Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	ACOUSTICS AND LIGHTING
COURSE CODE	:	BFB 41103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS. 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**. 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

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THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Define sound power and sound pressure.

(2 marks)

(b) A classical music performance is held at Malaysian Philharmonic Orchestra. The instruments used for the musical performance included violin, piano and saxophone. When the musicians play all three instruments together, the total sound level in the hall is 96 dB. The entire sound pressure level of the hall dropped to 90 dB when the violinist stopped playing the violin. However, the total sound level of the hall becomes 95 dB when the pianist stops playing the piano while the musicians play the other two instruments.

i. Estimate the sound pressure level generated by the violin alone.

(3 marks)

ii. Estimate the sound pressure level generated by the piano alone.

(3 marks)

iii. If the background noise of the hall is 60 dB, examine the sound pressure level contributed by the saxophone alone.

(3 marks)

(c) Speech quality in the lecture hall is important to ensure students can clearly hear the messages from the lecturer. Justify **THREE (3)** methods that can be done to enhance speech intelligibility in a lecture hall. You may use suitable sketches to illustrate your explanations.

(9 marks)

(d) Reverberation time is an important parameter that is used to evaluate an indoor environment's acoustic performance. Predict the reverberation time of a classroom with the dimension of 5.0 m x 4.5 m x 4.2 m. Assume the average absorption coefficient of the room is 0.06.

(5 marks)

Q2 (a) A classroom needs an excellent acoustic quality to ensure the teaching and learning process can be carried out effectively.

i. Discuss why a big cubic room consisting of six (6) hard surfaces with same dimensions is not suitable to be used as a classroom.

(3 marks)

ii. Propose **TWO (2)** solutions to increase the acoustic performance of the classroom.

(2 marks)

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(b) A resident's house is located next to a heavy traffic road of Jalan Kluang. A facade wall of the house is facing the road. The size of the facade is $10\boldsymbol{a}$ m^2 where $\boldsymbol{a}$ is last digit of your matric number (example: CF19012$\boldsymbol{a}$). If your last digit matric number is 0, use $\boldsymbol{a} = 10$. Assume that 15% of the facade is wooden door and 20% of the facade is casement window and the remaining is concrete wall with respective sound reduction index as the following:

Wooden door	:	26 dB
Casement window	:	18 dB
Concrete wall	:	50 dB

Based on the given information, estimate the average sound reduction index of the facade that faces to the road.

(8 marks)

(c) You are assigned by your company to collaborate with the Japanese government in designing a world-class classical concert hall. This hall will be built in the town of Tokyo, which is surrounded by busy transportation network systems.

As an engineer, produce illustrations of your designs or ideas to insulate the building from the noisy outdoor environment and vibration that may be caused by the earthquake. Provide brief description to support your illustrations.

(12 marks)

Q3. (a) Define "illuminance" according to your understanding.

(3 marks)

(b) Lighting quality in an office is vital for the occupants' visual comfort. The quality of lighting is depends on illuminance uniformity, luminance distributions, light color, color rendering and color temperature characteristics, nature of light and glare control. significantly contribute to the workers' concentration and performance.

i. Briefly discuss **THREE (3)** functions of lighting system in an office.

(6 marks)

ii. Explain **THREE (3)** benefits of a good lighting quality in an office.

(6 marks)

(c) Daylight is the combination of all direct and indirect sunlight during the daytime. Indirect sunlight can be achieved by the diffusion mechanism from the sky and reflection from the earth or terrestrial objects.

i. Briefly discuss **THREE (3)** benefits of the daylighting system in a building.

(6 marks)

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ii. Explain **TWO (2)** conflicts of the daylighting in a building.
(4 marks)

Q4. (a) The tropical climate of Malaysia is ideal for daylight harvesting in an office building as daylight is consistently available daily from 8 am to 6 pm. In order to promote building sustainability, you are assigned to design an office building by optimising natural daylighting. Explain **THREE (3)** consideration factors in your design. You may use a suitable illustration to support your explanations.
(9 marks)

(b) A structure laboratory in FKAAB is planned to be converted into a drawing studio for the architecture programme. The floor area of this laboratory is 120 m (length) x 80 m (width), and it will be illuminated by artificial lighting for 12 hours per day. During the weekend (Friday and Saturday), all the lighting fittings will be turned off for energy saving. Based on information in **Table Q4**:

(i) Calculate the electricity cost per year of this drawing studio with two different types of lamps if the overall illumination of the studio is to be maintained over the floor area at 250 lux.
(11 marks)

(ii) Compare the total costs of each lighting system using tungsten-halogen lamps and tubular fluorescent if the operation period is **THREE (3)** years.
(5 marks)

-END OF QUESTIONS-

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TABLE Q4: Lighting information for drawing studio

150W tungsten-halogen lamps		
Total lighting	:	48 weeks/ year
Electricity cost	:	RM 0.60 / kWh
Light loss factor	:	70 %
Efficacy of lamp	:	25 lumen/watt
Lamp life cycle	:	2,000 hours
Cost of lamp	:	RM15.50 per unit
80W tubular fluorescent warm white lamps		
Total lighting hour	:	48 weeks/ year
Electricity cost	:	RM 0.60 / kWh
Light loss factor	:	68 %
Type of lamps	:	80W tubular fluorescent warm white lamps
Efficacy of lamp	:	90 lumen/watt
Lamp life cycle	:	10,000 hours
Cost of lamp	:	RM25.00 per unit

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The following information may be useful. The symbols have their usual meaning.

$$T = \frac{0.161V}{A}$$

$$\mathrm{SRI}_{\mathrm{average}} = -10\log\left(\frac{S_1\left(10^{\frac{-\mathrm{SRI}_1}{10}}\right)+S_2\left(10^{\frac{-\mathrm{SRI}_2}{10}}\right)+S_3\left(10^{\frac{-\mathrm{SRI}_3}{10}}\right)}{S_1+S_2+S_3}\right)]$$

$$L_2 = L_1 - SRI + 10\log S_p - 10\log A$$

$$L_{p(total)} = L_w + 10\,log_{10}\left(\frac{Q}{4\pi r^2} + \frac{4}{R_c}\right)$$

$$Installed\ lumens = \frac{Lux \times Floor\ area}{Light\ loss\ factor}$$

$$Input\ power = \frac{Installed\ lumen}{Efficacy}$$

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