

National Exams

07-Bld-B9, Building Services

3 hours duration

**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.  
One of two calculators is permitted any Casio or Sharp approved models.
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.

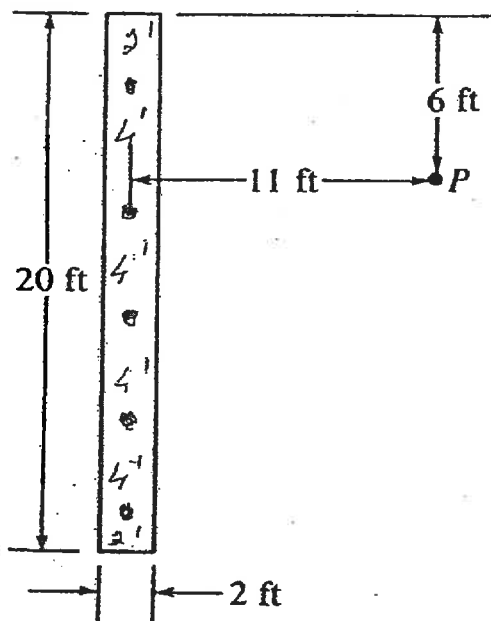
- (1.a) Sound Power Level, as dB and as dBA
- (1.b) National Fire Code
- (1.c) Absorption coefficient and NRC
- (1.d) Point Method of Lighting Calculations and its applications
- (1.e) Sound Transmission Loss
- (1.f) Luminance
- (1.g) Parts of a water distribution system for a townhouse complex
- (1.h) Daylight
- (1.i) Electricity distribution system for a 2000 sq.ft detached house
- (1.j) Helmholtz Resonators as sound absorbers

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

- (2.a) The music room (no windows) of an apartment unit has dimensions 5 m X 4 m X 3 m high. The walls and the ceiling are made with gyproc with absorption coefficient of 0.1 at 250 Hz and 0.05 at 1000 Hz. The floor has thick carpet with absorption coefficient of 0.35 at 250 Hz and 0.71 at 1000 Hz. The ambient sound in the room was measured as 45 dB at 250 Hz and 37 dB at 1000 Hz. An ideal music room must have a design value of NC-30. What measures can you provide to achieve NC-30? Present your design data such as area of materials and absorption coefficients etc. (10 marks)
- (2.b) The transmission loss of an enclosure wall which contains a 0.5 m X 0.5 m window and a 1m X 2m door is to be determined. The transmission loss of the well sealed door is 25 dB and that of the window is 28 dB. The side of the wall is 3m X 6 m
- a) What will be the required transmission loss of an enclosure wall if the overall TL is to be 30 dB?
  - b) What is the greatest overall TL that is theoretically possible?
  - c) What would be the effect of a 25 mm high crack underneath the door on the overall TL of the construction in Part a) at a frequency of 500 Hz? (10 marks)

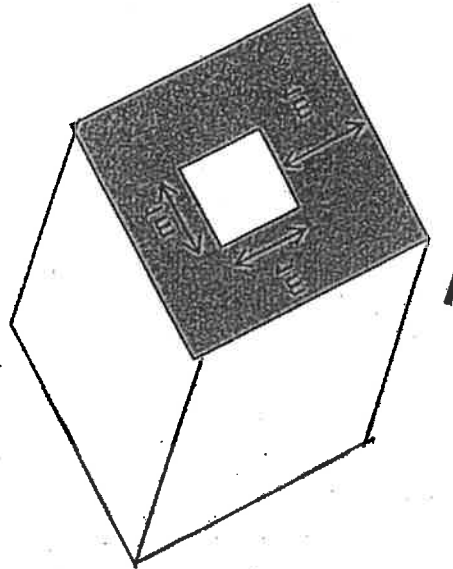
**Question 3 Lighting 1 (20 marks)**

- (3.a) A row of 5 lamps, each of whose intensity is  $= 2000 \cos(\theta)$  candelas is mounted 7' above the work plane as shown below. Calculate the illuminance at point P (5 marks).



- (3.b) A 100W MH (metal halide) lamp (100 lumens per watt) is used in a search light. The beam of light from this lamp illuminates a surface to 10 fc. Determine the approximate distance between the lamp and the surface assuming no light loss. (5 marks)
- (3.c) A highly reflective surface is illuminated to 50 fc using a directed 500 W incandescent lamp. If the surface is painted grey, how much closer would you need to move the lamp to achieve the same illumination on the display? (5 marks).
- (3.d) A large isolated building in Montreal has a single window (skylight) on the ceiling 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.

- c) The horizontal illuminance on the skylight.
- d) The exitance on the interior side of the skylight.
- e) The luminance on the interior side of the skylight.
- f) The illuminance on the workplane 2 meter directly below and centered below the skylight.
- g) Describe how workplane illuminance could be affected by snow on the ground.

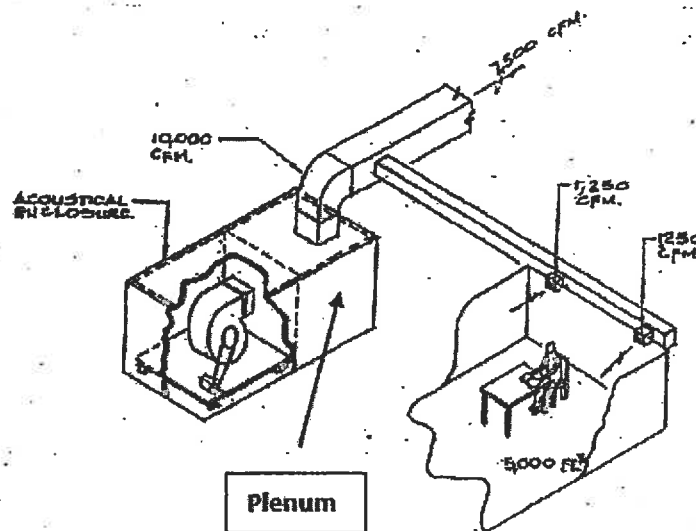


**Question 4 Acoustics 2 (20 marks)**

(4.a) An office is located close to a mechanical room as shown below and conditioned air is being supplied to the office through two ceiling mounted diffusers. Assume the following:

- 1) The length of the main supply duct is 15 feet till the first branch.
- 2) The main duct is 24" square.
- 3) There is one 90 degree bend
- 4) Ignore the noise reduction effect of the plenum
- 5) The fan is a centrifugal fan of 20" dia blades, airfoil backward curve
- 6) The fan's static pressure rise is 4" water gauge.

Calculate the noise levels in the office and provide mitigation methods for an office with NC-35 space. (15 Marks)

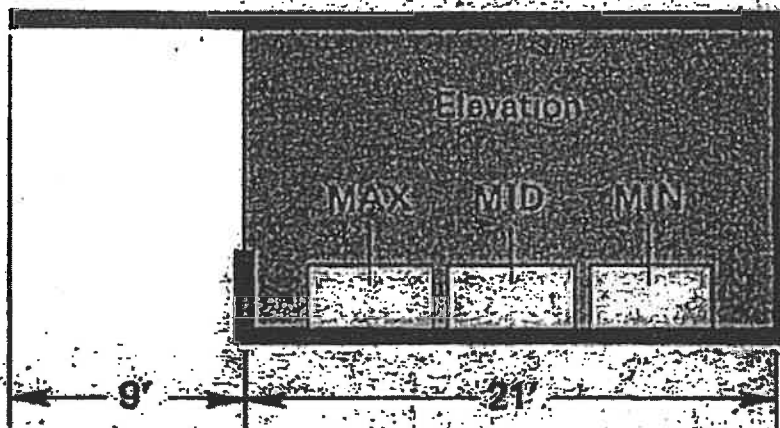


(4.b) An architect is planning to build a 25 single family houses along a main road. The site of the proposed development is approximately 100 m from a major auto warehouse whose buildings are one storey high. Develop a site plan of the proposed buildings to protect the residents from excessive noise. List all the factors that will influence the site. Include and list all factors such as applicable Canadian regulations, site plan, site orientation, noise mitigation methods (both interior and exterior). (5 Marks)

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

**Problem: Daylighting calculation – Use Daylight Factor Method**

The details for an artist's studio in Washington DC are shown below. There are no obstructions between the work plane and the sky. Calculate the illumination on the work plane in fc for MID location and the MIN Location. MID is at mid point and is 30" high. MIN location is 5' from the far wall and is 30" high. A) Use Daylight factor Method; b) Proper Daylight calculations at Solar Noon on 15 January.



The details of the rooms are:

Room length	.....	30 ft.
Room width	.....	21 ft.
Ceiling height	.....	12 ft.
Sill height	.....	3 ft.
Roof overhang	.....	9 ft.
Ceiling reflectance	.....	80%
Wall reflectance	.....	70%
Floor reflectance	.....	30%

The window occupies the entire wall above the sill.  
 Frame and metalwork are 20% of the area of the opening. Clear thermopane glass transmits 77%.

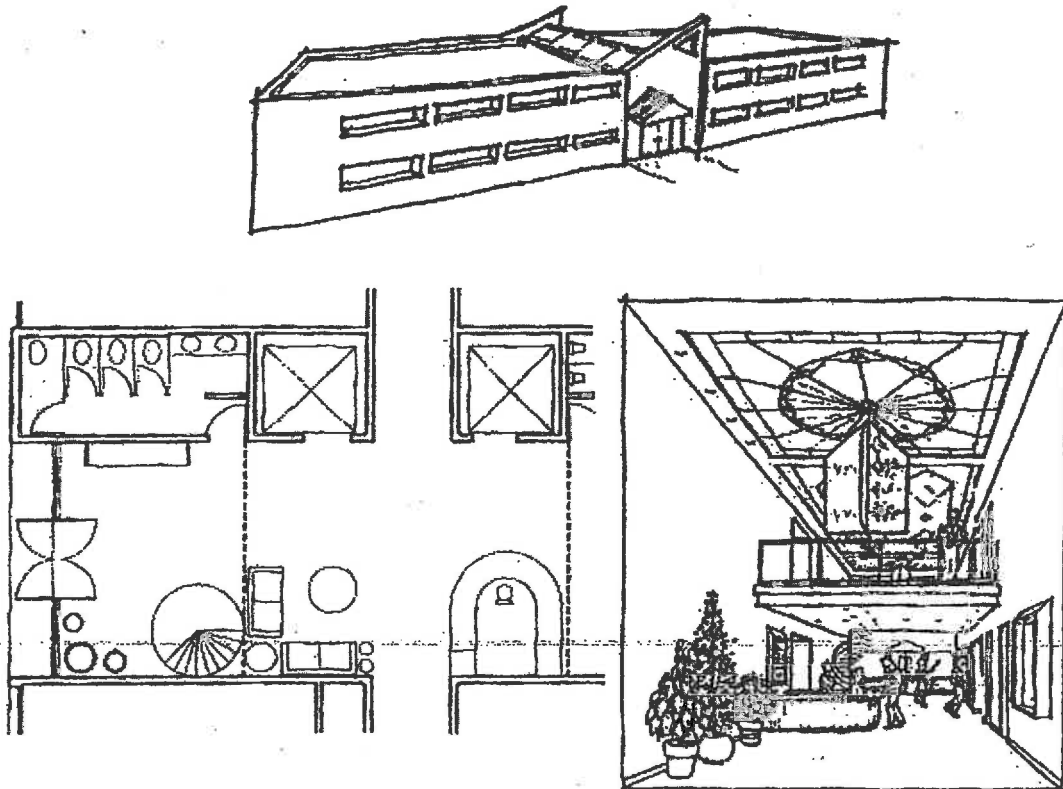
**Question 6 Electrical Distribution (20 marks)**

The following sketches includes the floor plan of the lobby of a two storey office building and the lobby is part of an atrium. The lobby defines "building image." Planters and display cases flank the entry doors, and two large tapestries suspended below a stained glass ceiling add visual interest in the tall space. A bridge, accessed by elevators and a decorative circular stair, carries second floor occupants and guest traffic between east and west offices. A reception desk, building directory, and a small waiting area share the space beneath the bridge.

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) The owner of an industrial plant (5000 sq.ft, two storey building) is very keen to follow as many Green Initiatives as possible. One of the ideas is to collect the rain water and use it in the plant's site. Identify all the steps necessary for the design of rain water collection. Provide a short description of each of the steps and their application. (5 Marks)

(7,b) The floor plan of two bedroom row house is shown below. (15 Marks)

Five row houses are attached together and they get all water related services from a common service room. The developer of the complex is keen to follow energy saving methods. One of the ideas is a Gray water collection system. Plan the grey water system for the complex and show all details. The site is located in Toronto.

