

Answer all the following questions:

Question-1

[15 marks]

- a) Mention some different sources of pollutants inside the closed spaces. (4 marks)
- b) Explain with details the meaning of: IAQ, ACR and ASHRAE Standards 62. (3marks)
- c) Formaldehyde is the most general public of volatile organic compound. Mention its sources and the side effect on the human health. (4marks)
- c) Mention two different methods which are used to control the indoor air pollutants. (4 marks)

Question-2

[15 marks]

- a- Describe using diagrammatic sketch the operation of natural ventilation system and report its advantages and disadvantages. (8 marks)
- b- Show the difference between the two methods of industrial ventilation system (i.e. dilution and local exhaust), and mention only the disadvantages of each method. (7 marks)

Question-3

[40 marks]

- A restaurant has the dimensions as shown in the figure (1). The inlet and exit ventilation openings have the same shape and the same dimensions (25 cm×75 cm). The difference between the levels of inlet and exit opening (i.e. ΔH) is 1.0 m and the discharge coefficient C_D is 0.61 for all the openings. The dynamic pressure head at the inlet opening is neglected 1.2 Pa. The average temperature inside the garage is 30 °C while the outside temperature is 23 °C. The air flow rate from duct openings are $Q_B=30\%$ of the fan flow rate and $Q_D=Q_E=40\%$ of the fan flow rate. Take the pressure loss coefficients at bend is 0.8 and the exit is 1.0 along the duct. Also, take the velocity for the main duct is 8 m/s and the fan efficiency is 0.82. Assume any required data and calculate the following:

- i- The required air flow rate if the air change rate (ACR) equals 8.
- ii- The natural flow rate based on the wind effect and buoyancy effect.

iii- Design the ventilation duct using the equal friction coefficient method if the aspect ratio is 2.

iv- The fan horse Power (HP).

Question-4

[30 marks]

To achieve the standard concentration of pollutants inside workshop shown in figure (2), it is required that the air change rate by 5 times each hour (ACR=5). The dimensions of the workstation are 10 m × 8 m × 4 m. The workstation has three gas pollutant sources with the same generation rate. The sucked air from source-1 is equal to the sucked air from source-2 and they equal 70% of the total sucked air (i.e. $Q_1=Q_2=0.35 Q_{total}$). Assume any missing data to find out the following:

- i- The required air flow rate of the induced fan,
- ii- Design the local exhaust ventilation duct if aspect ratio is 1.5,
- iii- The fan horse Power (HP).

Use the following relations if you need:

$$\frac{\Delta P_f}{L} = \frac{0.022243 \dot{Q}_{air}^{1.85}}{D^{4.973}}$$

$$D_{eq,B} = D_{eq,A} \left(\frac{Q_B}{Q_A} \right)^{\left(\frac{1.85}{4.973} \right)}$$

$$D_{eq} = 1.3 \frac{(ab)^{0.625}}{(a+b)^{0.25}}$$

$$\dot{V} = A_e C_e \sqrt{\frac{2g \Delta H \Delta T}{T}}, \quad \frac{1}{(A_e C_e)^2} = \frac{1}{(\sum A_i C_i)^2} + \frac{1}{(\sum A_o C_o)^2}$$

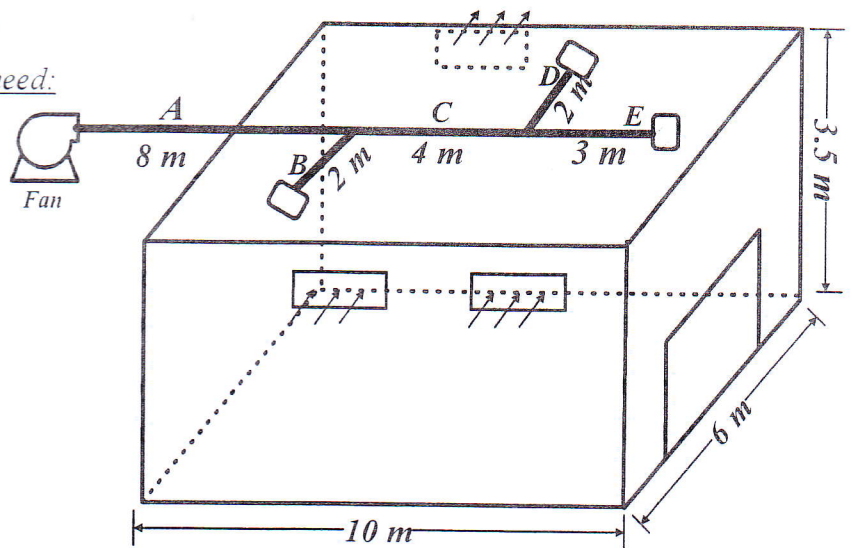


Figure (1)

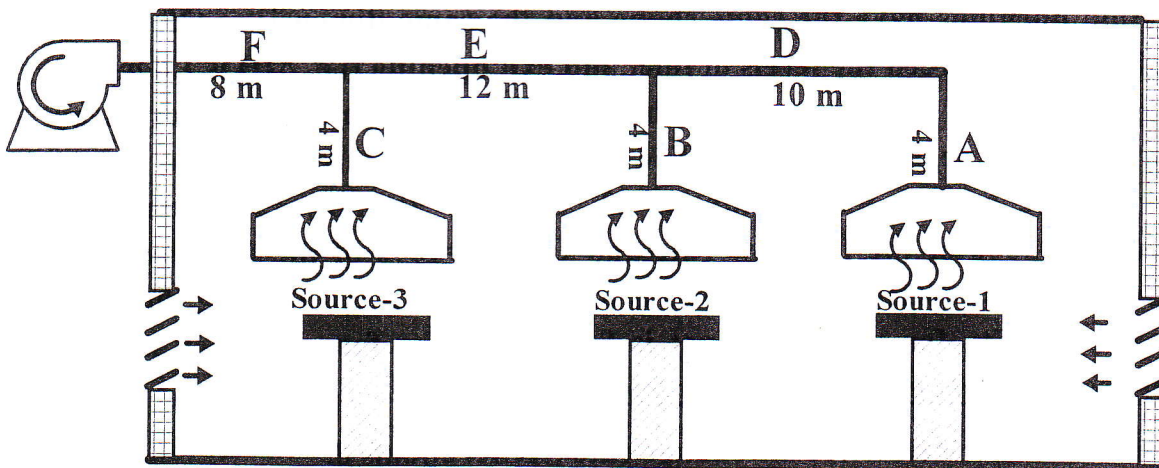


Figure (2)

With best wishes