

ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2015 SESSION

Open-book examination  
Calculators : only authorized models  
Duration : 3 hours

14-BA-B4 BUILDING SERVICES

Open-book examination  
Calculators: only authorized models  
Duration: 3 hours

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.  
Any non-communicating calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper.  
The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Some of the questions may require an answer in essay format. Clarity and organization of the answer are important.

### **Question 1 (20 marks)**

Give a brief description with application for five of the following concepts or terms (each is of 4 marks). If more than five questions are answered, the first five answers as they appear in the answer book will be marked.

- (1.a) A-Weighted Sound Pressure Level, dBA
- (1.b) National Electrical Code
- (1.c) Noise Criterion Curves, NC
- (1.d) Lumen Method of Lighting Calculations
- (1.e) Sound Transmission Class
- (1.f) Illuminance
- (1.g) Parts of a water distribution system for a high rise building
- (1.h) Overcast sky
- (1.i) Electricity distribution system for a high rise building
- (1.j) Sound absorbers

### **Question 2 Acoustics 1 (20 marks)**

- (2.a) The noise level in a Day-Care Room is 60 dB at 2000 Hz. The room is a rectangular room 6 m X 4 m X 4 m (high). The floor is tile; the walls are gypsum board and the ceiling is also gypsum board. 60 dB sound level is too high and it was decided to install acoustic panels on two perpendicular walls with  $\alpha = 0.95$  at 2000 Hz. Calculate the new noise level in the room in dBA. (10 marks)
- (2.b) A 6" thick poured concrete wall construction divides a general office from a sensitive Board room. The area of the wall is 10 sq.m. The TL of the wall is 56 dB at 500 Hz. The NC value in the Boardroom from the noises of the office space was NC40. It was decided to increase the office space absorption at 500 Hz from 10 metric Sabine to 30 metric Sabine. The thickness of the concrete wall was increased from 6" to 12". Calculate the new NC in the Board room at 500 Hz. (10 marks)

### **Question 3 Lighting 1 (20 marks)**

(3.a) Calculate the illuminance at point A. Fixture information:  
([www.sportlite.com/DX-series.htm](http://www.sportlite.com/DX-series.htm)) (5 marks).

| degrees | output |
|---------|--------|
| 0       | 1974   |
| 10      | 2458   |
| 20      | 2700   |
| 30      | 2200   |
| 40      | 1109   |
| 50      | 155    |



#### **Input Watts**

- 42 Watt Lamp = 151 Watts
- 32 Watt Lamp = 115 Watts
- 26 Watt Lamp = 94 Watts

#### **Total Initial Lumens**

- 42 Watt Lamp = 12,800
- 32 Watt Lamp = 9,600
- 26 Watt Lamp = 7,200

#### **Lumen Maintenance**

- 85%

#### **Color Reading Index**

- 82-84

#### **Available Lamp Colors**

- 300K, 3500K, 4100K

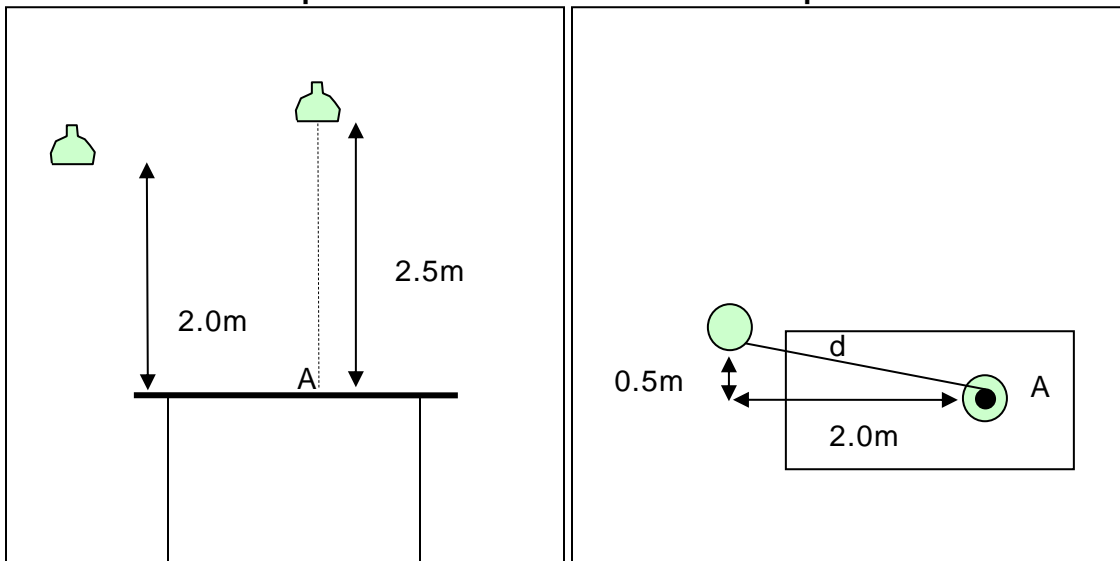
#### **Lamp Life**

- 15,000 hours (continuous)
- 10,000 hours (3 hrs/start)

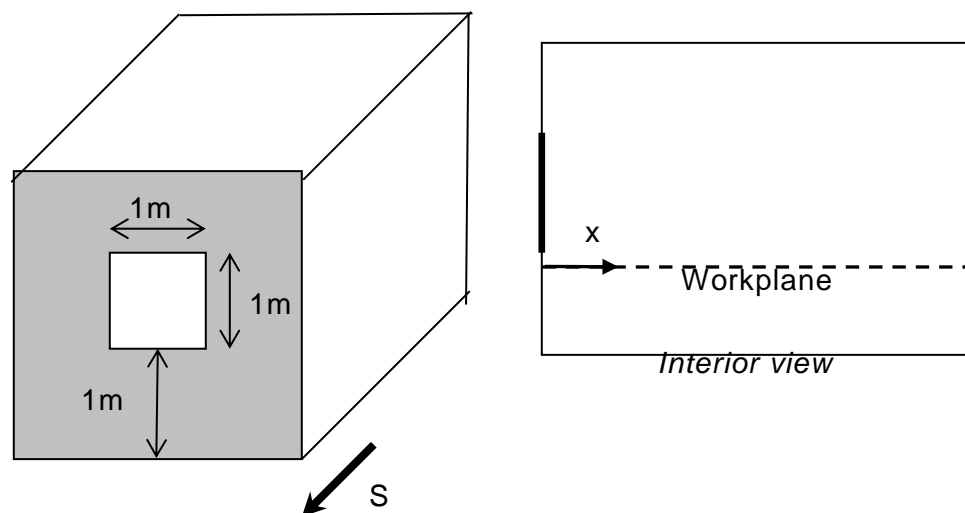
#### **Electronic Ballast Ratings**

- 30° C to 90° C
- .95 Ballast Factor
- .99 Power Factor

#### **Elevation of two lamps above a table    Plan of two lamps and table**

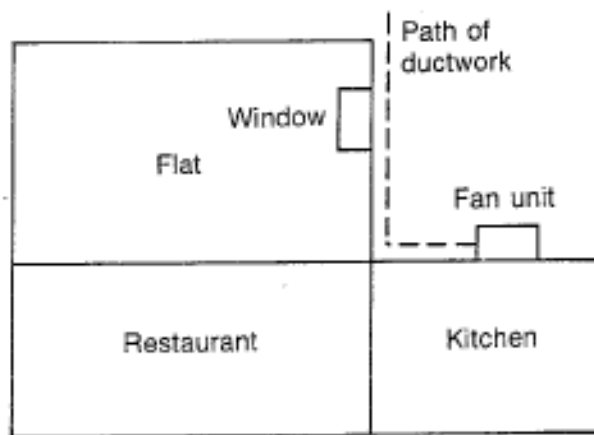


- (3.b) Would a 200-W incandescent lamp be adequate to illuminate a dark coloured display located 4' away from it to a brightness of 25 lumens if the light source is directed to form a 3' diameter circle? (5 marks).
- (3.c) Estimate the wattage of a flashlight needed to illuminate a 10 square feet section of a wall to 5 lumens at 30 feet. (5 marks).
- (3.d) A large isolated building in Montreal has a single window on the south-facing wall as shown in the diagram below. The translucent window has a transmittance of 60% and is perfectly diffusing. On Feb. 15, at solar noon, determine the following: (5 Marks)
- The solar altitude.
  - The horizontal illuminance on the ground far from any obstructions.
  - The vertical illuminance on the south-facing wall.
  - The exitance on the interior side of the window.
  - The luminance on the interior side of the window.
  - The illuminance on the workplane (0.8 meters above the floor) 1 meter directly out from the wall and centered below the window. Use a spreadsheet to plot the illuminance on the workplane at 1 meter increments between the wall and 10 meters from the wall. That is, according to the diagram,  $x = 0, 1, 2, \dots, 10$  meters. Assume all of the room's walls completely absorb all incident light. That is, we are only interested in directly incident light from the window. (tip: you will not be able to find the illuminance at  $x=0$ ; use  $x=1\text{mm}$  instead).
  - Describe how workplane illuminance could be affected by snow on the ground.

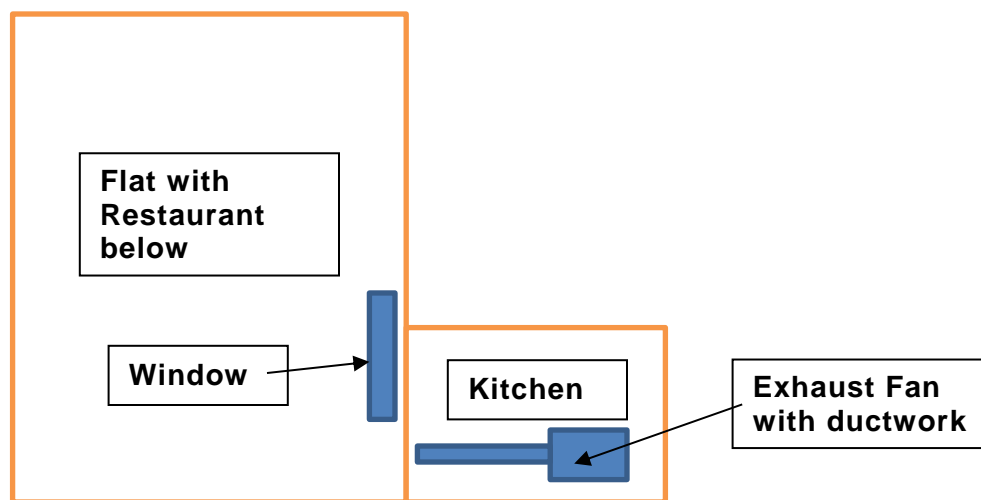


#### **Question 4 Acoustics 2 (20 marks)**

- (4.a) The occupants of an apartment located above a restaurant are complaining about the noise from a kitchen exhaust system of the restaurant. Plan and a sectional view through the kitchen is shown below. The kitchen is a flat-roofed extension of the restaurant. The exhaust fan unit is built on the roof and the system layout is shown in the sketch below. The window of the apartment overlooks the kitchen exhaust and the fan unit and the ductwork passes close to the apartment walls and terminates at the roof level. Describe the various path by which noise caused by the exhaust system can intrude into the apartment and suggest possible mitigation measures in each case. (5 Marks)



**(SECTION through the Kitchen)**



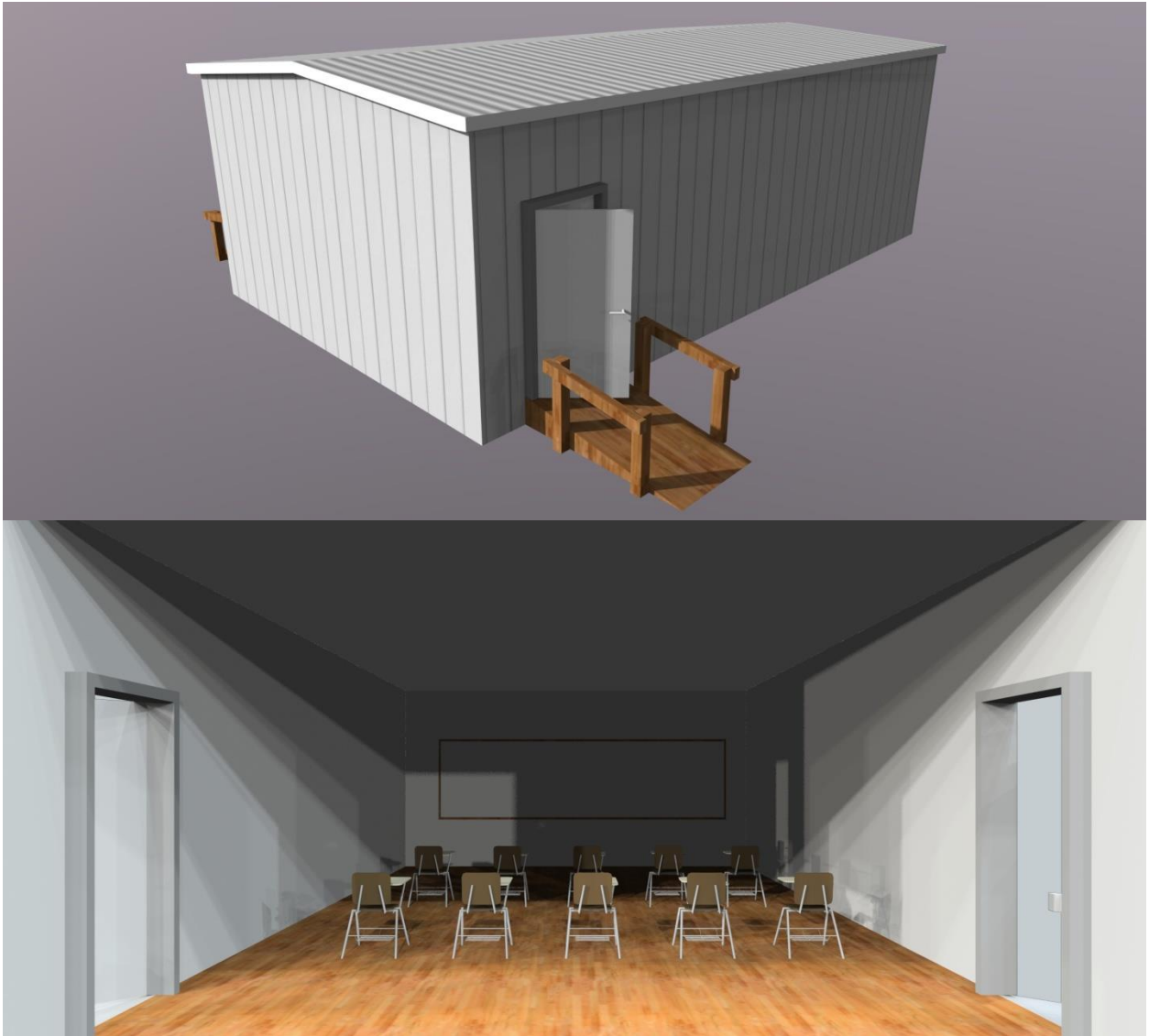
**Plan of the Flat and the Restaurant**

- (4.b) An architect is planning to build a set of high-rise condominiums housing in a major suburban location. The site of the proposed development is approximately 100 m from a major six-lane high way with a posted speed of 100 km/hour. Develop a site plan of the proposed buildings to protect the residents from excessive noise. List all the factors that will influence the site. Include and list all factors such as applicable Canadian regulations, site plan, and site orientation, noise mitigation methods (both interior and exterior). Describe also the procedure involved in preparing a noise assessment report so that the proposed development can be acceptable from a noise perspective. (15 Marks)

### **Question 5 Lighting 2 (20 marks)**

Problem: Portable Classroom Daylighting Design

Interior and exterior views of a portable classroom, located in Toronto, are shown below. The details of the requirement are given below.



- Problem: Design a “green” portable classroom
- Details: The room is 12 m by 7 m. Height is 4 m.
- Holds 36 typical desks - hard
- Assume typical portable materials

- Criteria:
  - Daylighting
  - Electric Lighting (Assume any fixtures for which you can get luminaire data)
  - Energy Efficiency
  - Resource Efficiency
  - Economic Practicality
- Develop a design that is effective in all orientations
- Orientation and locations are entirely up to you.

Show all calculations (simplified) for both daylighting and electric lighting for 2 pm on May 20th.



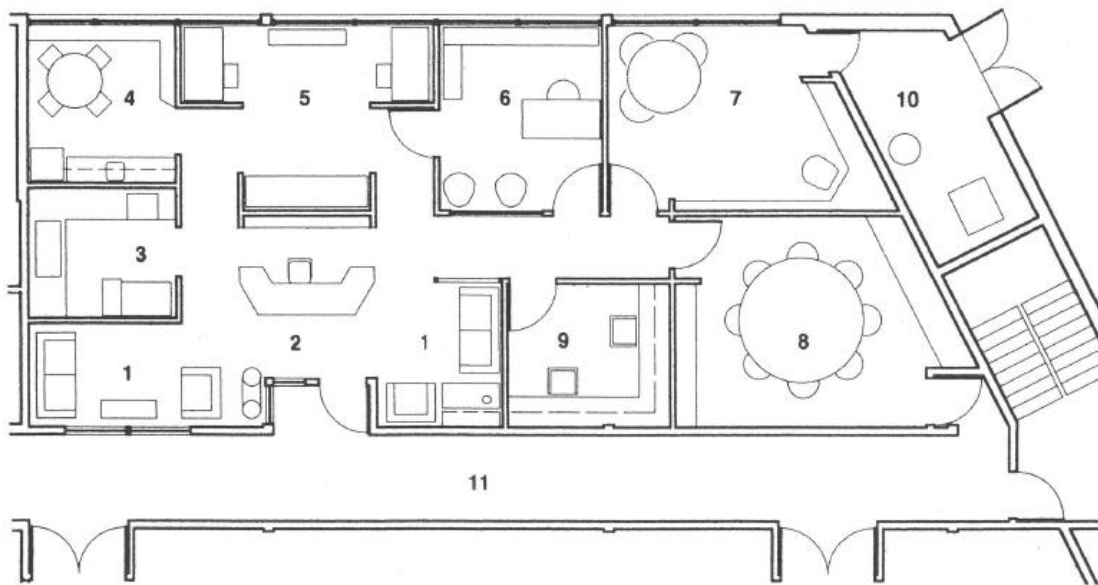
### **Question 6 Electrical Distribution (20 marks)**

The following floor plan is that of small graphic design copy, which occupies the second floor of a two storey building. Its area is about 5,500 sq.ft and it is about 1/4<sup>th</sup> of the overall second floor area. The room descriptions are: 1-Waiting area; 2-Reception; 3- Print Room; 4- Lunch Room; 5- Graphic designer workstations; 6- Office manager; 7- Owner; 8-Board room; 9-Library with two work stations; and 10-Mechanical and storage. 11- Corridor.

Assume typical usage of lighting, power etc. and load conditions. Sketch the distribution layout for the following items:

- (6,a) Switching Lights;
- (6,b) Lighting Circuits;
- (6,c) Duplex and power circuits

Apply all necessary code guidelines and any other requirements for electrical distribution system for typical commercial applications.



**Question 7 Water Distribution (20 marks)**

(7,a) A 2,000 sq.m factory, one storey high, is being planned to be located in the Industrial zone area of Vancouver, BC. The owner is very keen to follow as many Green Initiatives as possible. One of the ideas is to collect the rain water and use it to flush toilets. Identify all the steps necessary for the design of rain water collection. Provide a short description of each of the steps.

(5 Marks)

(7,b) The floor plan of two bedroom row house is shown below. There are three sets of row houses that constitute small development along Street B as shown below.

Five row houses, that face Street B, are attached together and they get water from a common service room for all the uses of the five houses. Describe in detail the necessary distribution system for the complete usage of the houses such as domestic hot water, cold water, heating and cooling requirements. Locate the service room appropriately. The site is located in Montreal.

(15 Marks)

