1	0.47
Car porch	1.26	0.504	2	1.26	0.505	2	0.20
Stairs	0.37	0.217	1	0.37	0.217	1	0.00
Bedroom 2	1.26	0.504	2	1.26	0.505	2	0.20
Toilet 2	0.46	0.270	1	0.46	0.268	1	0.75
Bedroom 3	1.10	0.493	1	1.10	0.492	1	0.20
Bedroom 4	0.95	0.475	1	0.95	0.473	1	0.42
Bedroom 5	0.59	0.346	1	0.59	0.347	1	0.29
Toilet 3	0.44	0.258	1	0.44	0.261	1	1.16
Family space 2	1.02	0.457	2	1.02	0.456	2	0.22
Family space 3	1.30	0.520	3	1.30	0.521	3	0.19
Toilet 4	0.41	0.241	1	0.41	0.241	1	0.00
Stairs	0.73	0.428	1	0.73	0.429	1	0.23
Upper balcony	0.73	0.428	1	0.73	0.426	1	0.47

From all three cases study, there are slightly differences on the value of utilisation factor. The results from Microsoft Visual Basic application show differences of utilisation factor up to 1.16% higher than the Microsoft Excel calculation. This is due to the decimal points taken by the previous calculation which is room index value were calculated from the length, width and height of the room or space. However, the quantity of lighting point for all three cases study is not affected.



#### 4. Conclusion

In conclusion, the lighting point calculation for residential houses has been performed using Microsoft Excel and Microsoft Visual Basic. In addition, the lighting point calculator application for residential houses also has been designed using Microsoft Visual Basic as well as the comparison of results between manual calculation and Microsoft Visual Basic simulation lighting point calculator application has been analyzed and investigated. The detailed formulae and equations determine the quantity lighting point, the procedure to use lighting point calculator application and the Malaysian Standard also has been clearly explained. The lighting point calculator application for residential houses is designed to estimate the quantity of lighting point for each space or room in a house. Research has been made to get the precise formula for the calculator. The user required to insert the value of length, width, height, illuminance used (lux) and lumen of the lamp used. The quantity of lighting point is calculated in MVB. From the result, it can be concluded that this proposed application suitable for consultant electrical engineer in determining the lighting point calculation for any type of residential houses with dimension insert in meter unit.

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