UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: July 2022

Module Number: ME8301 **Module Name: Building Services Engineering**

[Three Hours]

[Answer all questions]

Q1. (a) Explain with the aid of suitable sketches, three different illumination methods used for the requirements of different tasks.

[2 Marks]

(b) Define the following terms used in lighting system design;

(i) Luminaire

(ii) Colour Temperature

(iii) Colour-rendering

(iv) Daylight Factor

[2 Marks]

(c) A convenient shop of dimensions 30 m x 20 m and 4 m high has a white ceiling and mainly dark wall. The working plane is 1.2 m above the floor level. Bear fluorescent tube light fittings with two 58W, 1500 mm lamps are to be used. It has 5100 lighting design lumens and needs to be maintained 450 lx. Their nominal spacing-to-height ratio is 1.75 and total power consumption is 140 W. Use the Lumen design method and determine the following,

(i) The number of luminaires needed,

(ii) The layout of the luminaires

(iii) The electrical loading per square metre of floor area

(iv) The circuit current.

Table Q1(c)1 Luminance Factor for Painted Surfaces

Surface	*Typical colour*	*Luminance factor range (%)*
Ceiling	White, cream	70–80
Ceiling	Sky blue	50–60
Ceiling	Light brown	20–30
Walls	Light stone	50–60
Walls	Dark grey	20–30
Walls	Black	10
Floor	—	10

Table Q1(c)2 Utilization factor for a bare fluorescent fitting with two 58 W 1500 mm lamps (%)

Luminance factors		*Room index*								
Ceiling	*Walls*	*0.75*	*1*	*1.25*	*1.5*	*2*	*2.5*	*3*	*4*	*5*
70	50	48	53	59	64	71	75	79	83	86
70	30	40	46	51	57	64	69	73	78	82
70	10	35	40	46	51	59	64	68	74	78
50	50	43	48	52	57	63	67	70	74	76
50	30	37	41	46	51	57	62	65	70	73
50	10	33	37	42	46	53	58	61	67	70
30	50	39	42	46	50	55	59	61	65	67
30	30	34	37	42	46	51	55	58	62	65
30	10	30	33	38	42	48	52	55	59	62

[8 Marks]

Q2. (a) Explain sound power and sound pressure level and the units of measurements for sound power, sound pressure, sound power level and sound pressure level.

[2 Marks]

(b) Describe the sources of noise that could be found within a building which has an all air type central air-conditioning system.

[2 Marks]

(c) A plant room for an air-conditioning centrifugal fan is 6 m x 4 m in plan and 3 m high. It has four brickwork walls, a concreate floor and a pitched sheet steel deck roof having 15 mm acoustic ceiling tile with suspended 50 mm mineral fibre wool.

The fan is to be installed centrally within the plant room and its overall output power level (SWL) is 88 dB on the 'A' scale. Calculate the followings;

(i) The room sound absorption constant

(ii) The reverberation time for the plant room,

(iii) The sound pressure level that will be produced in the plant room at 1000 Hz, when the fan is operating, close to the fan and also generally within the room.

Table Q1(c) Absorption Coefficients of Common Materials

Material	*Absorption coefficient at*					
	125 Hz	*250 Hz*	*500 Hz*	*1000 Hz*	*2000 Hz*	*4000 Hz*
25 mm plaster, 18 mm plasterboard, 75 mm cavity	0.3	0.3	0.6	0.8	0.75	0.75
18 mm board floor on timber joists	0.15	0.2	0.1	0.1	0.1	0.1
Brickwork	0.05	0.04	0.04	0.03	0.03	0.02
Concrete	0.02	0.02	0.02	0.04	0.05	0.05
12 mm fibreboard, 25 mm cavity	0.35	0.35	0.2	0.2	0.25	0.3
Plastered wall	0.01	0.01	0.02	0.03	0.04	0.05
Pile carpet on thick underfelt	0.07	0.25	0.5	0.5	0.6	0.65
Fabric curtain hung in folds	0.05	0.15	0.35	0.55	0.65	0.65
15 mm acoustic ceiling tile, suspended 50 mm mineral fibre wool or glass fibre matt	0.5	0.6	0.65	0.75	0.8	0.75
50 mm polyester acoustic blanket, metallized film	0.25	0.55	0.75	1.05	0.8	0.7
50 mm glass fibre blanket, perforated surface finish	0.15	0.4	0.75	0.85	0.8	0.85

Note:

Absorption constant = $\frac{S\ \bar{\alpha}}{1-\bar{\alpha}}$ (m^2)

Reverberation Time = $\frac{0.161\ V}{S\ \bar{\alpha}}$ (s)

$SPL = SWL + 10\ log_{10}\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right)$ (dB)

All symbols represent their usual meaning.

[8 Marks]

Q3. (a) Explain the difference between the active and passive fire protection systems.

[2 Marks]

(b) What are the five main groups of portable fire extinguishers? How they are useful as the first-aid in different classes of fire.

[4 Marks]

(c) Explain with the aid of sketches parts of a Grinnell-type quartzoid sprinkler and its operating principle.

[2 Marks]

(d) Draw a sketch of a multi-jet sprinkler system and explain the operation of it giving the details of automatic control valve.

[4 Marks]

Q4. (a) Discuss the concept of green building.

[2 Marks]

(b) Name two thermal comfort indices used in the building sector.

[2 Marks]

(c) Write the Fanger's comfort equation and explain its terms.

[4 Marks]

(d) Explain four approaches of using electricity and water in buildings sustainably.

[4 Marks]

Q5. (a) Explain two methods of reducing noise in HVAC systems.

[2 Marks]

(b) Discuss two disadvantages of flexible ducting.

[2 Marks]

(c) Discuss two advantages of using fibreglass ducts over galvanized steel ducts.

[2 Marks]

(d) Figure Q2 (d) represents a poor ducting layout proposed to be installed. Suggest a better duct layout to replace it.

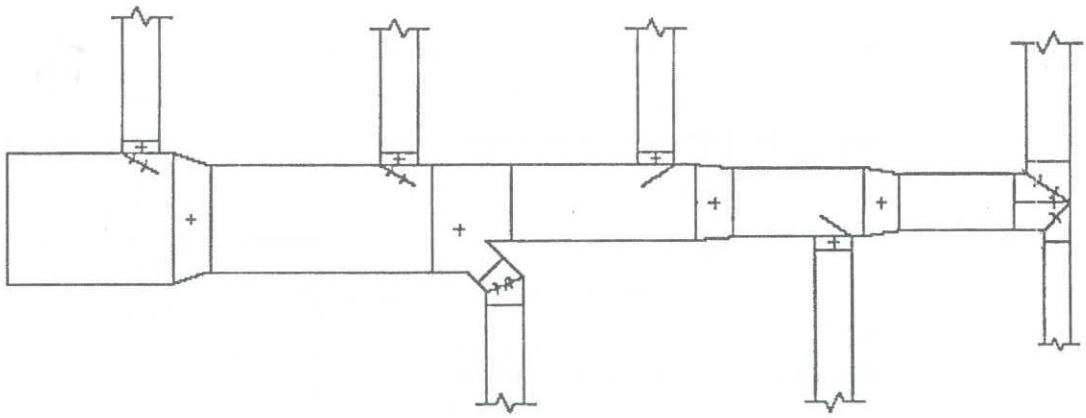

Figure Q2 (d)

[1 Mark]

(e) Figure Q2 (e) illustrates ducting layout proposed for a restaurant area of a five-star hotel. The airflow rate requirements for each space and the length of the main duct and its branches are also shown in the Figure Q2(e). The duct material is galvanized steel and the cross-section is rectangular with an aspect ratio of 3:2. Determine the following by using the equal-friction method in duct designing. Consider 12.5 pa pressure drop from the HA duct section.

(i) The frictional pressure drops in the AB duct segment.

(ii) Minimum power that is required to supply air to the duct system.

(iii) Calculate the amount of damping required from VCD 3.

Note: The velocity of air in the main duct AB is 6m/s. The dynamic loss coefficient for the upstream to downstream is 0.3, and it is 0.7 for upstream to branches, respectively. The dynamic loss coefficient for all the outlets is 0.5 and the density of the air is 1.2 kg/m^3. Use the following equation to calculate the frictional pressure gradient of the ducts, where the symbols of the equation are having their usual meaning.

$$\frac{\Delta P_f}{L} = \frac{0.022243 Q^{1.852}}{Deq^{4.973}}$$

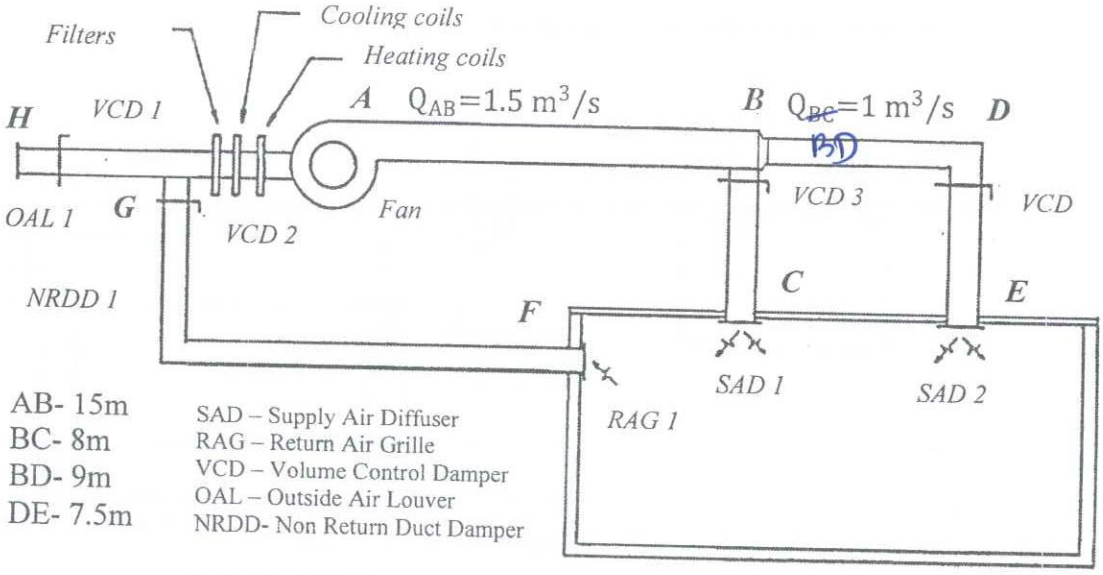

Figure Q2 (e)

[5 Marks]