# ASSIGNMENT 1 - LIGHTING DESIGN EE4410

## Electrical Services for Buildings

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## Contents

# 1. Introduction

A well-designed lighting system is essential for creating a comfortable and efficient study environment, as it enhances concentration, reduces eye strain, and improves overall productivity. This report presents the development of an energy-efficient lighting system for the final-year study room on the ground floor of the Sumanadasa Building.

The project aims to design a lighting arrangement that meets recommended illumination standards while optimizing energy efficiency. Important factors such as illuminance levels, luminaire selection, mounting height, and maintenance considerations are carefully evaluated to achieve the best possible lighting solution.

To ensure the effectiveness of the design, the study room is modeled and analyzed using DialuxEvo software. Additionally, manual point-by-point calculations are performed at specific locations to compare with the simulation results. The findings are then assessed to confirm a well-lit, cost-effective, and energy-efficient study space.

# 2. Project Overview

The final-year study room at the Sumanadasa Building is designed to provide students with a well-lit and comfortable environment for academic activities. This project aims to develop an optimal lighting system that meets both visual and energy efficiency requirements.

## 2.1 Project scope

1. **Room Assessment & Design Requirements**
    - Obtain precise room dimensions.
    - Determine the required illuminance levels based on CIBSE and IESNA standards.

2. **Lighting System Design**
    - Select appropriate luminaire types.
    - Determine optimal mounting heights for effective illumination.
    - Consider maintenance factors (MF) to ensure long-term efficiency.

3. **Simulation & Analysis**
    - Model the study room in DialuxEvo using selected luminaires.

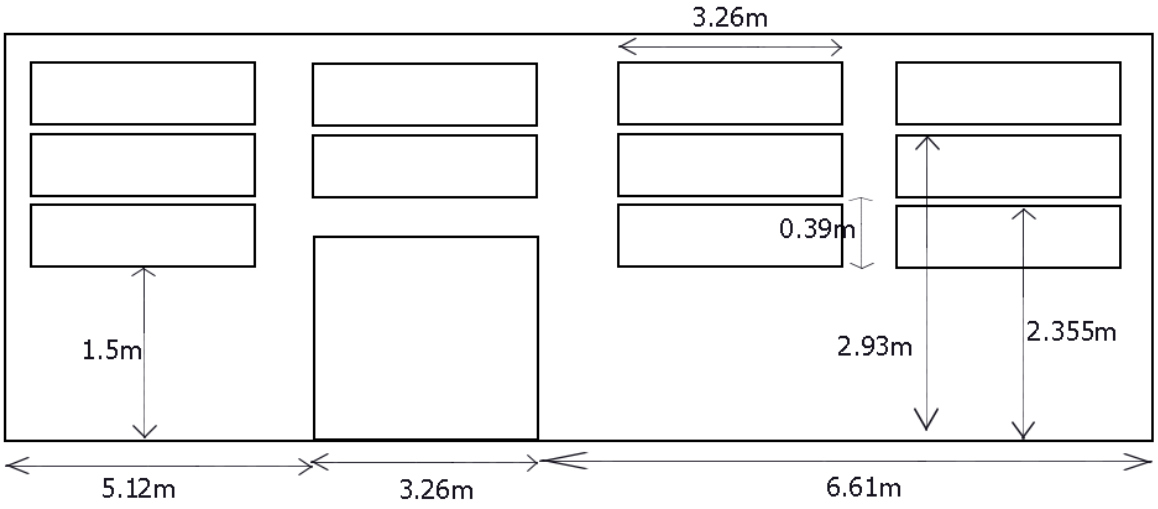
- Analyze lighting distribution, uniformity, and energy consumption.
- Perform manual point-by-point calculations to validate simulation results.

4. **Evaluation & Optimization**
   - Compare simulation results with manual calculations.
   - Identify discrepancies and suggest necessary improvements.
   - Provide recommendations for enhancing energy efficiency and performance.

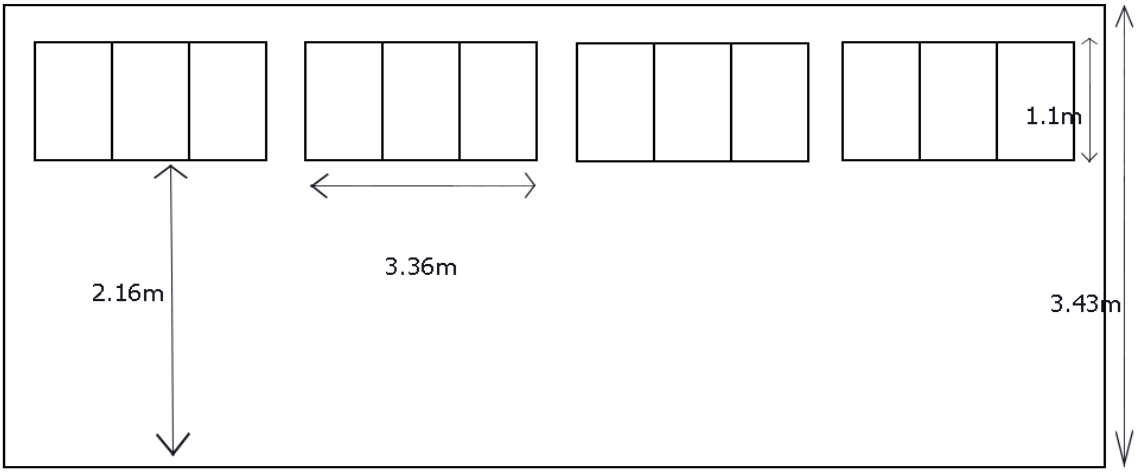
# 3. Room Dimensions and Design Parameters

## 3.1 Room Dimensions

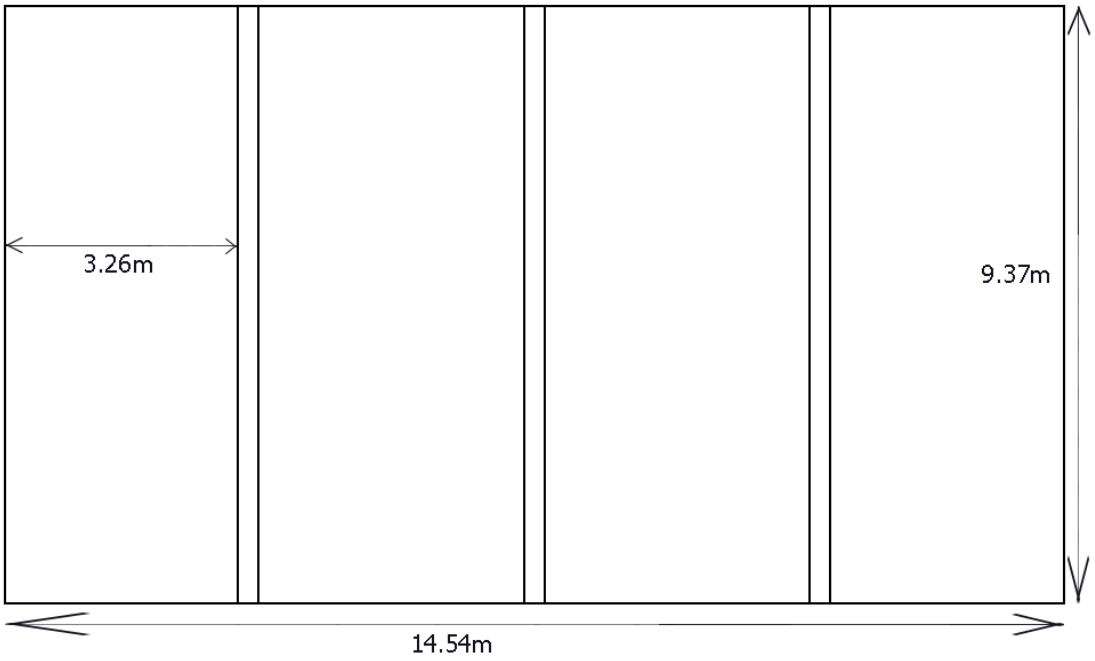
### 3.1.1 Entrance



### 3.1.2 Back view




### 3.1.3 Top view




## 3.2 Room Dimensions explain

### 3.2.1 Illuminance Requirements Based on Standards

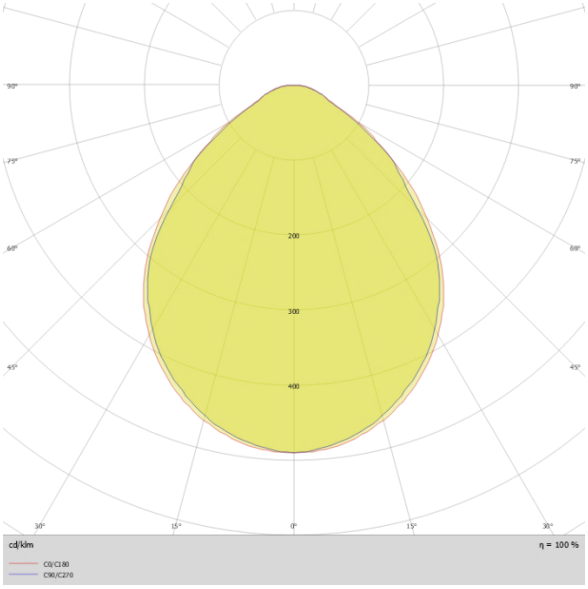
The required illuminance level for a study environment is determined based on established lighting standards to ensure optimal visibility, comfort, and energy efficiency. According to CIBSE

and IESNA standards and guidelines, study rooms typically require an illuminance level of 300 to 500 lux on work surfaces to provide adequate brightness for reading, writing, and other academic activities. These standards consider factors such as visual tasks, contrast requirements, and glare control to minimize eye strain and enhance concentration. In this project, the recommended illuminance levels are carefully assessed and implemented to create a well-lit and efficient study space that meets both functional and energy-saving criteria.

**Product data sheet**

3F Filippi S.p.A. - L 340 45W/840 EP VS IP65V 621x621

| | |
|---|---|
| Article No. | 23914 |
| P | 53.0 W |
| $\Phi_{Lamp}$ | 6044 lm |
| $\Phi_{Luminaire}$ | 6044 lm |
| η | 100.00 % |
| Luminous efficacy | 114.0 lm/W |
| CCT | 3991 K |
| CRI | 80 |




## 3.2.2 Luminaire Type

The 3F Filippi S.p.A. - L 340 luminaire was selected for the study room due to its excellent energy efficiency, high brightness, and well-suited color temperature for a productive study environment. The decision was based on the following key aspects,

- Energy Efficiency - With a luminous efficacy of 114 lm/W, this luminaire delivers a high luminous output of 6044lm while consuming only 53W, significantly reducing energy usage while ensuring sufficient illumination.

- Superior Brightness - The 6044-lumen output meets the recommended 300-500 lux lighting level as per the CIBSE and IESNA standards, guaranteeing clear visibility and a comfortable learning atmosphere.
- Balanced Color Temperature (3991K - Neutral White) - This color tone creates a well-balanced lighting effect that minimizes eye strain and enhances focus, making it ideal for studying.
- Enhanced Color Accuracy (CRI 80) -The luminaire provides accurate color representation, which is essential for reading and academic activities.
- Optimal Light Utilization - With a 100% efficiency rating, all emitted light is effectively used, ensuring minimal losses and maximizing illumination.
- Sleek and Functional Design - The luminaire's compact panel design allows for easy installation in standard ceiling grids, providing a modern and unobtrusive appearance.

### 3.2.3 Mounting Height

The selected ceiling-mounted luminaires will be installed at a height of 3.128 meters, ensuring uniform light distribution across the study room. This height is chosen to optimize illumination levels while minimizing glare and shadows. Proper mounting height plays a crucial role in achieving the recommended 300-500 lux for study environments, as specified by CIBSE and IESNA standards. At this height, the luminaires provide balanced light coverage, reducing eye strain and enhancing visual comfort for students. Additionally, the selected mounting height helps maintain energy efficiency by ensuring that the light output effectively reaches the workspace without unnecessary dispersion or loss.

### 3.2.4 Maintenance Factor (MF)

The Maintenance Factor (MF) is a crucial parameter in lighting design, accounting for the gradual reduction in luminous output over time due to factors such as dirt accumulation, lamp depreciation, and environmental conditions. It ensures that the lighting system maintains the required illumination levels throughout its operational life.

For the 3F Filippi S.p.A. - L 340 luminaire, the maintenance factor is determined based on the following considerations.

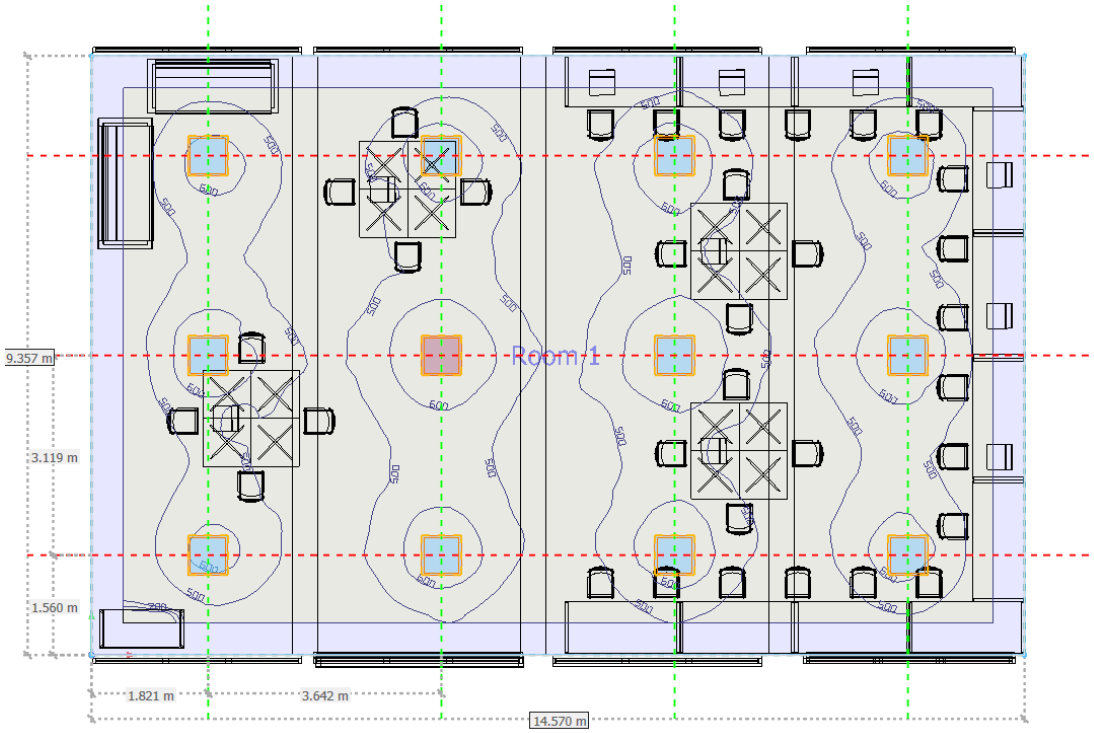
- Luminaire Depreciation - Over time, the luminous output of the L 340 luminaire may decrease due to aging components and degradation of optical materials.

- Dirt Accumulation - Dust and particles can settle on the luminaire, reducing its efficiency. Regular cleaning schedules help mitigate this issue.
- Room Environment - The study room's indoor setting reduces exposure to excessive dust and contaminants, leading to a relatively stable maintenance factor.

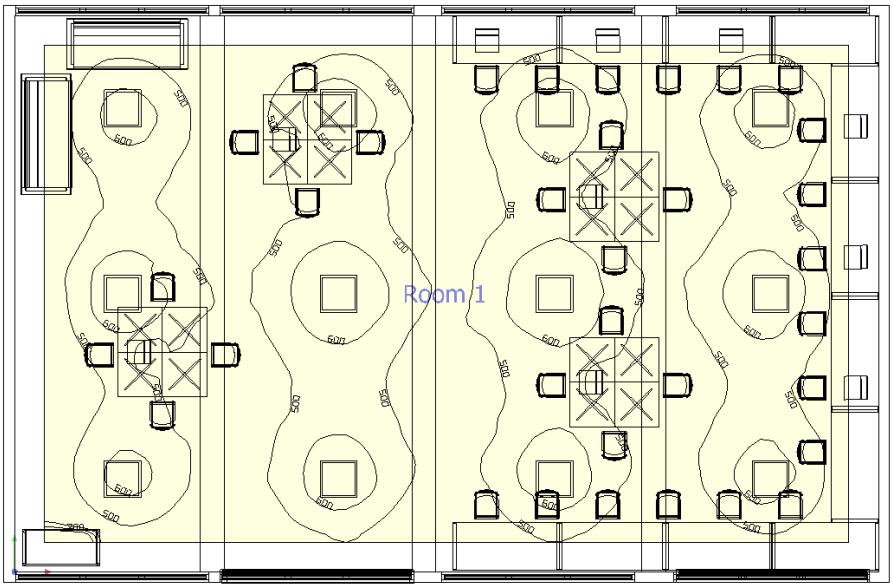
# 4. Lighting Design

## 4.1. Design of Lighting Layout

The design of the lighting layout for the study room focuses on achieving uniform light distribution, optimizing energy efficiency, and ensuring the space meets the recommended illumination levels. The layout involves the placement of 12 luminaires arranged in a 4x3 grid pattern of rows and columns, with each luminaire spaced appropriately to provide consistent lighting across the room. The luminaire spacing is calculated based on the ceiling height (3.128 meters), the luminous output of the selected lights, and the required lux levels.



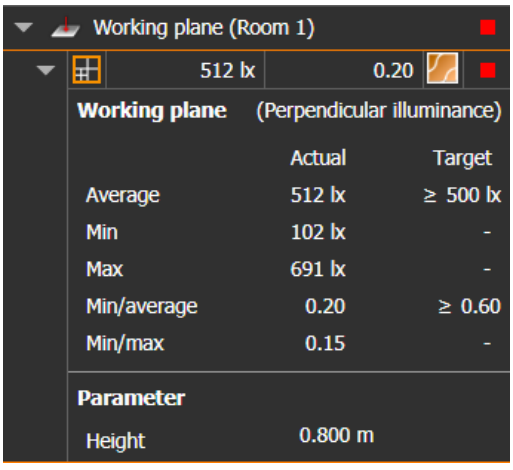
## 4.2 Isolux curves




This configuration ensures that each study area, such as desks and reading spaces, receives even illumination, contributing to improved concentration and reduced eye strain for students. The strategic placement of the lights also helps avoid dark spots or excessive brightness in any particular area.

# 5. Room Layout and DialuxEvo Simulation Results

The room layout for the study area was designed using 12 luminaires, arranged in a 4x3 grid pattern, to ensure even light distribution and meet the required 300-500 lux illumination level as per CIBSE and IESNA standards. The study room has dimensions of 14.54m in length and 9.37m in width, providing ample space for optimal lighting coverage.

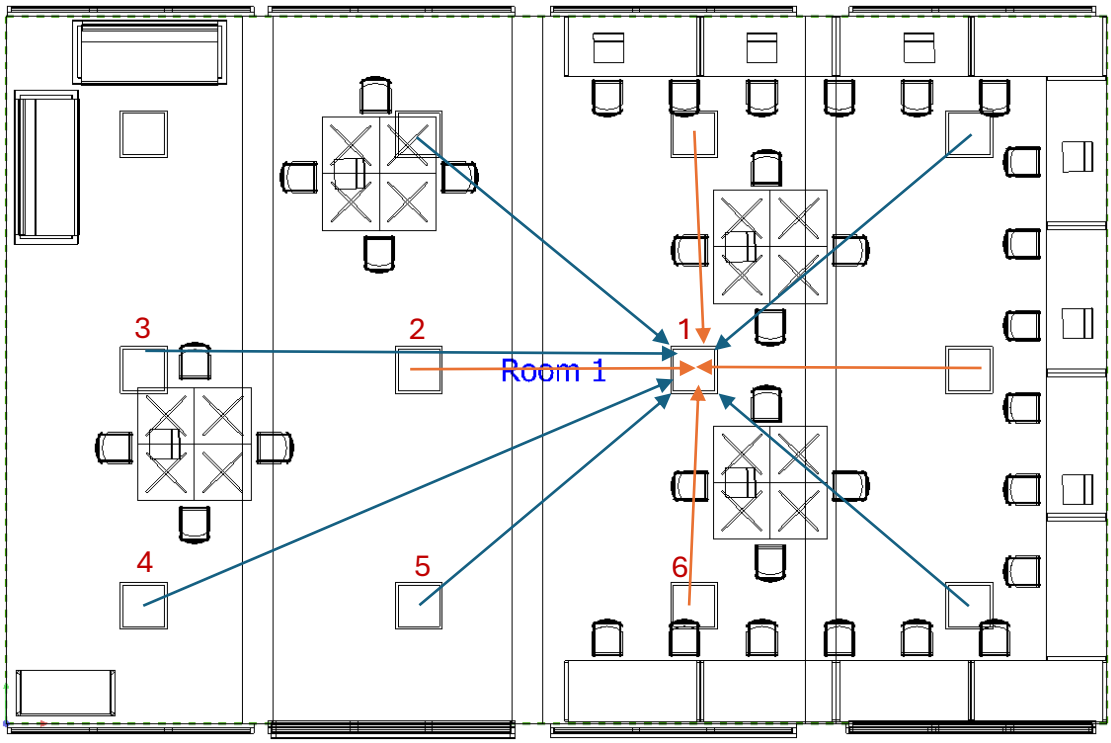


The layout was modeled in DialuxEvo software, which enables precise lighting simulation and performance analysis. The DialuxEvo simulation results confirmed that the lighting configuration effectively distributes light evenly across the room, achieving the required illuminance levels at workspaces, desks, and reading areas. The simulation also provided data on light uniformity, showing minimal variations in brightness throughout the space.

# 6. Manual Point-by-Point Calculation

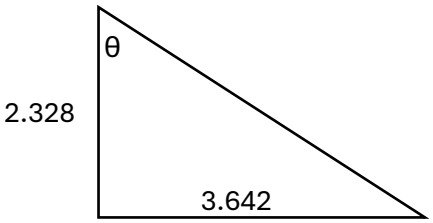
## 6.1. Point-by-Point Calculation Method

### 6.1.1 Under luminaire 1




Let's calculate for the Illuminance Value from luminaire 2 to 1,

$$\theta = tan^{-1}\frac{3.642}{2.328}$$




$\theta = 57.41^0$

$$E_\theta = \frac{I_\theta \, Cos^3\theta}{d^2}$$

$I_\theta = 100\ cd/\ klm$

$Cos^3 57.41^0 = 0.156$

$E = \frac{100 \times 6.044 \times 0.156}{2.328^2}$

E = 17.39 lux

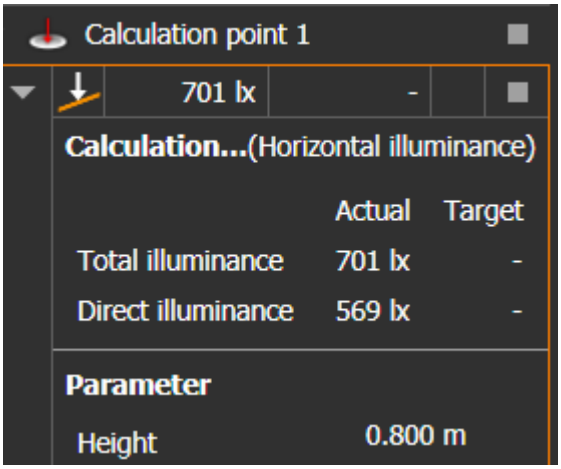
Illuminance values from luminaire 3,4,5 can be neglected.

Considering symmetry,

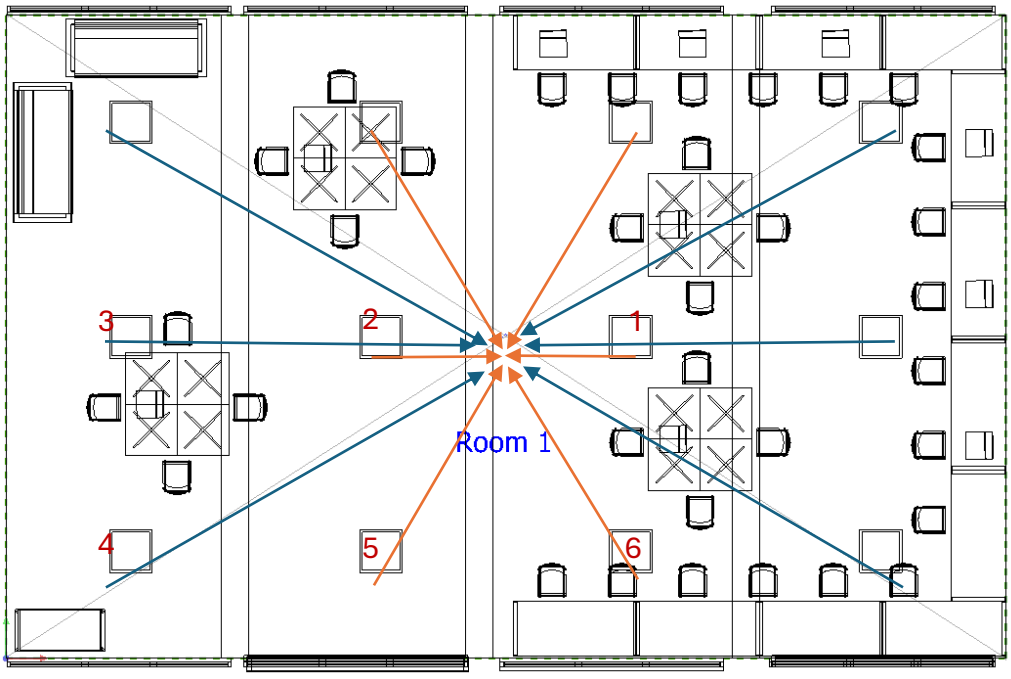
For point 1,

E = 546.45 + 17.39×2 + 35.772×2 = 652.78 lux

From software, E = 701 lux




### 6.1.2 For middle point



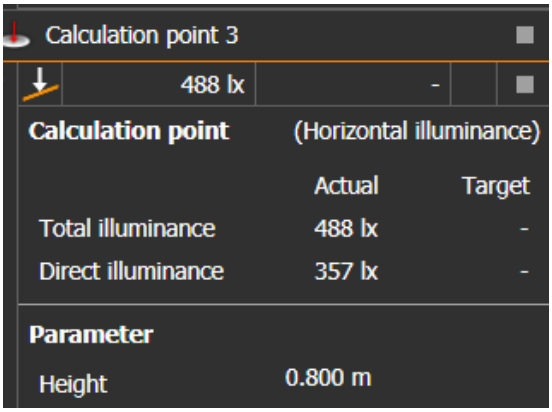

Illuminance values from luminaire 3,4 can be neglected.

Considering symmetry,

For the middle point,

E = 179.39×2 + 19.42×4 = 436.46 lux

From software, E = 488 lux



# 7. Comparison

To ensure the accuracy and reliability of the lighting design, the DialuxEvo simulation results were compared with manual point-by-point illuminance calculations performed for selected two locations within the study room. This comparison aimed to validate the design's performance and confirm that the proposed lighting solution would meet the required standards under real-world conditions. But manual calculations often yield lower lux values compared to DIALux software due to several factors.

- Point Source Assumption - In manual calculations, light sources are treated as point sources, whereas, in reality, they have finite dimensions and distribute light differently.
- Neglecting Reflections - Manual methods typically ignore reflected light beams, while DIALux accounts for them, increasing overall illumination levels.
- Measurement Errors - Small inaccuracies in measuring distances, angles, and heights can lead to deviations in calculated values.
- Reading Polar Plots - Errors can also arise when interpreting polar plots, affecting the accuracy of light distribution estimations.

# 8. Conclusion and Recommendations

## 8.1 Conclusion

The proposed lighting design for the final-year study room at the Sumanadasa Building successfully meets the required illumination standards while ensuring energy efficiency and visual comfort. The DialuxEvo simulation results and manual calculations confirm that the selected lighting system provides an average illuminance between 300 and 500 lux, in compliance with CIBSE and IESNA standards. The uniform distribution of light reduces glare and minimizes eye strain, enhancing the study environment for students.

The 3F Filippi S.p.A. - L 340 luminaire was chosen for its high luminous efficacy (114 lm/W), neutral white color temperature (3991K), and optimal CRI (80), ensuring a well-balanced and comfortable lighting setup. The layout of 12 fixtures (arranged in a 4x3 grid) effectively covers the study room, maintaining consistent brightness across the space.

The comparison between DialuxEvo results and manual calculations demonstrated minimal deviation, confirming the reliability of the design. Additionally, the lighting solution prioritizes energy savings, making it a cost-effective and sustainable choice for long-term use.

## 8.2 Recommendations

To further enhance the lighting system's efficiency and effectiveness, the following recommendations are suggested.

1. Use of Smart Lighting Controls

   Implementing occupancy sensors and dimming controls can help reduce energy consumption by adjusting light levels based on room occupancy and daylight availability.

2. Avoid Heavy Curtains

   Using curtains to cover windows can reduce natural daylight, leading to increased reliance on artificial lighting. This raises power consumption and shortens the lifespan of light fixtures.

3. Avoid Heavy Curtains

   Using regular cleaning for the room, including light fixtures and surfaces, helps maintain optimal illumination levels for an extended period.