



# BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

## School of Refrigeration & Air conditioning Skills

Session: 2021-22 (Winter Semester)

B. Voc. Program, V-Semester,

End-Sem. Examination

Set-A

Course Code: HVA1504

Course Name: AC system and testing

Instruction: Read the question carefully, do attempt all

Time: 2 Hours

Max. Marks: 50

### Section – A

10\*01 = 10 Marks

- Q1) Ratio of maximum dimension to minimum dimension is known as?  
a. Aspect ratio  
b. possession ratio  
c. Pressure ratio  
d. dimension ratio
- Q2) ducting is classified according to \_\_\_\_\_?  
a. Shapes  
b. pressure  
c. velocity  
d. all of the above
- Q3) Friction value of chart is taken per \_\_\_\_\_ ft of duct length?  
a. 100  
b. 200  
c. 10  
d. 50
- Q4) Duct with high pressure have \_\_\_\_\_ friction value of?  
a. 6.5 to 12.25  
b. 3.5 to 4.25  
c. 2.5 to 8.25  
d. 1 to 3.25
- Q5) Evaporators of chillers are \_\_\_\_\_ categories as?  
a. Shell and tube  
b. PHE  
c. Coil and tube  
d. all of the above
- Q6) What G.I. in a metal sheet means?  
a. Gram squared milli meter  
b. Galvanized iron  
c. Grinded edge sheet  
d. Gram squared moles
- Q7) What is Nacph \_\_\_\_\_?  
a. Number of air change per hour  
b. Number of air condensed per hour  
c. Number of person cfm per hour  
d. Number of air cumulated per hour
- Q8) NBC stands for  
a. National boiler codes  
b. National BIM codes  
c. National bureau of standard  
d. National building codes
- Q9) BIS – 277 stands for \_\_\_\_\_  
a. Sheet metal specification  
b. sheet metal fabrication and erection  
c. work safety standard  
d. Duct work



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Q10) What is GSM in sheet metal working for duct?

- a. Gram squared milli meter
- b. Galvanized iron
- c. Grinded edge sheet
- d. Gram squared moles

## Section – B

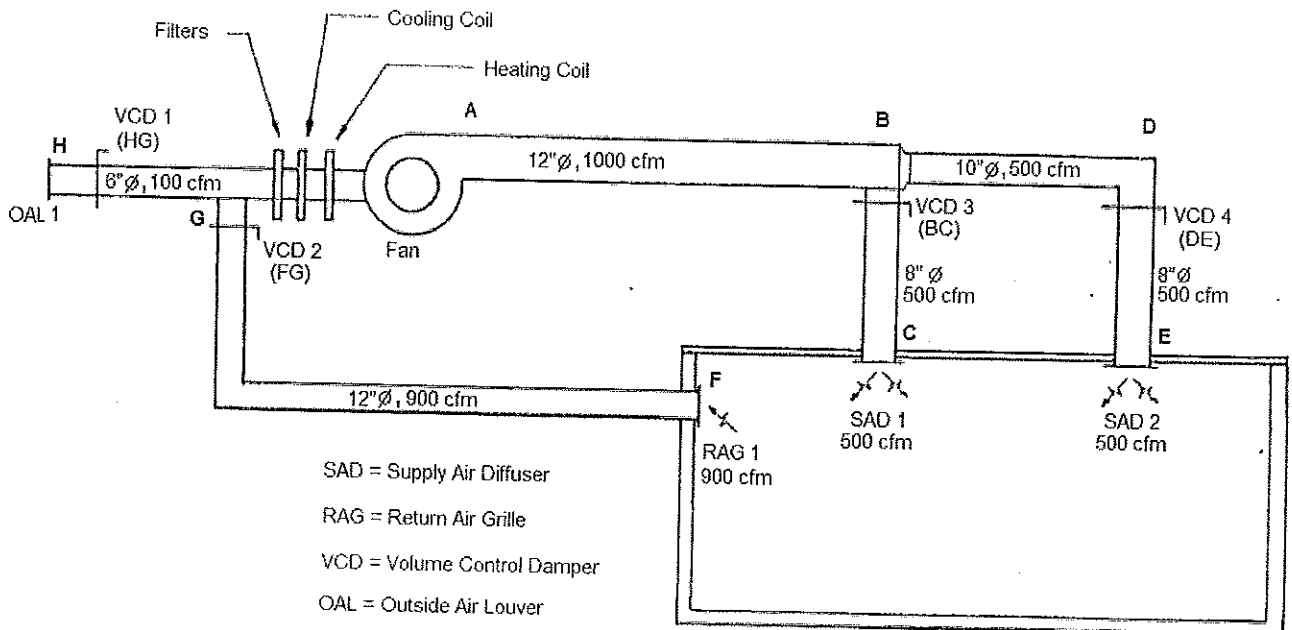
04\*04 = 16 Marks

- Q1) Write down about; CFM, FPM and area. Also, write relation among them.
- Q2) Write down the name of duct sizing methods.
- Q3) Mention the various types of pressure in the duct system with their application?
- Q4) Explain duct components with neat sketch?

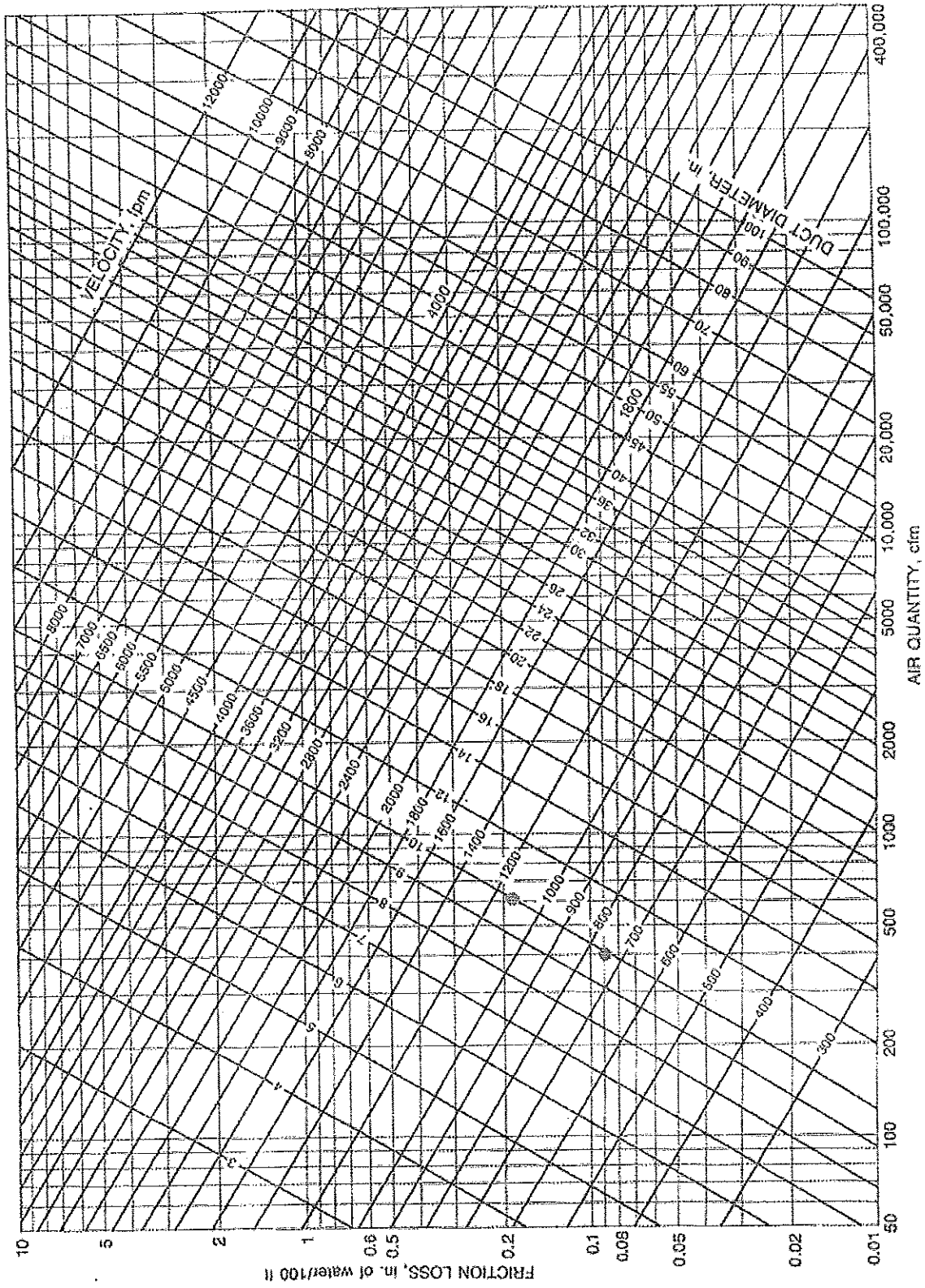
## Section – C

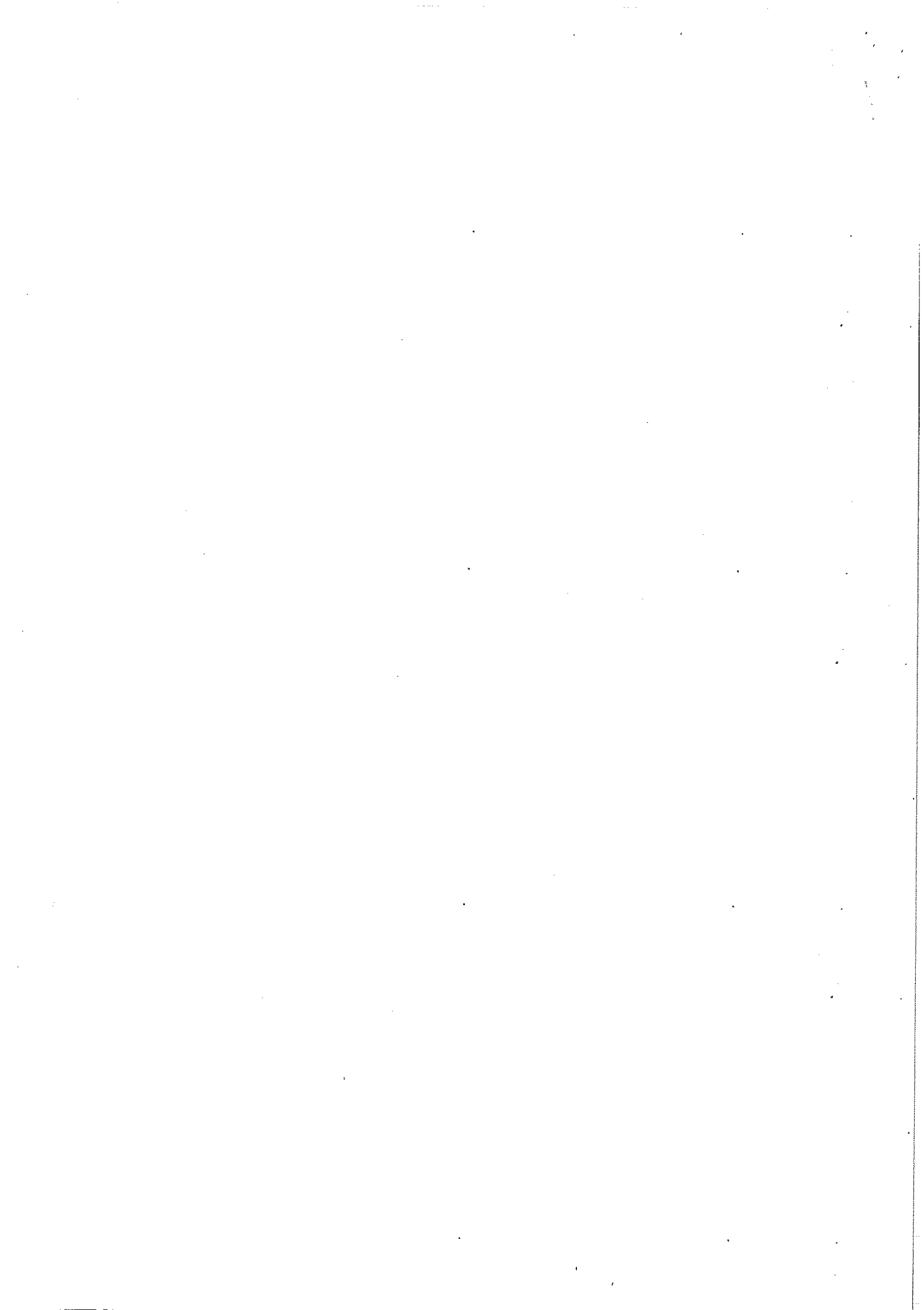
04\*06 = 24 Marks

- Q1) Write types of duct materials along with application?
- Q2) Explain converging, diverging and constant cross-sectional areas with neat sketch?
- Q3) Explain round shape and rectangular shape duct?
- Q4) An air conditioning layout below depicts an air handling unit (AHU) supplying cool air to an office space. The supply air fan discharges to supply air diffusers SAD -1 & SAD - 2 through the supply duct and draws air through the return duct via the return air grille (RAG - 1). It also draws fresh air through a louver (OAL - 1). Estimate the total pressure loss for sizing the fan.



*Shubham Jai*







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**Max. Marks: 50**

**Answer key**

**Section – A**

**10\*01 = 10 Marks**

- A1) A
- A2) D
- A3) A
- A4) A
- A5) D
- A6) B
- A7) A
- A8) D
- A9) A
- A10) A

**Section – B**

**04\*04 = 16 Marks**

A 1. Write down about; CFM, FPM and area. Also, write relation among them.

- CFM: volume of air flow; cubic feet/minute
- FPM: velocity or speed of air flow; feet/minute
- Area (sq.ft): duct size or cross-sectional area; square feet

Relation,  $CFM = FPM * Area$

A 2. Write down the name of duct sizing methods.

1. Equal friction method
2. Velocity reduction method
3. static regain method

A 3. Mention the various types of pressure in the duct system with their application?

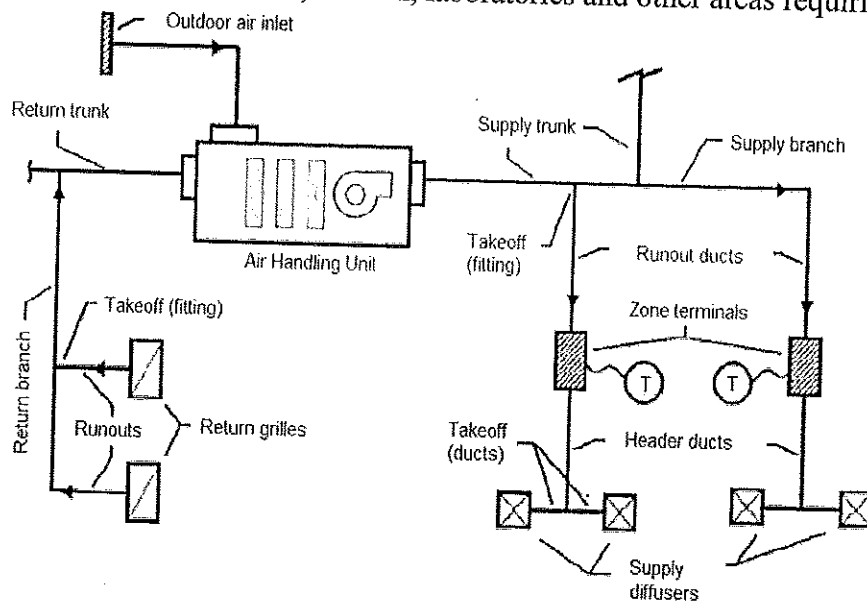
Duct system is pressurized by three pressures:

- Static pressure: It is the air pressure in the duct, which is used for fan selection.
- Velocity pressure: It is the pressure generated by the velocity and weight of the air, which is used for measuring the flow (cfm) in a system.
- Total pressure: It is used to find velocity pressure. Static pressure plus velocity pressure equals total pressure.

Pressure in the ductwork is measured in inches of water column (in-wc).

A 4. Explain duct components with neat sketch?

1. Supply air ductwork supplies conditioned air from the air handling unit to the conditioned area.
2. Return air ductwork removes air from the conditioned building spaces and returns the air to the air handling unit, which reconditions the air. In some cases, part of the return air in this ductwork is exhausted to the building exterior.
3. Fresh air ductwork supplies outdoor air to the air handling unit. Outdoor air is used for ventilating the occupied building space.
4. Exhaust (relief) air ductwork carries and discharges air to the outdoors. Exhaust air is taken from toilets, kitchen, laboratories and other areas requiring ventilation.



Section – C

04\*06 = 24 Marks

A 1. Write types of duct materials along with application?

1. Galvanized Steel: It is a standard, most common material used in fabricating ductwork for most comfort air conditioning systems.
2. Aluminum: It is widely used in clean room applications. These are also preferred systems for moisture laden air, special exhaust systems and ornamental duct systems.
3. Stainless Steel: It is used in duct systems for kitchen exhaust, moisture laden air, and fume exhaust.
4. Copper: It is mainly used for certain chemical exhaust and ornamental ductwork.
5. Fiber-glass Reinforced Plastic (FRP)
6. PVC
7. Fabric

A 2. Explain converging, diverging and constant cross-sectional areas with neat sketch?

Static and velocity pressure are mutually convertible. The magnitude of each is dependent on the local duct cross-section which determines the flow velocity. The following pressure changes are affected in the ducts:

- Constant cross-sectional areas: Total and static losses are equal.



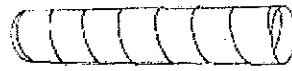
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- Diverging sections (increase in duct size): Velocity pressure decreases, total pressure decreases, and static pressure may increase (static regain).
- Converging sections (decrease in duct size): Velocity pressure increases in the direction of flow, total and static pressure decrease.

A 3. Explain round shape and rectangular shape duct?

## Round Ducts

The duct shape that is the most efficient (offers the least resistance) in conveying moving air is a round duct, because it has the greatest cross-sectional area and a minimum contact surface. In other words, it uses less material compared to square or rectangular ducts for the same volume of air handled.



Round Duct

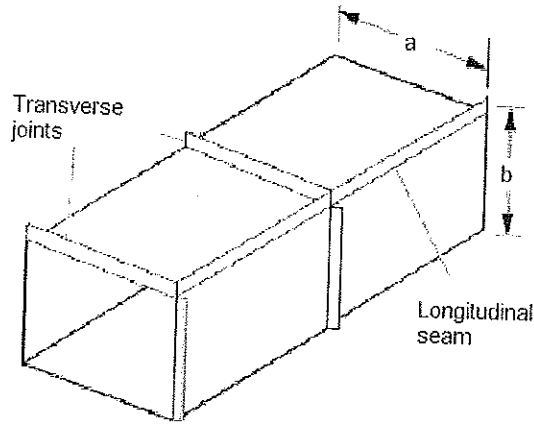
Some of the advantages of round ductwork include:

- Round shape results in lower pressure drops, thereby requiring less fan horsepower to move the air and, consequently, smaller equipment.
- Round shape also has less surface area and requires less insulation when externally wrapped.
- Round ducts are available in longer lengths than rectangular ducts, thereby eliminating costly field joints. Spiral lock-seams add rigidity; therefore, spiral ducts can be fabricated using lighter gauges than longitudinal seam ducts. Spiral ducts leak less and can be more easily sealed compared to rectangular ducts.
- The acoustic performance of round and oval ducts is superior because their curved surfaces allow less breakout noise. The low-frequency sound is well contained in round ducts.

## Rectangular Ducts

Square or rectangular ducts fit better to building construction. They fit above ceilings and into walls, and they are much easier to install between joists and studs.

When rectangular ducts must be used due to space limitations, keep the width-to-height ratio (aspect ratio) low. A rectangular duct section with an aspect ratio close to 1 yields the most efficient rectangular duct shape in terms of conveying air. A duct with an aspect ratio above 4 is much less efficient in use of material and experiences great pressure losses. Aspect ratios of 2 to 3 are ideal in trading off added duct cost of material and fan energy for headroom savings.



A4) An air conditioning layout below depicts an air handling unit (AHU) supplying cool air to an office space. The supply air fan discharges to supply air diffusers SAD -1 & SAD - 2 through the supply duct and draws air through the return duct via the return air grille (RAG - 1). It also draws fresh air through a louver (OAL -1). Estimate the total pressure loss for sizing the fan.

The layout shows four (4) paths of air flow and six (6) duct sections.

**Path #1:** Air supply through duct sections AB and BC

**Path #2:** Air supply through duct sections AB, BD and DE

**Path #3:** Air return through duct section FG

**Path #4:** Outdoor air intake through duct section HG

The section occurs at:

- Change in duct size
- Change in air volume

Now using the friction charts, let's find out the duct pressure losses per 100-ft. length of duct.

**Path #1:**

- a. Duct run AB; (12" diameter, 1000 cfm) = 0.2 in.-wc/100 ft. duct length
- b. Duct run BC ; ( 8 " diameter, 500 cfm) = 0.37 in.-wc/100 ft. duct length
- c. SAD-1 = 0.12 in.-wc (from manufacturer's catalog)
- d. Total Pressure Loss =  $[0.2 + 0.37 + 0.12] = 0.69$  in.-wc/100 ft. of duct length

**Path #2:**

- a. Duct run AB; (12" diameter, 1000 cfm) = 0.2 in.-wc/100 ft. duct length
- b. Duct run BD ; ( 10" diameter, 500 cfm) = 0.14 in.-wc/100 ft. duct length
- c. Duct run DE; ( 8" diameter, 500 cfm) = 0.37 in.-wc/100 ft. duct length
- d. SAD-2 = 0.12 in. -wc (from manufacturer's catalog)
- e. Total Pressure Loss =  $[0.2 + 0.14 + 0.37 + 0.12] = 0.83$  in.-wc/100 ft. duct length

**Path #3:**

- a. RAG -1 = 0.08 in.-wc (from manufacturer's catalog)
- b. Duct runs FG; ( 12" diameter, 900 cfm) = 0.16 in.-wc/100 ft. duct length
- c. Total Pressure Loss =  $[0.08 + 0.16] = 0.24$  in. -wc/100 ft. duct length

**Path #4:**

- a. OAL-1 = 0.08 in. -wc (from manufacturer's catalog)
- b. Duct runs HG; ( 6" diameter, 100 cfm) = 0.08 in.-wc/100 ft. duct length



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c. Total Pressure Loss =  $[0.08 + 0.08] = 0.16$  in.-wc/100 ft. duct length

*Sheela J*





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**Time: 2 Hours**

**Course Name: AC system and testing**

**Max. Marks: 50**

**Instruction: Read the question carefully, do attempt all**

**Section – A**

**10\*01 = 10 Marks**

Q1) Part of central air-conditioning system is

- a. Split AC
- b. VRV
- c. Chiller
- d. All

Q2) Duct with low pressure have \_\_\_\_\_ friction value of?

- a. 6.5 to 12.25
- b. 3.5 to 4.25
- c. 2.5 to 8.25
- d. 1 to 3.25

Q3) condensers of chillers are \_\_\_\_\_ categories as?

- a. Shell and tube
- b. PHE
- c. Coil and tube
- d. all of the above

Q4) What commonly used material in a metal sheet are

- a. Copper
- b. Galvanized iron
- c. Silver
- d. None of the above

Q5) What is CFM \_\_\_\_\_?

- a. Centimeter feet meter
- b. cubic feet meter
- c. None of the above
- d. all of the above

Q6) Which lines in psychrometry shows wet bulb

- a. Horizontal lines
- b. vertical lines
- c. Lines on curve left
- d. enthalpy lines

Q7) Humidity ratio is shown on \_\_\_\_\_ psychrometry chart.

- a. Horizontal line
- b. vertical line
- c. inclined line
- d. all

Q8) Horizontal lines in psychrometry chart show \_\_\_\_\_.

- a. WBT
- b. DBT
- c. DPT
- d. None

Q9) Ratio of maximum dimension to minimum dimension is known as?

- a. Aspect ratio
- b. possession ratio
- c. Pressure ratio
- d. dimension ratio



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Q10) Duct shapes are

- a. Round
- b. Rectangular
- c. Oval
- d. all of the above

## Section – B

04\*04 = 16 Marks

Q1) Define total pressure, static pressure and velocity pressure.

Q2) Write down the name of duct sizing method.

Q3) Write down about; CFM, FPM and area. Also, write relation among them.

Q4) Classify dust based on various pressure range.

## Section – C

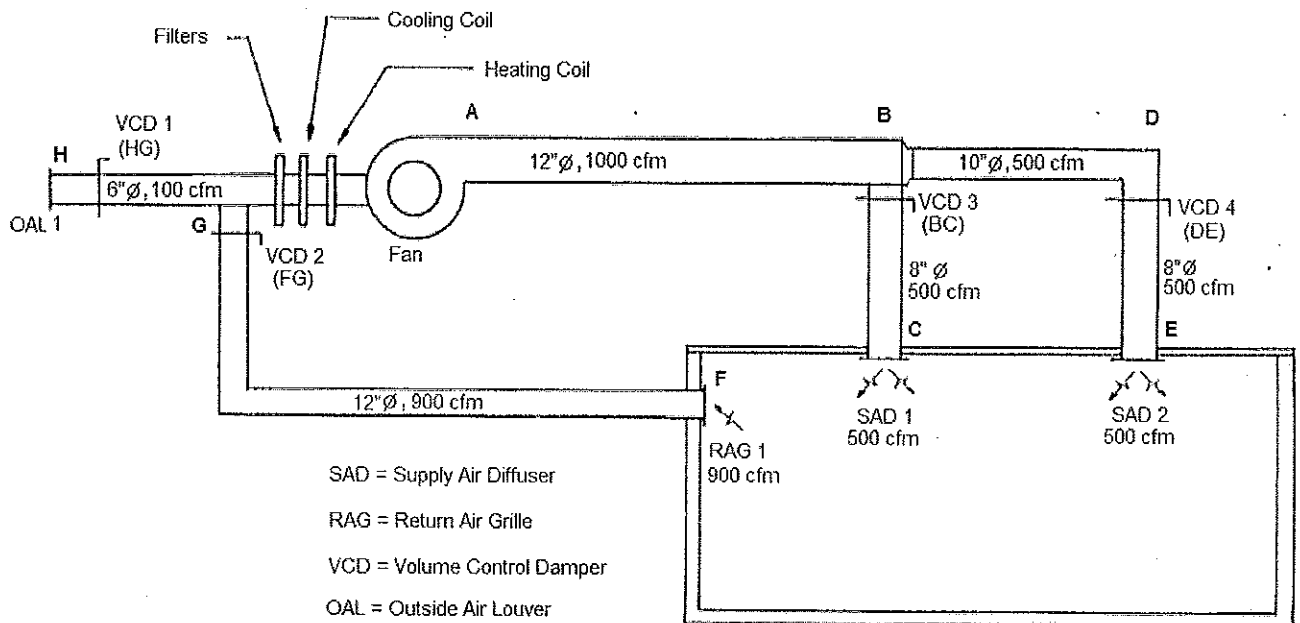
04\*06 = 24 Marks

Q1) Explain equal friction method.

Q2) Differentiate round duct and rectangular duct with neat sketch.

Q3) Explain converging, diverging and constant cross-sectional areas with neat sketch?

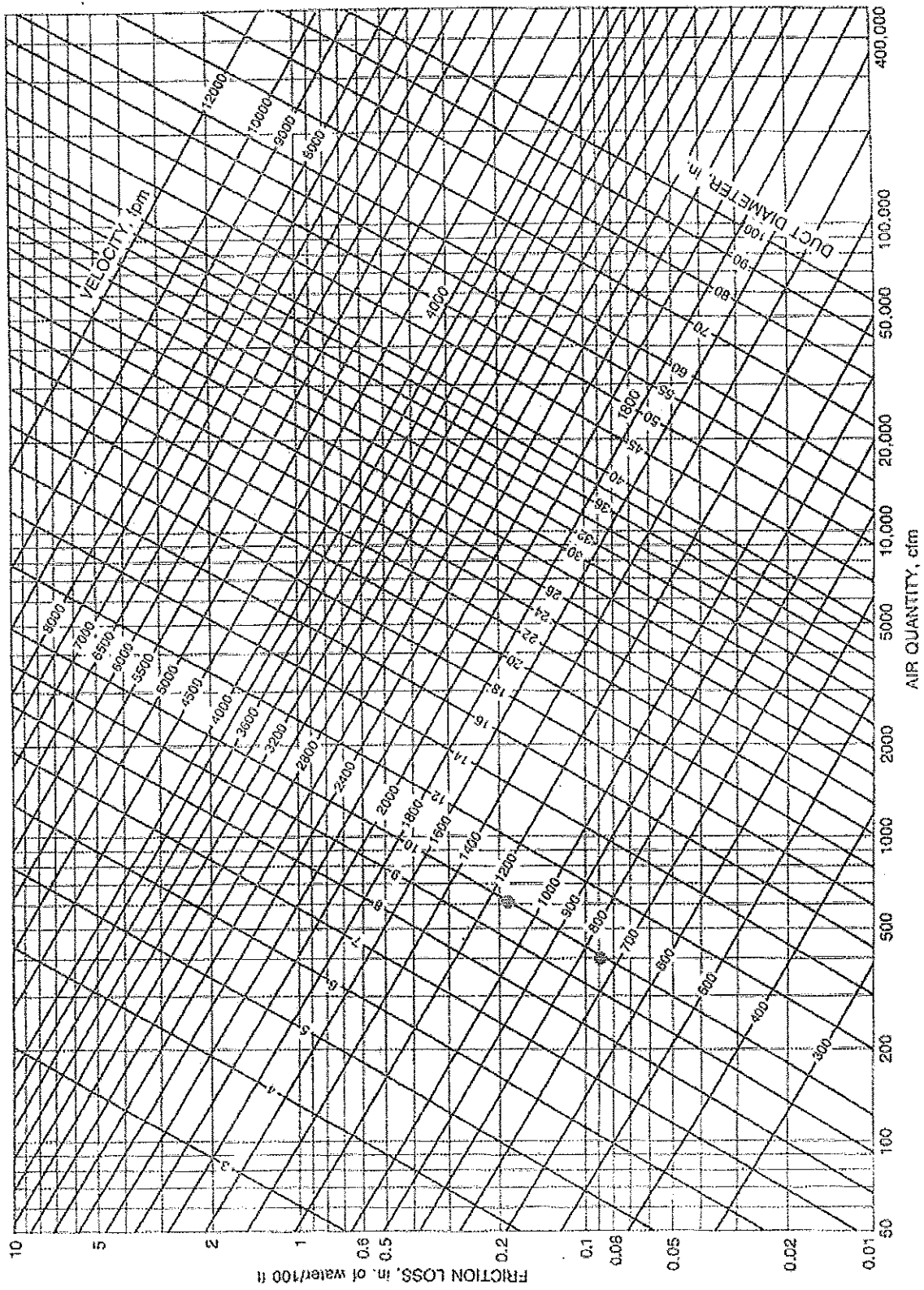
Q4) An air conditioning layout below depicts an air handling unit (AHU) supplying cool air to an office space. The supply air fan discharges to supply air diffusers SAD - 1 & SAD - 2 through the supply duct and draws air through the return duct via the return air grille (RAG - 1). It also draws fresh air through a louver (OAL - 1). Estimate the total pressure loss for sizing the fan.

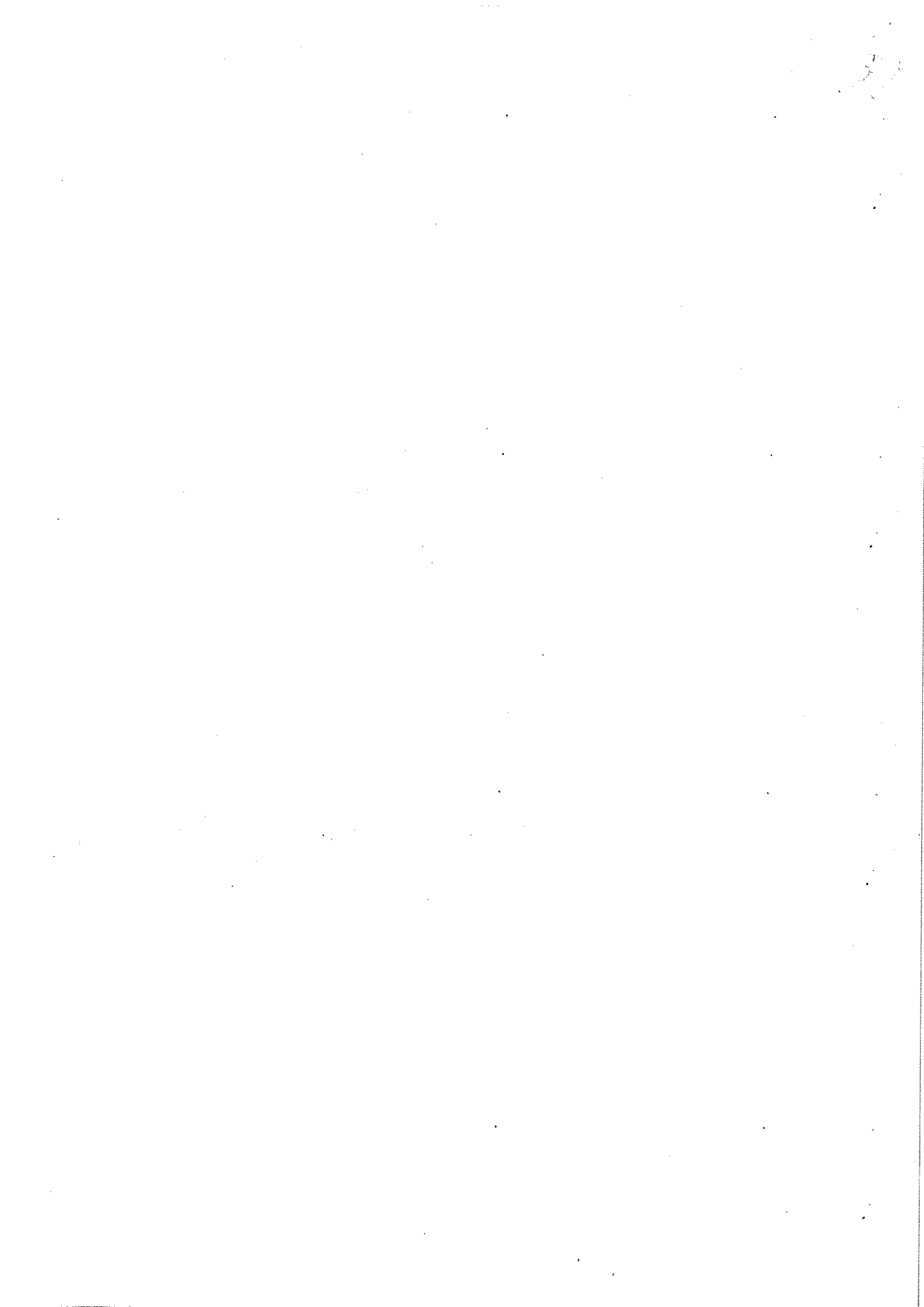


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**Section – A**

10\*01 = 10 Marks

- A1) D
- A2) D
- A3) D
- A4) B
- A5) B
- A6) D
- A7) A
- A8) D
- A9) A
- A10) D

**Section – B**

04\*04 = 16 Marks

A 1. Define total pressure, static pressure and velocity pressure.

Duct system is pressurized by three pressures:

- Static pressure: It is the air pressure in the duct, which is used for fan selection.
- Velocity pressure: It is the pressure generated by the velocity and weight of the air, which is used for measuring the flow (cfm) in a system.
- Total pressure: It is used to find velocity pressure. Static pressure plus velocity pressure equals total pressure.

Pressure in the ductwork is measured in inches of water column (in-wc).

A 2. Write down the name of duct sizing method.

1. Equal friction method
2. Velocity reduction method
3. static regain method

A 3. Write down about; CFM, FPM and area. Also, write relation among them.

- CFM: volume of air flow; cubic feet/minute
- FPM: velocity or speed of air flow; feet/minute
- Area (sq.ft): duct size or cross-sectional area; square feet



Relation, CFM = FPM\*Area

A 4. Classify dust based on various pressure range.

Duct systems are also divided into three pressure classifications, matching the way supply fans are classified.

**Low Pressure:** The term low-pressure applies to systems with fan static pressures less than 3 inches WC. Generally, duct velocities are less than 1,500 fpm.

**Medium Pressure:** The term medium pressure applies to systems with fan static pressures between 3 to 6 inches WC. Generally, duct velocities are less than or equal to 2,500 fpm.

**High Pressure:** The term high pressure applies to systems with fan static pressures between 6 to 10 inches WC.

## Section – C

04\*06 = 24 Marks

A 1. Explain equal friction method

The Equal Friction design method sizes the ducts for a constant “Friction Rate”, which describes the average pressure drop per 100 feet of duct in a system. A very common friction rate for a reasonably well-designed system is 0.1 in.-wc per 100 ft. of duct length. Reduced friction rates of 0.05 in.-wc per 100 ft. increases the duct size and costs by 15%, but cuts the portion of the total pressure drop in ductwork by 50%, resulting in fan energy savings of 15% to 20%.

Procedure:

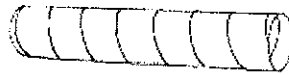
Equal friction method uses a duct slide rule, duct calculator, or friction rate chart to determine the relationship between duct size and air flow, i.e., how much air will come out of a given size duct. The methodology is as follows:

- a) Select maximum air velocity in main duct after fan outlet.
- b) Enter the friction chart knowing the cfm and velocity to determine the friction rate per 100 feet of duct length and select the diameter (refer to chart below).
- c) From the friction rate obtained in the previous step, use the same value to determine diameters for all other sections of the ductwork.
- d) The total friction loss in the duct system is then calculated by multiplying the friction loss per 100-foot of length to the equivalent length of the most critical path of the ductwork having maximum resistance.

A 2. Differentiate round duct and rectangular duct with neat sketch.

### *Round Ducts*

The duct shape that is the most efficient (offers the least resistance) in conveying moving air is a round duct, because it has the greatest cross-sectional area and a minimum contact surface. In other words, it uses less material compared to square or rectangular ducts for the same volume of air handled.



## Round Duct

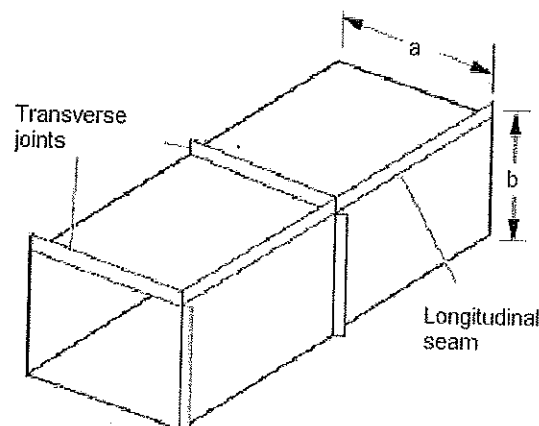
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A 3. Explain converging, diverging and constant cross-sectional areas with neat sketch?

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- Constant cross-sectional areas: Total and static losses are equal.
- Diverging sections (increase in duct size): Velocity pressure decreases, total pressure decreases, and static pressure may increase (static regain).
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- Duct run BC; (8" diameter, 500 cfm) = 0.37 in.-wc/100 ft. duct length
- SAD-1 = 0.12 in.-wc (from manufacturer's catalog)
- Total Pressure Loss =  $[0.2 + 0.37 + 0.12] = 0.69$  in.-wc/100 ft. of duct length

Path #2:

- Duct run AB; (12" diameter, 1000 cfm) = 0.2 in.-wc/100 ft. duct length
- Duct run BD; (10" diameter, 500 cfm) = 0.14 in.-wc/100 ft. duct length
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- SAD-2 = 0.12 in.-wc (from manufacturer's catalog)
- Total Pressure Loss =  $[0.2 + 0.14 + 0.37 + 0.12] = 0.83$  in.-wc/100 ft. duct length

Path #3:

- RAG -1 = 0.08 in.-wc (from manufacturer's catalog)
- Duct runs FG; (12" diameter, 900 cfm) = 0.16 in.-wc/100 ft. duct length
- Total Pressure Loss =  $[0.08 + 0.16] = 0.24$  in.-wc/100 ft. duct length

Path #4:

- OAL-1 = 0.08 in.-wc (from manufacturer's catalog)
- Duct runs HG; (6" diameter, 100 cfm) = 0.08 in.-wc/100 ft. duct length
- Total Pressure Loss =  $[0.08 + 0.08] = 0.16$  in.-wc/100 ft. duct length