BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2021-22 (Summer Semester)

B. Voc. 5th Semester

End-Sem. Examination

Course Code: HVA1501 **Time: 2 Hours**

Course Name: Heat Load Estimation **Max. Marks: 50**

Instruction: Attempt all questions

Calculator is allowed

SET-A

Section – A

10X01 = 10 Marks

1. Which of the following is not an air change method?
   a) ACPH b) Effective Leakage area Method c) LPD d) None of the above
2. Dependency on direction is referred to as –
   a) Spectral
   b) Specular
   c) Both A&B
   d) None of the above
3. The space served by an HVAC system commonly is referred to as a _____ zone?
   a) Thermal
   b) Perimeter
   c) Boundary
   d) Core
4. Exhausting air through kitchens and bathrooms is necessary for health and safety but it increases _____
   a)Exfiltration
   b)Infiltration
   c)Pressure
   d)Temperature
5. The lighting use factor (F_{ul}) is the ratio of the wattage actually in use at the time that the load estimate is being made to the total _____wattage.
   a) Installed b) Consumed c) Overall d) all of the above.
6. Which of the following is not an envelope problem?
   a) Cracking
   b) Spalling
   c) Durability
   d) Moisture
7. A person at rest gives off approx.:
   a) 300 BTU b) 400 BTU c) 600 BTU d) 800 BTU
8. The rated motor horsepower is multiplied by _____ to convert units to Btu/h.
   a) 2345 b) 2545 c) 2025 d) 2115
9. Which of the following causes latent heat gain?
   a) Glasses
   b) Motors
   c) People
   d) Appliances
10. DHW stands for:
    a) Dynamic Heat Wavelength
    b) Domestic Hot water
    c) Domestic Home Water
    d) none of the above

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. Explain Wind and Stack effect?
2. What is the importance of a thermal envelope in a building?
3. What is Effective leakage area method and how does it differ from air change method?
4. What is scheduling and why is it done in energy estimation?

Section – C

04X06 = 24 Marks

1. A 300 seat school band room(Type C) is used continuously from 10 am until 6:00pm each day. For the first four hours, it is at 60% capacity; during the last four hours, it is at 90% capacity. Estimate the sensible heat gain from people at 12 pm, 2:00 pm, 4:00 pm.Take Sensible gain per person as 250 BTU/hr.

2. A 12 x 14 ft private office with carpeted floors and gypsum walls(Type D) contains a personal computer with laser printer(1000Btu/h) and a small copier(800 Btu/hr). Estimate the usage pattern and sensible heat gains for each of these at 12:00pm, 2:00pm and 4:00pm. The office work starts at 10 am-6 pm.

3. How is the U value for a wall is calculated? What is its importance in Heat load estimation?

4. What is the importance of zoning and spacing?

Cooling Load Factors for People and Unhooded Equipment[1]

Hours in Space	Number of Hours after Entry into Space or Equipment Turned On																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Zone Type A																								
2	0.75	0.88	0.18	0.08	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.75	0.88	0.93	0.95	0.22	0.10	0.05	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.75	0.88	0.93	0.95	0.97	0.97	0.23	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.75	0.88	0.93	0.95	0.97	0.97	0.98	0.98	0.24	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
10	0.75	0.88	0.93	0.95	0.97	0.97	0.98	0.98	0.99	0.99	0.24	0.12	0.07	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
12	0.75	0.88	0.93	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.25	0.12	0.07	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00
14	0.76	0.88	0.93	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03	0.02	0.02	0.01	0.01
16	0.76	0.89	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03	0.02	0.02
18	0.77	0.89	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03
Zone Type B																								
2	0.65	0.74	0.16	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.65	0.75	0.81	0.85	0.24	0.17	0.13	0.10	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
6	0.65	0.75	0.81	0.85	0.89	0.91	0.29	0.20	0.15	0.12	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
8	0.65	0.75	0.81	0.85	0.89	0.91	0.93	0.95	0.31	0.22	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
10	0.65	0.75	0.81	0.85	0.89	0.91	0.93	0.95	0.96	0.97	0.33	0.24	0.18	0.14	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01
12	0.66	0.76	0.81	0.86	0.89	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.34	0.24	0.19	0.14	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02
14	0.67	0.76	0.82	0.86	0.89	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.35	0.25	0.19	0.15	0.11	0.09	0.07	0.05	0.04	0.03
16	0.69	0.78	0.83	0.87	0.90	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.35	0.25	0.19	0.15	0.11	0.09	0.07	0.05
18	0.71	0.80	0.85	0.88	0.91	0.93	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.35	0.25	0.19	0.15	0.11	0.09
Zone Type C																								
2	0.60	0.68	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
4	0.60	0.68	0.74	0.79	0.23	0.18	0.14	0.12	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
6	0.61	0.69	0.74	0.79	0.83	0.86	0.28	0.22	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
8	0.61	0.69	0.75	0.79	0.83	0.86	0.89	0.91	0.32	0.26	0.21	0.17	0.14	0.11	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.02
10	0.62	0.70	0.75	0.80	0.83	0.86	0.89	0.91	0.92	0.94	0.35	0.28	0.23	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03
12	0.63	0.71	0.76	0.81	0.84	0.87	0.89	0.91	0.93	0.94	0.95	0.96	0.37	0.29	0.24	0.19	0.16	0.13	0.11	0.09	0.07	0.06	0.05	0.04
14	0.65	0.72	0.77	0.82	0.85	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.38	0.30	0.25	0.20	0.17	0.14	0.11	0.09	0.08	0.06
16	0.68	0.74	0.79	0.83	0.86	0.89	0.91	0.92	0.94	0.95	0.96	0.96	0.97	0.98	0.98	0.98	0.39	0.31	0.25	0.21	0.17	0.14	0.11	0.09
18	0.72	0.78	0.82	0.85	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.99	0.39	0.31	0.26	0.21	0.17	0.14
Zone Type D																								
2	0.59	0.67	0.13	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
4	0.60	0.67	0.72	0.76	0.20	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
6	0.61	0.68	0.73	0.77	0.80	0.83	0.26	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02
8	0.62	0.69	0.74	0.77	0.80	0.83	0.85	0.87	0.30	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03
10	0.63	0.70	0.75	0.78	0.81	0.84	0.86	0.88	0.89	0.91	0.33	0.27	0.22	0.19	0.17	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05
12	0.65	0.71	0.76	0.79	0.82	0.84	0.87	0.88	0.90	0.91	0.92	0.93	0.35	0.29	0.24	0.21	0.18	0.16	0.13	0.12	0.10	0.09	0.08	0.07
14	0.67	0.73	0.78	0.81	0.83	0.86	0.88	0.89	0.91	0.92	0.93	0.94	0.95	0.95	0.37	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.11	0.09
16	0.70	0.76	0.80	0.83	0.85	0.87	0.89	0.90	0.92	0.93	0.94	0.95	0.95	0.96	0.96	0.97	0.38	0.31	0.26	0.23	0.20	0.17	0.15	0.13
18	0.74	0.80	0.83	0.85	0.87	0.89	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.97	0.97	0.98	0.98	0.39	0.32	0.27	0.23	0.20	0.17

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2021-22 (Summer Semester)

B. Voc. 5th Semester

End-Sem. Examination

Course Code: HVA1501 **Time: 2 Hours**

Course Name: Heat Load Estimation **Max. Marks: 50**

Instruction: Attempt all questions

Calculator is allowed

SET-A

Section – A

10X01 = 10 Marks

1. C
2. A
3. A
4. A
5. B
6. C
7. A
8. B
9. C
10. B

Section – B

04X04 = 16 Marks

1. Stack effect is air movement caused by thermal differences. Higher-temperature air is less dense than cooler air. As the warmer air rises, it creates a pressure difference, with lower pressure below and higher pressure above. In buildings during the winter, the lower pressure allows cooler air from outside to move into the bottom floors. The temperature of the cooler air starts to increase, continuing the cycle. During summer or in warmer climates, the stack effect is reversed. The hot air outside enters the upper portion of the cooler building and creates a draft down.

2. A building envelope has the role of physically isolating the inside of the building from the outside environment. It serves as an external protection to enhance the quality and control the indoor conditions irrespective of transient outdoor conditions [16]. The building envelope consists of opaque and transparent parts. The opaque envelope covers walls, roofs, floors, and insulation and transparent envelope include windows, skylights, and glass doors.

3.Calculation in square inches equal to the total area of all air leaks in a building envelope. D efined by the Lawrence Berkeley National Laboratory, the ELA is the area of a nozzle-shaped hole that would leak the same amount of air as the building does when pressurized t o 4 pascals. Estimating leakage in this way enables one to visualize the cumulative impact many tiny holes can have on the air-tightness of a house.

4. The occupancy schedule is based on the % of occupants that occupy a certain thermal zone at a given time. For example, in the weekday occupancy schedule example below, the office thermal zone is 95% occupied from 8am -12pm and from 2pm to 5pm. If you want the space to be fully occupied, you model it as 100% and if you want the space to be completely

unoccupied, you model it as 0%.This schedule can be modeled using a Schedule: Compact object. You would need to define the occupancy for all days. That is, define the occupancy for design days, weekends, holidays, etc.

Section – C

04X06 = 24 Marks

1. Assuming the walls are concrete block with few windows and the floor is not carpeted, this could be a zone type C construction. The activity level might best be described as sedentary work, comparable to a restaurant.The total adjusted heat gain per person is 275 Btu/h sensible and 275 Btu/h latent. The CLF and sensible cooling loads are shown in the table below. At 2:00 pm, there are 50 people in the room, with another 30 just entering. The energy the new class generates will not occur until 3:00 pm. Note that the latent load is always an instantaneous load.

People	Heat Gain (each)	Hours/ Day	Start Time	CLF at 2:00	CLF at 4:00	CLF at 6:00	Cooling Load at 2:00	Cooling Load at 4:00	Cooling Load at 6:00
50	275	4	12:00	0.68	0.79	0.18	9350	10863	2475
30	275	2	2:00	0	0.68	0.11	0	5610	908
	275	(Latent)					13750	0	0
Sensible Total, Btu/h							9350	16473	3383
Latent Total, Btu/h							13750	0	0

2.

A

People	Heat Gain (each)	Hours/ Day	Start Time	CLF at 2:00	CLF at 4:00	CLF at 6:00	Cooling Load at 2:00	Cooling Load at 4:00	Cooling Load at 6:00
50	275	4	12:00	0.68	0.79	0.18	9350	10863	2475
30	275	2	2:00	0	0.68	0.11	0	5610	908
	275	(Latent)					13750	0	0
Sensible Total, Btu/h							9350	16473	3383
Latent Total, Btu/h							13750	0	0

3. The technical name for which we use the shorthand 'U-Value' is Thermal Transmittance. The **U-value** of a building component like a wall, roof or window, measures the amount of energy (heat) lost through a square metre (m^2) of that material for every degree (K) difference in temperature between the inside and the outside. Before we start looking at what that means, lets sort out the units we use to define it.

• **Energy** flows along in watts (which is a measure of energy in 'joules' flowing over a period of time in 'seconds').

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Refrigeration & Air Conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: HVA1502 Time: **2 Hours**

Course Name: Cold Chain & Cold Storage Max. Marks: 50

ANSWER KEY-A

Section – A

10X01 = 10 Marks

1. What is food preservation?
   a. Retaining food over a period of time
   b. Distribution food over a period of time
   c. Harvesting food over a period of time
   d. None of the above

2. causes of food deterioration and spoilage are-.
   a. Mechanical effects
   b. Physical effects
   c. Microbial effects
   d. All of the above
3. Which of the following is food preservation method?
   a. Inhibition
   b. Inactivation
   c. Avoid recontamination
   d. All of the above

4. What is the goal of a cold storage?
   a. Slow the biological activity of fruits
   b. Slow the growth of microorganisms
   c. a & b both
   d. None of the above
5. Factors to be considered for successful produce storage are-.
   a. Temperature
   b. Relative humidity
   c. Air movement
   d. All of the above
6. Which of the following is not a pre harvesting factor for foods?
   a. Genetic
   b. Maturity
   c. Climatic
   d. Cultural
7. LIFO stands for-.
   a. Last in first out
   b. Late in first out
   c. Low in full out
   d. None of the above
8. 7200 KJ equal to-.
   a. 2 KWh
   b. 3 KWh
   c. 4 KWh
   d. 5 KWh

9. In which direction cold air spills out?
   a. Upward
   b. Downward
   c. Horizontal
   d. None of the above
10. Which of the following is known as constant pressure type valve?
   a. Capillary tube
   b. Thermostatic expansion valve
   c. Automatic expansion valve
   d. Float type valve

Section – B

04X04 = 16 Marks

1. Write down the definition of food and food preservation.

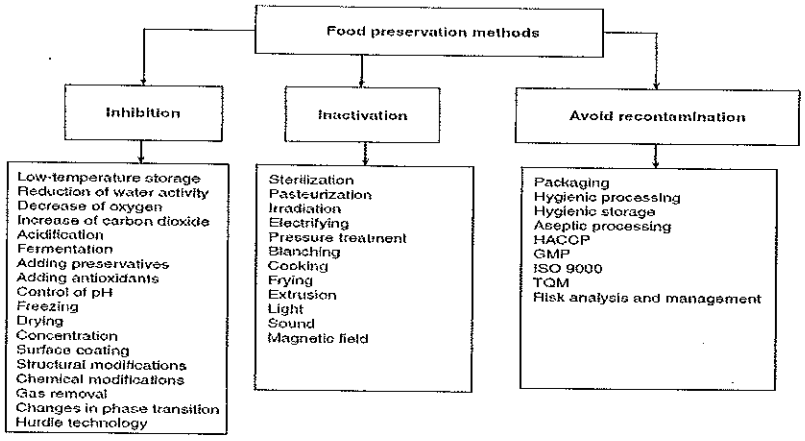
   What Are Foods?

   Foods are materials, raw, processed, or formulated, that are consumed orally by humans or animals for growth, health, satisfaction, pleasure, and satisfying social needs.

   What is food preservation?

   Retaining food over a period of time without being contaminated by pathogenic organisms or chemicals and without losing its colour, texture, flavour and nutritious value.

2. Write down the different food preservation methods through flow diagram.



3. What are the climacteric and non- climacteric type fruit?

   Climacteric fruits

   Those in which ripening is associated with a distinct increase in respiration and ethylene production, the respiration rate rising up to the climacteric peak and then declining. Such an increase can occur either while the fruit is attached to or separated from the plant. A further distinguishing feature is that treatment of climacteric fruits

with ethylene or propylene stimulates both respiration and autocatalytic ethylene production. Low temperatures greatly reduce the magnitude of the climacteric. The climacteric generally coincides with changes associated with ripening such as colour changes, softening, increased tissue permeability, and the development of characteristic aromas. Typical climacteric fruits include apples, pears, peaches, nectarines, bananas, mangoes, plums, tomatoes, and avocadoes.

Non-Climacteric fruits

In non climacteric fruits, ripening is protracted and the attainment of the ripe state is not associated with a marked increase in respiration or ethylene production.

Treatment of non climacteric fruits with ethylene stimulates respiration only; there is no increase in autocatalytic ethylene production. Fruits such as citrus, strawberries, and pineapples are non climacteric.

4. Write a short note on cold store doors.

Their main function is, to allow the free and easy passage of goods and personnel yet still retain the integrity of the insulated enclosure.

When a cold store door is opened, the dense cold air spills out along the floor and the lighter, warmer, outside air flows in to replace it at the door head Modern doors are usually manufactured by one of two methods: by injecting polyurethane foam into pre-formed door skins or by means of insulated panels. The first method is normally adopted for hinged doors and smaller sliding doors, as the size is restricted by the hydraulic presses required. The inside and outside door skins are pressed from sheet metal; the material is typically O.63mm thick or O.8mm stainless steel.

Door openings should be made as small as possible yet big enough to allow the largest loads to pass through safely and without damage to the frames and doors. It is recommended that the following allowances should be made when determining the size:

Width = Maximum load width + 800mm

Height = Maximum load height + 300mm

Section – C

04X06 = 24 Marks

1. Write down the importance of insulation materials and explain the different types of insulation materials.

Thermal insulators are meant to reduce the rate of heat transfer by conduction, convention and radiation -- the standard methods by which heat transfers.

The best thermal insulators have the lowest thermal conductivity; this is the property of a material that measures how well it can conduct heat through its mass.

Expanded polystyrene

Expanded polystyrene (EPS) is one of the most efficient rigid insulation materials available today and is widely and successfully used throughout the cold store industry.

Derived from crude oil, by the combination of benzene and ethylene, which produces styrene monomer, EPS bead is created by the addition of catalysts and an expanding agent, pentane. In the bead form it is a sugar like material. During the process known as pre-foaming, the raw material expands rapidly forming thousands of tiny cells within each head; these hold the air captive and produce the EPS. After conditioning, the pre-foamed bead is moulded to produce blocks up to 7500 x 1350 x 650mm in size. From these blocks are cut sheets and slabs in any required thicknesses to be used in the composite and continuous laminate processes of panel production.

Extruded polystyrene

Extruded polystyrene is basically manufactured from the same raw material as EPS, with the exception that extruded polystyrene for use in panel production is a foam insulation board without a skin. Other forms of extruded polystyrene are available, incorporating a skin, such as the heavier density used for floor insulation purposes. It is manufactured by a continuous extruding process which gives a rigid closed cell structure with unique properties. It is an ideal material for the use of panel production in the cold store industry because of its high resistance to water absorption and its superior mechanical properties.

Polyurethane

Rigid polyurethane (PUF) foams are highly cross-linked polymers with closed cell structures which bubble within the material, with unbroken walls, so that gas movement is retarded. The chlorofluoromethane gas is contained within the walls and, as these substances have a much lower thermal conductivity than air, such closed cell forms have significantly lower thermal conductivity than any open cell foam. However, to retain this low thermal conductivity the gas must not leak away; consequently, rigid foam insulation must have at least 90% closed cells and a density above 30kg/m3.

2. Explain the working of Thermostatic expansion valve with the help of diagram in detail.

The thermostatic expansion valve controls the flow of refrigerant through the evaporator in such a way that the quality of the vapor leaving the evaporator will be always in superheated condition.

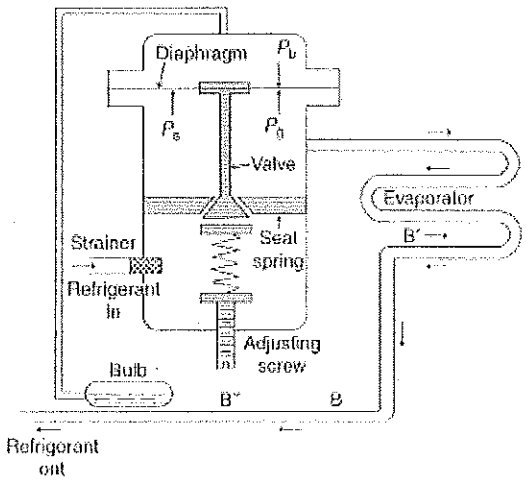
Its operation is used for maintaining a constant degree of superheat at the evaporator outlet.

The valve motion to allow the flow of more or less refrigerant to maintain a constant level of superheat at the evaporator outlet is controlled by three pressures:

*P*b = pressure in the bulb

*P*s = spring tension

*P*e = pressure in the evaporator



3. Following data given for a cold room:

Store Dimensions: 15mX10mX5m. Over all U Value - 0.35 w/sqm°C. Outside Design Conditions: 35°C DBT, 20°C WBT (Enthalpy = 66 KJ/Kg), Inside Design Conditions: 4°C+/-1 °C, 75%RH (Enthalpy = 13 KJ/Kg). Product: Daily 2500Kg/24 hrs coming at 35°C with specific heat 3.0 KJ/Kg°C and 2APCH. Consider 4 men working for 4 hours daily. 4 fans are used of motor capacity 150 W each and run for 10 hours. 4 Lamps are used of capacity 50 W each and run for 5 hours. Each cubic meter of new air provides 2KJ/ cm°C. Find out total load.

1. Transmission Load

Q = U*A*(Outside Temperature – Inside Temperature) *24/1000

= 138.6 Kwh/day

2.Product Load

Q = M*C_P*(Outside Temperature – Inside Temperature)/(3600)

= 62.5 Kwh/day

3. Occupancy Load

Q = persons* Time* Heat/1000

= 4 Kwh/day

4. Lighting Load

Q = Lamps* Time* Wattage/1000

= 1 Kwh/day

5. Equipment Load

Q = Fans* Time* Wattage/1000

= 6 Kwh/day

6. Infiltration Load

Q = Changes* Energy* Volume*(Outside Temperature – Inside Temperature)/3600

= 44.1 Kwh/day

Therefore,

Total Load = Sum of all loads:

256 Kwh/day ans.

4. A cold storage of dimension 10mx5mx3m. Outside and inside temperatures are 30°C and 6°C, while the floor temperature is 8°C. Overall heat transfer coefficient is 0.37 w/sqm°C. 2500 Kgs of apple are to be stored and 4 people work daily for four hours inside the cold storage and each person generates heat of 270 W. Specific heat of apple is 2.2 kJ kg^{-1} $°C^{-1}$. Enthalpy at 30°C DBT and 18.5°C WBT is 63 KJ/Kg of da. Enthalpy at 6°C and 90% RH is 20 KJ/Kg of da. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Find out total load of storage (Consider 2 ACPH and respiration rate of product is 9.1 KJ/Kg/day).

1. Transmission Load
Q = U*A*(Outside Temperature – Inside Temperature) *24/1000
= 0.37*140(30-6)24/1000
= 29.8 Kwh/day.
For floor,
= 0.37*50(30-8)24/1000
= 9.8 Kwh/day
Total Transmission Load = 29.8 +9.8 = 39.6 Kwh/day
2.Product Load
Q = M*C_P*(Outside Temperature – Inside Temperature)/(3600)
= 36.6 Kwh/day
3. Occupancy Load
Q = persons* Time* Heat/1000
= 4.3 Kwh/day

4. Lighting Load

Q = Lamps* Time* Wattage/1000
= 2 Kwh/day

5. Equipment Load

Q = Fans* Time* Wattage/1000

= 4.8 Kwh/day

6. Infiltration Load

Q = Changes* Energy* Volume*(Outside Temperature – Inside Temperature)/3600

= 4.3 Kwh/day

7. Respiration load

Q = Mass X Respiration rate/3600

= 6.3 Kwh/day

Therefore,

Total Load = Sum of all loads = 98 Kwh/day

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration and Air-conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 5th Semester,

End-Sem. Examination

Time: 2 Hour

Course Code: HVA 1503

Max. Marks: 50

Course Name: Chilled water supply system design

Set-A

Section – A

10*01 = 10 Marks

10 objective type questions, each question carries 01 mark.

Q. 1: D
Q. 2: A
Q. 3: B
Q. 4: B
Q. 5: D
Q. 6: A
Q. 7: C
Q. 8: B
Q. 9: C
Q. 10: A

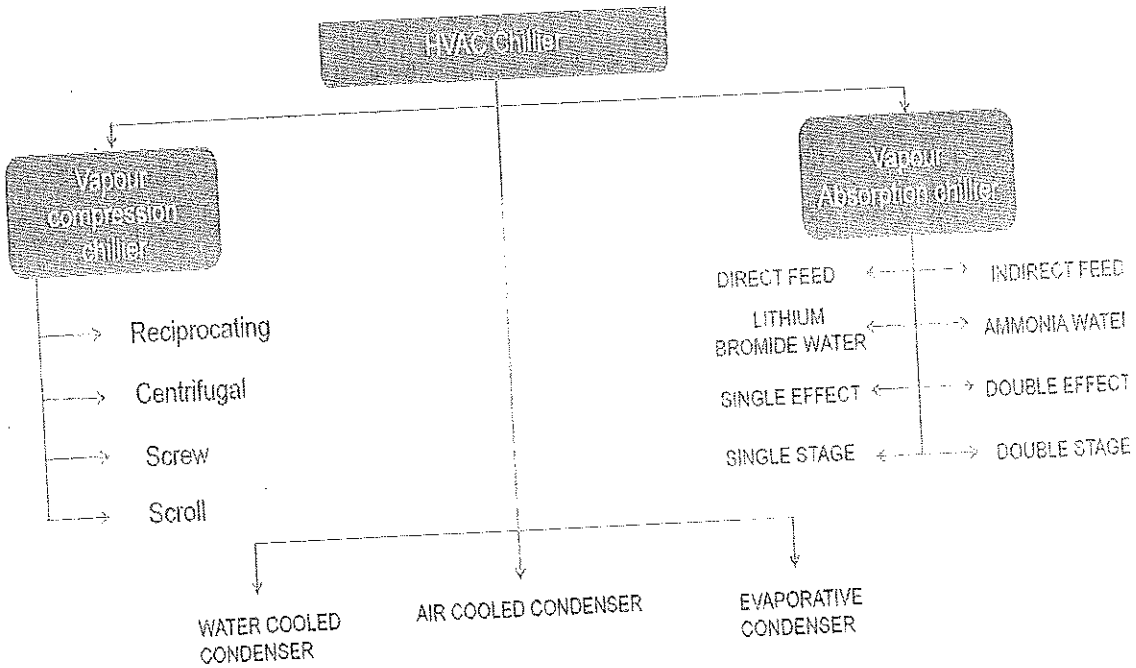
Section – B

4X4 = 16 Marks

4 short answer type questions, each question carries 04 marks.

Q. 1: Classified the HVAC chiller.

Ans.



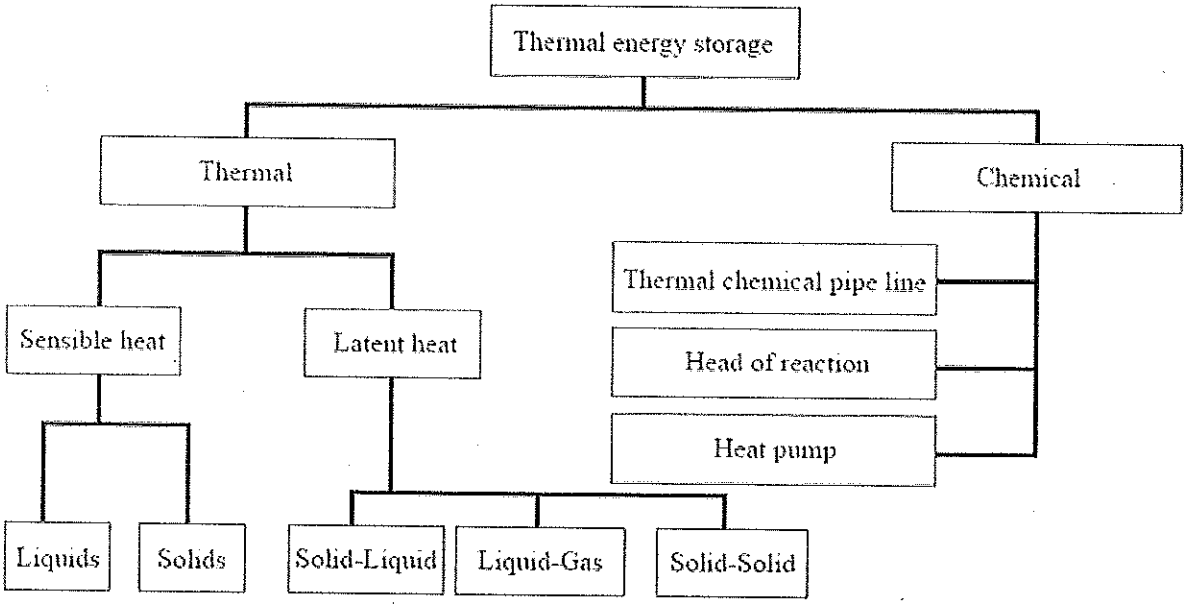
Q. 2: What is the difference between symmetrical and asymmetrical chiller?

Ans. Symmetrical chiller: With this approach, all of the chillers are sized for equal capacity. The number of chillers and, thus, the size of the chiller "module" are based on the minimum anticipated load.

Asymmetrical chiller: There is no engineering rule that says that all chillers in a multichiller system have to be of the same size. While there may be some maintenance advantages (common parts, etc.), different-sized chillers can be operated together.

Q. 3: Explain thermal energy storage system with classification.

Ans. Thermal energy storage (TES) allows the storage of heat and cold, which is used later. TES is also known as heat or cold storage. TES can aid in the efficient use and provision of thermal energy whenever there is a mismatch between energy generation and use. This mismatch can be in terms of time, temperature, power, or site. Different methods for TES are defined and discussed – sensible (air, water, and underground thermal energy storage) and latent (with phase change materials). Cool thermal energy storage (CTES) has recently attracted increasing interest in industrial refrigeration applications, such as process cooling, food preservation, and building air-conditioning systems.



Q. 4: Define the terms with respect to chiller:- off peak period, on peak period, charging and discharging.

Ans. Off peak period represent when the system is not in use while on peak period represent when system is working. Charging represents the off-peak period production of cooling energy by the chiller that is stored, while discharging is the use of that stored energy during the on-peak period.

Section – C

04X06 = 24 Marks

04 essay type questions, each question carries 06 marks.

Q. 1: Explain the water-cooled HVAC system with neat sketch.

Ans.

- Loop 1: Air system: Cold air is distributed by one or more air-handling units (AHUs) to the spaces within the building. The distributed air is returned to the air handling unit, mixed with the required quantity of outdoor air for ventilation.
- Loop 2: Chilled water system: The warmer-returned chilled water enters the water chiller where it is cooled to the desired chilled water supply temperature by transferring the heat extracted from the building spaces to a primary refrigerant.
- Loop 3: Condenser water system: The heat of compression must then be added to the heat load on the chilled water loop to establish the amount of heat that must be rejected by the condenser to a heat sink, typically the outdoor air.

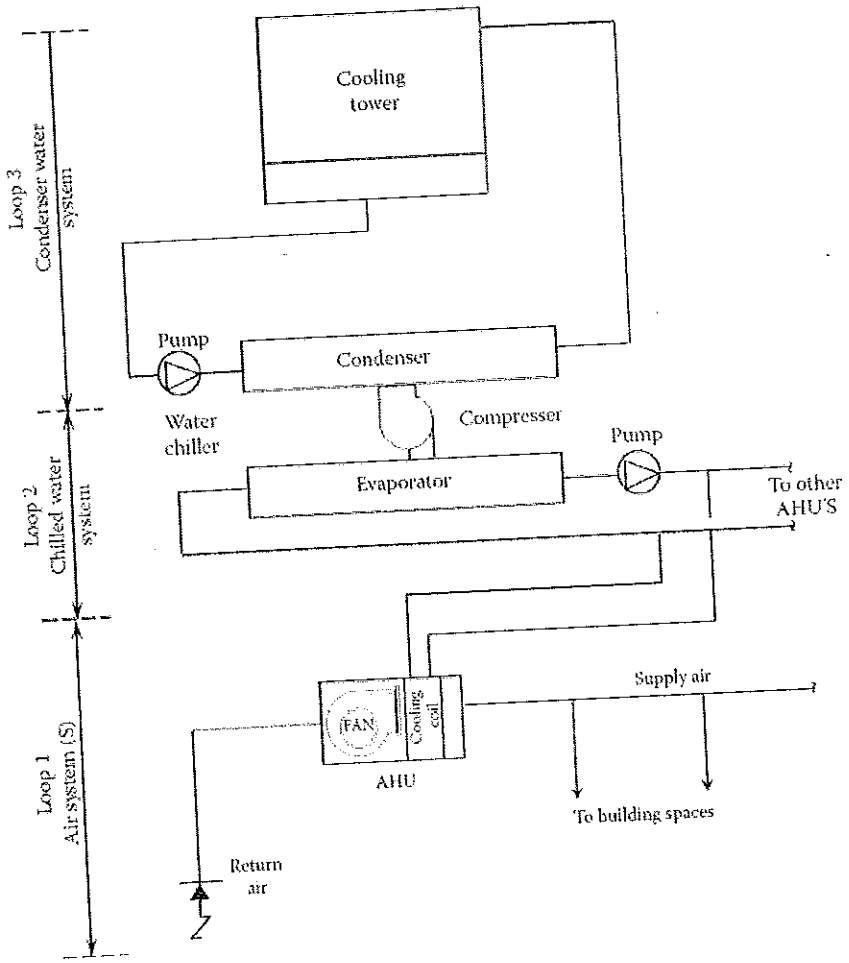
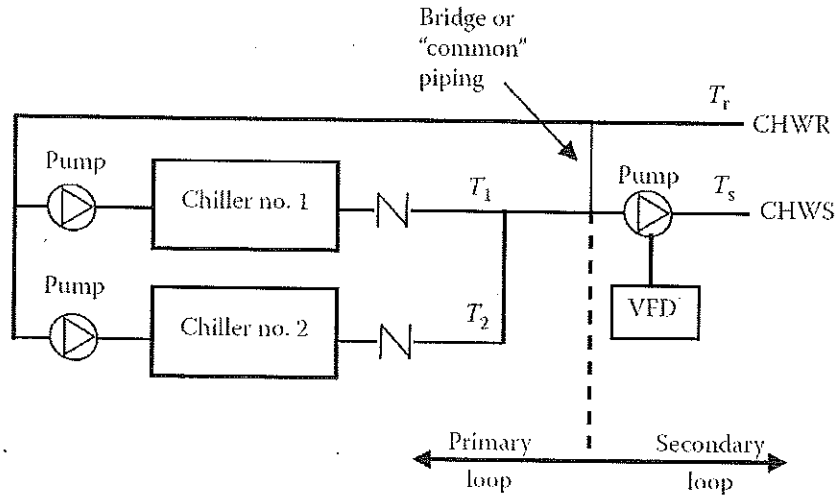


Fig. Water-cooled HVAC system

Q. 2: Explain primary and secondary parallel configuration with neat sketch.

Ans. In the primary–secondary variable flow piping arrangement, here, the production loop (primary loop) through the two chillers is hydraulically isolated from the distribution loop (secondary loop) by a piping bridge. The bridge is a short section of piping shared by both loops and designed to have little or no pressure drop. Thus, the flow in one loop is not affected by flow in the other. On the primary or production loop side, the system acts as multiple-pump parallel chiller installation, as described earlier. Flow in this loop varies in "steps" as the chillers are staged on or off and their respective pumps are started and stopped. However, in the secondary or distribution loop, the cooling coils utilize two-way control valves and the distribution pump(s) utilize a variable frequency drive(s) (VFD) so that the chilled water flow rate is modulated from 0% to 100% of peak design flow as a function of the imposed cooling load. Thus, this loop has fully variable flow, but maintains a constant temperature range.



Q. 3: Write down the various piping materials used in chiller plant.

Ans. Chilled water distribution systems are assembled from commercially available piping materials, most commonly steel and copper.

Steel pipe: This is the most common above-ground piping type and is defined by its wall thickness, called schedule, and its finish. Up through 10″ pipe size, Schedule 40 piping is normally used for chilled water (and condenser) water applications.

Copper tubing: The cost of copper tubing is higher than that of a steel pipe, but the installation labor cost for smaller sizes, 2″ and smaller, is much less than that of steel.

Therefore, most designers will allow copper tubing to be used in water systems for these smaller sizes at the contractor's option.

The wall thickness of copper tubing is indicated by its *type*, defined as Types K, L, and M in decreasing order of wall thickness. Typically, Type K or L tubing can be used for chilled water piping, but Type M copper tubing is not rated as for pressure service and can be used only for drain lines or other atmospheric pressure applications.

PVC or CPVC: As an alternative to iron piping for underground chilled water distribution, polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) piping can be used. PVC and CPVC piping wall thickness is defined in terms of schedules, much like steel pipe.

Cast or ductile iron

- For underground piping, cast iron piping or ductile iron piping is routinely used.
- Iron piping is rated for application in terms of "pressure class".
- for most chilled water systems, Class 350 is used up through 12″ pipe size,
- Class 250 for 14–20″ pipe, and
- Class 150 for piping 24″ and larger.
- Fittings are cast gray or ductile iron and the fittings and piping are assembled with gasketed mechanical pressure joints.

Q. 4: Explain vapour absorption refrigeration cycle with neat sketch.

Ans. In this system, the vapour refrigerant from the evaporator is drawn into an absorber where it is absorber by weak solution of the refrigerant forming a strong solution. This strong solution is pumped to the generator where it is heated by some external source (waste heat or solar energy). During the heating process, the vapour refrigerant is driven off by the solution and enters into the condenser where it is liquified. The liquid refrigerant then flows into the evaporator and thus the cycle is completed. The vapour absorption system uses heat energy, instead of mechanical energy as in VCRC. In VARS, the compressor is replaced by an absorber, a pump, a generator and a pressure reducing valve. These components in VARS perform the same function as that of a compressor in VCRC system.

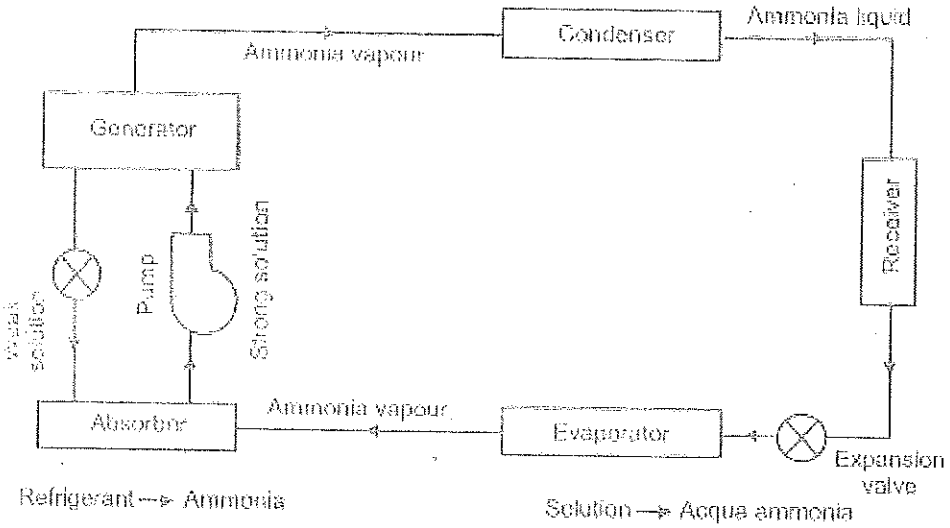


Fig. Vapour absorption refrigeration system

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2021-22 (Summer Semester)

B. Voc. 5th Semester

End-Sem. Examination

Course Code: HVA1501 **Time: 2 Hours**

Course Name: Heat Load Estimation **Max. Marks: 50**

Instruction: Attempt all questions

Calculator is allowed

SET-B

Section – A

10X01 = 10 Marks

1. Which of the following is not a requirement for vapor barrier?:
   a) Durability b) Strength c) Rigidity d) None of the above

2. The rate of convection heat transfer depends on the _____difference:
   a) Temperature
   b) moisture
   c) Pressure
   d) None of the above
3. Dependency on the wavelength is referred to as –
   a) Spectral
   b) Specular
   c) Both A&B
   d) None of the above
4. Which of the following is not a radiation property?
   a) Absorptance
   b) Emittance
   c) Conductance
   d) Reflectance
5. Which of the following is not an infiltration method:
   a)Air change method
   b)Effective leakage area Method
   c)Ventilation method
   d)None of the above
6. Poorly designed or installed systems can have leakage rates of
   a) 50%to60% b) 70%-80% c) 20%-40% d) 10% to 30%.
7. Temperature affiliated to solar irradiation is called:
   a) Air temperature b) Irradiation temperature c) sol-air temperature d) none of the above
8. Stacking is caused by:
   a) Exfiltration
   b) Infiltration
   c) Pressure difference
   d) All of the above

9. Which of the following Law's determine intensity
   a) Planck's Law
   b) Charles Law
   c) Boyle's Law
   d) none of the above
10. DHW stands for:
    a) Domestic Hot Water
    b) Domestic Heat Wavelength
    c) Domestic High Water
    d) none of the above

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Section – B

04X04 = 16 Marks

1. What are impacts of building envelope?
2. What are human requirements for buildings?
3. What is Infiltration gain?
4. What is view factor? Explain with diagram

Section – C

04X06 = 24 Marks

1. A shop(Type D) owner is considering replacing the shop's present fluorescent fixtures (90 bulbs at 35 W each with magnetic ballast) with either new T-8 lamps (with electronic ballast) or 6000 W of incandescent bulbs to highlight the products. The shop is open from 8:00am until 9:00pm, seven days per week. Determine the sensible heat gain at 10:00 am, 3:00pm and 8:00pm for all three scenarios. Use this data to discuss briefly how each might affect the cooling load on the space, and make a recommendation to the owner from a thermal system design perspective.
2. What is wind and stack effects? Explain.
3. What are the cooling system gains?
4. What is effective leakage area method?

Cooling Load Factors for Lights[1]

Lights On For	Number of Hours after Lights Turned On																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Zone Type A																								
8	0.85	0.92	0.95	0.96	0.97	0.97	0.97	0.98	0.13	0.06	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
10	0.85	0.93	0.95	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.14	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
12	0.86	0.93	0.96	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.14	0.07	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
14	0.86	0.93	0.96	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.15	0.07	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.02
16	0.87	0.94	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.15	0.08	0.05	0.04	0.03	0.03	0.03	0.02
Zone Type B																								
8	0.75	0.85	0.90	0.93	0.94	0.95	0.95	0.96	0.23	0.12	0.08	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01
10	0.75	0.86	0.91	0.93	0.94	0.95	0.95	0.96	0.96	0.97	0.24	0.13	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02
12	0.76	0.86	0.91	0.93	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.24	0.14	0.09	0.07	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03
14	0.76	0.87	0.92	0.94	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.25	0.14	0.09	0.07	0.06	0.05	0.05	0.04	0.04	0.03
16	0.77	0.88	0.92	0.95	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.25	0.15	0.10	0.07	0.06	0.05	0.05	0.04
Zone Type C																								
8	0.72	0.80	0.84	0.87	0.88	0.89	0.90	0.91	0.23	0.15	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03
10	0.73	0.81	0.85	0.87	0.89	0.90	0.91	0.92	0.92	0.93	0.25	0.16	0.13	0.11	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04
12	0.74	0.82	0.86	0.88	0.90	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.26	0.18	0.14	0.12	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05
14	0.75	0.84	0.87	0.89	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.27	0.19	0.15	0.13	0.11	0.10	0.09	0.08	0.08	0.07
16	0.77	0.85	0.89	0.91	0.92	0.93	0.93	0.94	0.95	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.28	0.20	0.16	0.13	0.12	0.11	0.10	0.09
Zone Type D																								
8	0.66	0.72	0.76	0.79	0.81	0.83	0.85	0.86	0.25	0.20	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04
10	0.68	0.74	0.77	0.80	0.82	0.84	0.86	0.87	0.88	0.90	0.28	0.23	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06
12	0.70	0.75	0.79	0.81	0.83	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.30	0.25	0.21	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08
14	0.72	0.77	0.81	0.83	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.32	0.26	0.23	0.20	0.18	0.16	0.14	0.13	0.12	0.10
16	0.75	0.80	0.83	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.96	0.34	0.28	0.24	0.21	0.19	0.17	0.15	0.14

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2021-22 (Summer Semester)

B. Voc. 5th Semester

End-Sem. Examination

Course Code: HVA1501 **Time: 2 Hours**

Course Name: Heat Load Estimation **Max. Marks: 50**

Instruction: Attempt all questions

Calculator is allowed

SET-B

Section – A

10X01 = 10 Marks

1. D
2. A
3. B
4. C
5. C
6. D
7. C
8. B
9. A
10. A

Section – B

04X04 = 16 Marks

1. Barrier between conditioned inside air and unconditioned outside air .Significant impact on passive heat lost and gained by the building.Passive heat transfer increases the load on the HVAC system

2. A fully insulated thermal envelope.

- A well-sealed air barrier.
- The thermal and air boundaries to be continuous and in contact with one another.
- Efficient, properly sized equipment to condition the living space and heat water.
- A well-designed and balanced distribution system.

3. Infiltration is the process of air coming into the house from the outdoors. There are many factors that can cause infiltration such as windy days, a large temperature difference from indoors and out, and the stack effect. There are two main forces driving infiltration: the prevailing wind and natural draft.

4. The effect of view angle between the energy source and receiver is shown.

- As the angle between the hot surface and cold surface decreases, more of the available energy is transferred between the two plates. The maximum radiant heat transfer occurs when the two plates are parallel.
- This geometry frequently occurs in buildings (double-pane glazings, hollow core walls, suspended ceilings and roofs, etc.).

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Section – C

04X06 = 24 Marks

1. The indicated zone type is B. The total installed wattage is 6 (bulbs)·34W/ bulb)= 204 W.

- The use factor is 1.0 (all lights are on) and the special allowance factor is 1.2.
- The CLF from Table for zone type B, 8 h on, 6 h after being turned on is 0.95. The values at 4 pm and 6 pm are 0.96 and 0.12, respectively. Therefore the sensible heat gains are as shown in the following table:

	Btu/W	W	F_{ul}	F_{sa}	(CLF_{el})	q_{el}	
at 2 pm:	3.41	204	1	1.2	0.95	793	Btu/h
at 4 pm:	3.41	204	1	1.2	0.96	801	Btu/h
at 6 pm:	3.41	204	1	1.2	0.12	100	Btu/h

2. Hot air rises through the building and escapes through cracks in the top ceiling. This causes cold outside air to be drawn in low (around the sole plate, basement windows or crawlspace access).

- While some outside air is necessary for fired equipment that is usually located in the basement (dryer, water heater, furnace, etc.), it is better to provide this air directly to the mechanical room.
- This helps to reduce drafts in the building caused by these devices. This stack effect becomes very pronounced in high-rise buildings, often causing noisy elevator and stair doors, where air is drawn into (or out of) these vertical shafts.

3. Depending on the type of system installed, this heat gain will affect the system differently. For example, if the fan is in front of the cooling coil (blow-through), then the coil will remove the energy immediately, but the space load will be unaffected. However, when the fan is after the cooling coil (drawthrough), these losses become heat gains to the system. Either the supply air temperature must be reduced slightly, or the air flow through the system must be increased slightly to compensate for this energy gain.

4. The second method to determine the rate of air infiltration is based on the effective leakage area of various construction components used in both residential and commercial buildings.

- To obtain the building's total leakage area, multiply the overall dimensions or number of occurrences of each building component by the Leakage related to them.

$$Q = L\left(A\Delta T + BV^2\right)^{0.5}$$

where,

Q = air flow rate, cfm

L = effective leakage area, in.^{2}

A = stack effect coefficient, cfm^2/(in.^{4}·°F)

ΔT = average indoor-outdoor temperature difference, °F

B = wind coefficient, cfm^2/(in.^{4}·mph^2)

V = average wind speed, mph

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Without Answer key

School of Refrigeration & Air Conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: HVA1502 Time: **2 Hours**

Course Name: Cold Chain & Cold Storage Max. Marks: 50

SET-A

Instruction:

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. What is food preservation?
   a. Retaining food over a period of time
   b. Distribution food over a period of time
   c. Harvesting food over a period of time
   d. None of the above

2. causes of food deterioration and spoilage are-.
   a. Mechanical effects
   b. Physical effects
   c. Microbial effects
   d. All of the above

3. Which of the following is food preservation method?
   a. Inhibition
   b. Inactivation
   c. Avoid recontamination
   d. All of the above

4. What is the goal of a cold storage?
   a. Slow the biological activity of fruits
   b. Slow the growth of microorganisms
   c. a & b both
   d. None of the above

5. Factors to be considered for successful produce storage are-.
   a. Temperature
   b. Relative humidity
   c. Air movement
   d. All of the above

6. Which of the following is not a pre harvesting factor for foods?
   a. Genetic
   b. Maturity
   c. Climatic
   d. Cultural

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7. LIFO stands for-.
   a. Last in first out
   b. Late in first out
   c. Low in full out
   d. None of the above
8. 7200 KJ equal to-.
   a. 2 KWh
   b. 3 KWh
   c. 4 KWh
   d. 5 KWh
9. In which direction cold air spills out?
   a. Upward
   b. Downward
   c. Horizontal
   d. None of the above
10. Which of the following is known as constant pressure type valve?
   a. Capillary tube
   b. Thermostatic expansion valve
   c. Automatic expansion valve
   d. Float type valve

Section – B

04X04 = 16 Marks

1. Write down the definition of food and food preservation.
2. Write down the different food preservation methods through flow diagram.
3. What are the climacteric and non- climacteric type fruit?
4. Write a short note on cold store doors.

Section – C

04X06 = 24 Marks

1. Write down the importance of insulation materials and explain the different types of insulation materials.
2. Explain the working of Thermostatic expansion valve with the help of diagram in detail.
3. Following data given for a cold room:

   Store Dimensions: 15mX10mX5m. Over all U Value - 0.35 w/sqm°C. Outside Design Conditions: 35°C DBT, 20°C WBT (Enthalpy = 66 KJ/Kg), Inside Design Conditions: 4°C+/-1 °C, 75%RH (Enthalpy = 13 KJ/Kg). Product: Daily 2500Kg/24 hrs coming at 35°C with specific heat 3.0 KJ/Kg°C and 2APCH. Consider 4 men working for 4 hours daily. 4 fans are used of motor capacity 150 W each and run for 10 hours. 4 Lamps are used of capacity 50 W each and run for 5 hours. Each cubic meter of new air provides 2KJ/cm°C. Find out total load.

4. A cold storage of dimension 10mx5mx3m. Outside and inside temperatures are 30°C and 6°C, while the floor temperature is 8°C. Overall heat transfer coefficient is 0.37 w/sqm°C. 2500 Kgs of apple are to be stored and 4 people work daily for four hours inside the cold storage and each person generates heat of 270 W. Specific heat of apple is 2.2 kJ kg^{-1} $°C^{-1}$. Enthalpy at 30°C DBT and 18.5°C WBT is 63 KJ/Kg of da. Enthalpy at 6°C and 90% RH is 20 KJ/Kg of da. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Find out total load of storage (Consider 2 ACPH and respiration rate of product is 9.1 KJ/Kg/day).

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Refrigeration & Air Conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Time: **2 Hours**

Course Code: HVA1502

Max. Marks: 50

Course Name: Cold Chain & Cold Storage

SET-B

Instruction:

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Factors Considered in the Design of Evaporators:
   a. Heat transfer
   b. Air velocity
   c. a & b both
   d. None of the above

2. Air cooled condensers are more efficient than water cooled condensers.
   a. True
   b. False
   c. Not Comparable
   d. Depends on machine capacity

3. Temperature range maintained in a walk-in freezer is-.
   a. -15 to -25 °C
   b. +2 to +8 °C
   c. +5 to +15 °C
   d. None of the above

4. A Servo Controlled Voltage Stabilizer provides-.
   a. Constant Voltage
   b. Constant Current
   c. a & b both
   d. None of the above

5. Temperature range maintained in a ice lined refrigerator is-.
   a. -15 to -25 °C
   b. +2 to +8 °C
   c. +5 to +15 °C
   d. None of the above

6. The Cold Chain involves the transportation of-.
   a. Temperature sensitive product
   b. Non temperature sensitive product
   c. a & b both
   d. none of the above

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

7. Power consumption in induced draft cooling tower fan is higher than forced draft cooling tower fan-.

a. True
b. False
c. Equal
d. Not comparable

8. In DX chiller refrigerant flows through-.

a. Tubes
b. Shell
c. a & b both
d. None of the above

9. Food preservation is done for-.

a. Maintaining nutritious
b. Maintaining flavor
c. Maintaining texture
d. All of the above

10. Damage of food product may start in-.

a. Harvesting
b. Distribution
c. Processing
d. All of the above

Section – B

04X04 = 16 Marks

1. Write down the cold chain management with the help of flow diagram.
2. Write down the cause of deterioration and spoilage for food.
3. What are the climacteric and non- climacteric type fruit?
4. What are the main purposes of using cold storages?

Section – C

04X06 = 24 Marks

1. Explain the different types of air conditioning systems with the help of line diagram in detail.
2. Explain the evaporator and its types in detail.
3. Store Dimensions: 10mX6mX3m. Over all U Value - 0.24 w/sqm°C. Outside Design Conditions: 40°C DBT, 25°C WBT (Enthalpy = 94 KJ/Kg), Inside Design Conditions: 4°C+/-1 °C, 75%RH (Enthalpy = 13 KJ/Kg). Product: Daily 3000Kg/24 hrs coming at 30°C. Consider 2 men working for 4 hours daily. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Consider specific heat of product is 2.5 KJ/Kg°C and 2 ACPH. Find out total load.
4. A cold storage of dimension 10mx5mx3m. Outside and inside temperatures are 30°C and 6°C, while the floor temperature is 8°C. Overall heat transfer coefficient is 0.37 w/sqm°C. 2500 Kgs of apple are to be stored and 4 people work daily for four hours inside the cold storage and each person generates heat of 270 W. Specific heat of apple is 2.2 kJ $kg^{-1}\,°C^{-1}$. Enthalpy at 30°C DBT and 18.5°C WBT is 63 KJ/Kg of da. Enthalpy at 6°C and 90% RH is 20 KJ/Kg of da. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Find out total load of storage (Consider 2 ACPH and respiration rate of product is 9.1 KJ/Kg/day).

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Refrigeration & Air Conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: HVA1502 Time: **2 Hours**

Course Name: Cold Chain & Cold Storage Max. Marks: 50

ANSWER KEY-B

Section – A

10X01 = 10 Marks

1. Factors Considered in the Design of Evaporators:
   a. Heat transfer
   b. Air velocity
   c. a & b both
   d. None of the above

2. Air cooled condensers are more efficient than water cooled condensers.
   a. True
   b. False
   c. Not Comparable
   d. Depends on machine capacity
3. Temperature range maintained in a walk-in freezer is-.
   a. -15 to -25 °C
   b. +2 to +8 °C
   c. +5 to +15 °C
   d. None of the above

4. A Servo Controlled Voltage Stabilizer provides-.

   a. Constant Voltage
   b. Constant Current
   c. a & b both
   d. None of the above
5. Temperature range maintained in a ice lined refrigerator is-.

   a. -15 to -25 °C
   b. +2 to +8 °C
   c. +5 to +15 °C
   d. None of the above
6. The Cold Chain involves the transportation of-.
   a. **Temperature sensitive product**
   b. Non temperature sensitive product
   c. a & b both
   d. none of the above
7. Power consumption in induced draft cooling tower fan is higher than forced draft cooling tower fan-.

   a. True
   b. False
   c. Equal
   d. Not comparable

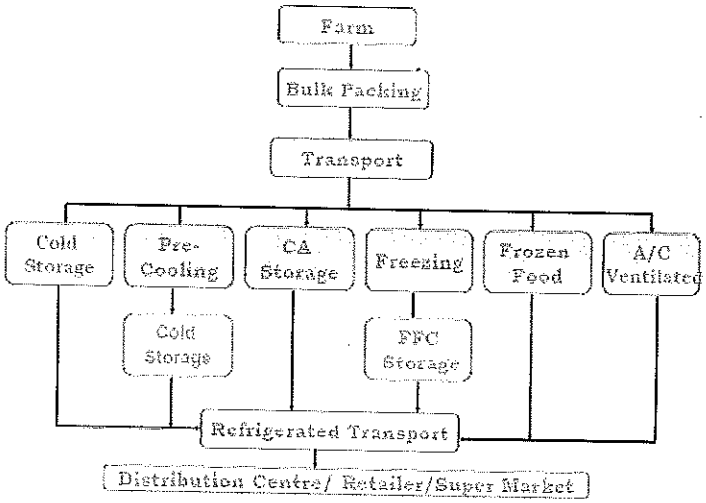
8. In DX chiller refrigerant flows through-.
   a. Tubes
   b. Shell
   c. a & b both
   d. None of the above
9. Food preservation is done for-.
   a. Maintaining nutritious
   b. Maintaining flavor
   c. Maintaining texture
   d. All of the above

10. Damage of food product may start in-.
    a. Harvesting
    b. Distribution
    c. Processing
    d. All of the above

Section – B

04X04 = 16 Marks

1. Write down the cold chain management with the help of flow diagram.



2. Write down the cause of deterioration and spoilage for food.

   Mechanical, physical, chemical, and microbial effects are the leading causes of food deterioration and spoilage. Damage can start at the initial point by mishandling of foods during harvesting, processing, and distribution; this may lead to ultimate reduction of shelf life.

3. What are the climacteric and non- climacteric type fruit?

   Climacteric fruits

   Those in which ripening is associated with a distinct increase in respiration and ethylene production, the respiration rate rising up to the climacteric peak and then declining. Such an increase can occur either while the fruit is attached to or separated from the plant. A further distinguishing feature is that treatment of climacteric fruits

with ethylene or propylene stimulates both respiration and autocatalytic ethylene production. Low temperatures greatly reduce the magnitude of the climacteric. The climacteric generally coincides with changes associated with ripening such as colour changes, softening, increased tissue permeability, and the development of characteristic aromas. Typical climacteric fruits include apples, pears, peaches, nectarines, bananas, mangoes, plums, tomatoes, and avocadoes.

Non-Climacteric fruits

In non climacteric fruits, ripening is protracted and the attainment of the ripe state is not associated with a marked increase in respiration or ethylene production.

Treatment of non climacteric fruits with ethylene stimulates respiration only; there is no increase in autocatalytic ethylene production. Fruits such as citrus, strawberries, and pineapples are non climacteric.

4. What are the main purposes of using cold storages?

The main goals of storage include the following:

1. Slow the biological activity of fruits and vegetables without chilling injury.
2. Slow the growth of microorganisms.
3. Reduce transpirational losses to avoid the following undesirable processes that may occur in certain fruits and vegetables:

a. *Sprouting*: potatoes, onions, ginger, garlic

b. *Elongation*: asparagus, carrots, beets, kohlrabi

c. *Rotting*: due to increased humidity that may result in rapid decay, shriveling, and exhaustion of food reserves

d. *Greening*: exposure of potatoes to light during storage may produce green tissue and synthesis of toxic glycoalkaloids such as solanine and chaconine

e. *Toughening*: green beans and sweet corn due to prolonged storage at relatively high temperatures

Section – C

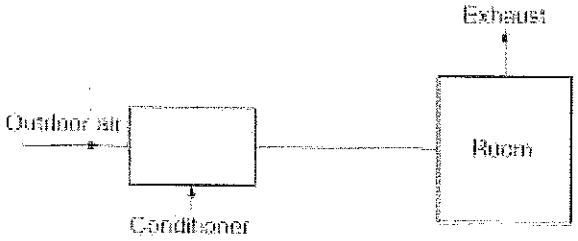
04X06 = 24 Marks

1. Explain the different types of air conditioning systems with the help of line diagram in detail.

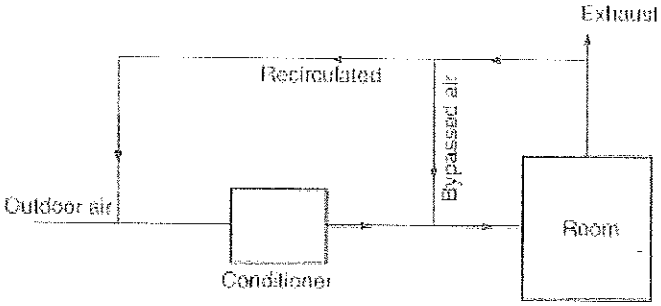
Types of Air-Conditioning Systems for the Cold Storages

1. All Fresh Air
2. Recirculated Air
3. Recirculated Air with Reheat Coil
4. Recirculated Air Used for Heating the Air Coming out of the Conditioner

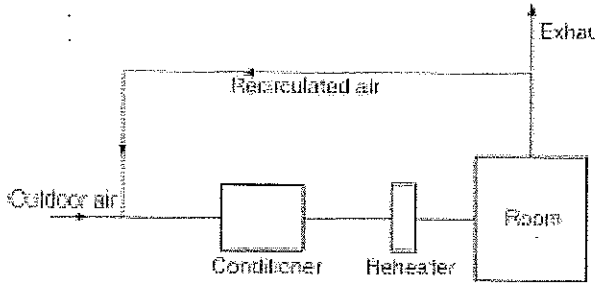
All Fresh Air



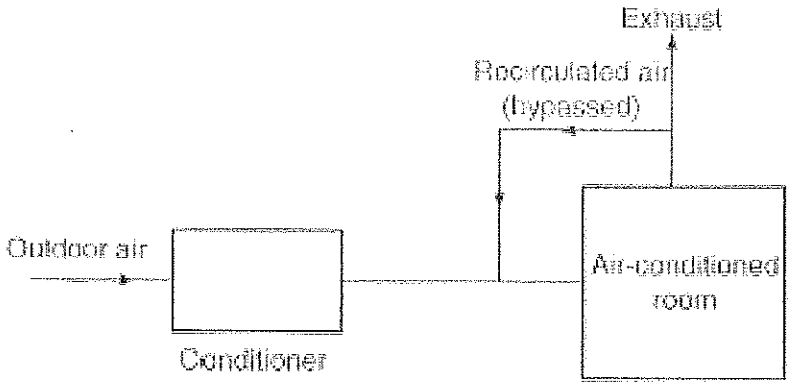
Recirculated Air



Recirculated Air with Reheat Coil



Recirculated Air Used for Heating the Air Coming out of the Conditioner



2. Explain the evaporator and its types in detail.

Evaporator is an important component together with other major components in a refrigeration system such as compressor, condenser and expansion device. The reason for refrigeration is to remove heat from air, water or other substance. It is here that the liquid refrigerant is expanded and evaporated. It acts as a heat exchanger that transfers heat from the substance being cooled to a boiling temperature.

D-X system: (a) Flooded or Direct Expansion (b) Dry Expansion Evaporators

Flooded or Direct Expansion

In flooded evaporators, the liquid refrigerant covers the entire heat transfer surface. In dry evaporators, a part of the heat transfer surface is used for superheating the vapor. A float valve is used for the expansion of the refrigerant in the case of a flooded evaporator, whereas a thermostatic expansion valve or a capillary tube (in case of small units) is used in conjunction with a dry evaporator. A distinction can also be made on the basis of the flow of refrigerant inside tubes in dry evaporators and outside tubes in flooded evaporators. The direct-expansion evaporators are also called D-X evaporators. Different types of D-X evaporators include the following:

1. Direct-expansion chiller
2. Direct-expansion cooling coil for air with forced convection
3. Direct-expansion coil for air blast freezer
4. Natural convection evaporator for freezers of domestic refrigerators
5. Evaporator coils submerged in brine tanks for ice plants

D-X Coil-Type Dry Evaporator

This type of evaporator with fins on the airside is used in air-conditioning equipment. Large D-X evaporators have more than one refrigerant circuit, otherwise the pressure will become too great. The name *direct-expansion* is derived from the fact that the refrigerant expands directly inside the tubing and evaporates, thus cooling the medium outside. To facilitate the return of oil to the compressor, D-X evaporators are fed from the top by a thermostatic expansion valve.

3. Store Dimensions: 10mX6mX3m. Over all U Value - 0.24 w/sqm°C. Outside Design Conditions: 40°C DBT, 25°C WBT (Enthalpy = 94 KJ/Kg), Inside Design Conditions: 4°C+/-1°C, 75%RH (Enthalpy = 13 KJ/Kg). Product: Daily 3000Kg/24 hrs coming at 30°C. Consider 2 men working for 4 hours daily. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Consider specific heat of product is 2.5 KJ/Kg°C and 2 ACPH. Find out total load.

1. Transmission Load

Q = U*A*(Outside Temperature – Inside Temperature) *24/1000

= 44.7 Kwh/day

2.Product Load

Q = M*C_P*(Outside Temperature – Inside Temperature)/(3600)

= 54.1 Kwh/day

3. Occupancy Load

Q = persons* Time* Heat/1000

= 2.2 Kwh/day

4. Lighting Load

Q = Lamps* Time* Wattage/1000

= 2 Kwh/day

5. Equipment Load

Q = Fans* Time* Wattage/1000

= 4.8 Kwh/day

6. Infiltration Load

Q = Changes* Energy* Volume*(Outside Temperature – Inside Temperature)/3600

= 10.5 Kwh/day

Therefore,
Total Load = Sum of all loads:
118.3 Kwh/day ans.

4. A cold storage of dimension 10mx5mx3m. Outside and inside temperatures are 30°C and 6°C, while the floor temperature is 8°C. Overall heat transfer coefficient is 0.37 w/sqm°C. 2500 Kgs of apple are to be stored and 4 people work daily for four hours inside the cold storage and each person generates heat of 270 W. Specific heat of apple is 2.2 kJ kg^{-1} $°C^{-1}$. Enthalpy at 30°C DBT and 18.5°C WBT is 63 KJ/Kg of da. Enthalpy at 6°C and 90% RH is 20 KJ/Kg of da. 4 fans are used of motor capacity 120 W each and run for 10 hours. 4 Lamps are used of capacity 100 W each and run for 5 hours. Find out total load of storage (Consider 2 ACPH and respiration rate of product is 9.1 KJ/Kg/day).

1. Transmission Load
Q = U*A*(Outside Temperature – Inside Temperature) *24/1000
= 0.37*140(30-6)24/1000
= 29.8 Kwh/day.
For floor,
= 0.37*50(30-8)24/1000
= 9.8 Kwh/day
Total Transmission Load = 29.8 +9.8 = 39.6 Kwh/day
2.Product Load
Q = M*C_P*(Outside Temperature – Inside Temperature)/(3600)
= 36.6 Kwh/day
3. Occupancy Load
Q = persons* Time* Heat/1000
= 4.3 Kwh/day

4. Lighting Load

Q = Lamps* Time* Wattage/1000
= 2 Kwh/day

5. Equipment Load

Q = Fans* Time* Wattage/1000

= 4.8 Kwh/day

6. Infiltration Load
Q = Changes* Energy* Volume*(Outside Temperature – Inside Temperature)/3600

= 4.3 Kwh/day

7. Respiration load

Q = Mass X Respiration rate/3600

= 6.3 Kwh/day

Therefore,
Total Load = Sum of all loads = 98 Kwh/day

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration and Air-conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 5th Semester,

End-Sem. Examination

without answer key

Course Code: HVA1503 **Time: 2 Hour**

Course Name: Chilled water supply system design **Max. Marks: 50**

Set-A

Section – A

10*01 = 10 Marks

Note: Each question carries 01 mark.

Q. 1: The purge unit in a low-pressure chiller removes

A. overcharge of refrigerant.
B. excess oil.
C. condensable refrigerant.
D. non-condensable

Q. 2: The compressor used in low-pressure chillers is the

A. Centrifugal
B. Screw
C. Rotary
D. Reciprocating

Q. 3: When a chiller is used, the secondary refrigerant that circulates in the building is

A. Air
B. water
C. barine
D. glycol

Q. 4: A vapour absorption refrigeration system

A. gives noisy operation
B. gives quiet operation
C. requires more power consumption
D. have more wear and tear

Q. 5: In aqua-ammonia and Li-Br water absorption refrigeration system, the refrigerants are respectively

A. water and water
B. water and Li-Br
C. ammonia and Li-Br
D. ammonia and water

Q. 6: The commonly used refrigerant in ice plant is

A. NH_3
B. CO_2
C. R-12
D. none of these

Q. 7: Efficiency of Electric-drive air-cooled scroll chiller is

A. 1.6
B. 1.9
C. 3.25
D. 5.8

Q. 8: Chillers operate efficiently in range of

A. 30% to 60% load
B. 40% to 80% load
C. 20% to 50% load
D. 10% to 70% load

Q. 9: Pipe schedule 40 is used for

A. Less than 18-inch pipe size
B. Less than 20-inch pipe size
C. Less than 10-inch pipe size
D. Less than 14-inch pipe size

Q. 10: The wall thickness of copper tubing is indicated by

A. Types K, L, and M
B. Types A, B, and C
C. Types J, K, and L
D. Types D, E, and F

Section – B

04*04 = 16 Marks

Note: Each question carries 04 mark.

Q. 1: Classified the HVAC chiller.

Q. 2: What are the differences between symmetrical and asymmetrical chiller?

Q. 3: Explain thermal energy storage system with classification.

Q. 4: Define the terms with respect to chiller:- off peak period, on peak period, charging and discharging.

Section – C

04*06 = 24 Marks

Note: Each question carries 06 mark.

Q. 1: Explain the water-cooled HVAC system with neat sketch.

Q. 2: Explain primary and secondary parallel configuration with neat sketch.

Q. 3: Write down the various piping materials used in chiller plant.

Q. 4: Explain vapour absorption refrigeration cycle with neat sketch.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration and Air-conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 5th Semester,

End-Sem. Examination

Course Code: HVA1503 **Time: 2 Hour**

Course Name: Chilled water supply system design **Max. Marks: 50**

Set-B

Section – A

10*01 = 10 Marks

Note: Each question carries 01 mark.

Q. 1: The commonly used refrigerant in ice plant is

A. NH_3
B. CO_2
C. R-12
D. none of these

Q. 2: Efficiency of Electric-drive air-cooled scroll chiller is

A. 1.6
B. 1.9
C. 3.25
D. 5.8

Q. 3: Chillers operate efficiently in range of

A. 30% to 60% load
B. 40% to 80% load
C. 20% to 50% load
D. 10% to 70% load

Q. 4: Pipe schedule 40 is used for

A. Less than 18-inch pipe size
B. Less than 20-inch pipe size
C. Less than 10-inch pipe size
D. Less than 14-inch pipe size

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A. Types K, L, and M
B. Types A, B, and C
C. Types J, K, and L
D. Types D, E, and F

Q. 6: The purge unit in a low-pressure chiller removes

A. overcharge of refrigerant.
B. excess oil.
C. condensable refrigerant.
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A. Centrifugal
B. Screw
C. Rotary
D. Reciprocating

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A. Air
B. water
C. barine
D. glycol

Q. 9: A vapour absorption refrigeration system

A. gives noisy operation
B. gives quiet operation
C. requires more power consumption
D. have more wear and tear

Q. 10: In aqua-ammonia and Li-Br water absorption refrigeration system, the refrigerants are respectively

A. water and water
B. water and Li-Br
C. ammonia and Li-Br
D. ammonia and water

Section – B

04*04 = 16 Marks

Note: Each question carries 04 mark.

Q. 1: Classified the refrigerants with examples.

Q. 2: Explain line mounted and base mounted pumps.

Q. 3: Explain series and parallel chiller system with neat sketch.

Q. 4: Explain one-pump parallel chiller configuration.

Section – C

04*06 = 24 Marks

Note: Each question carries 06 mark.

Q. 1: Compare the vapour absorption refrigeration system over vapour compression refrigeration system.

Q. 2: Explain vapour absorption refrigeration cycle with neat sketch.

Q. 3: Write down the various piping materials used in chiller plant.

Q. 4: Explain thermal energy storage system with classification. Define the terms with respect to chiller:- off peak period, on peak period, charging and discharging.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration and Air-conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 5th Semester,

End-Sem. Examination

Course Code: HVA1503

Time: 2 Hour

Course Name: Chilled water supply system design

Max. Marks: 50

Set-B

Section – A

10*01 = 10 Marks

10 objective type questions, each question carries 01 mark.

Q. 1: A

Q. 2: C

Q. 3: B

Q. 4: C

Q. 5: A

Q. 6: D

Q. 7: A

Q. 8: B

Q. 9: B

Q. 10: D

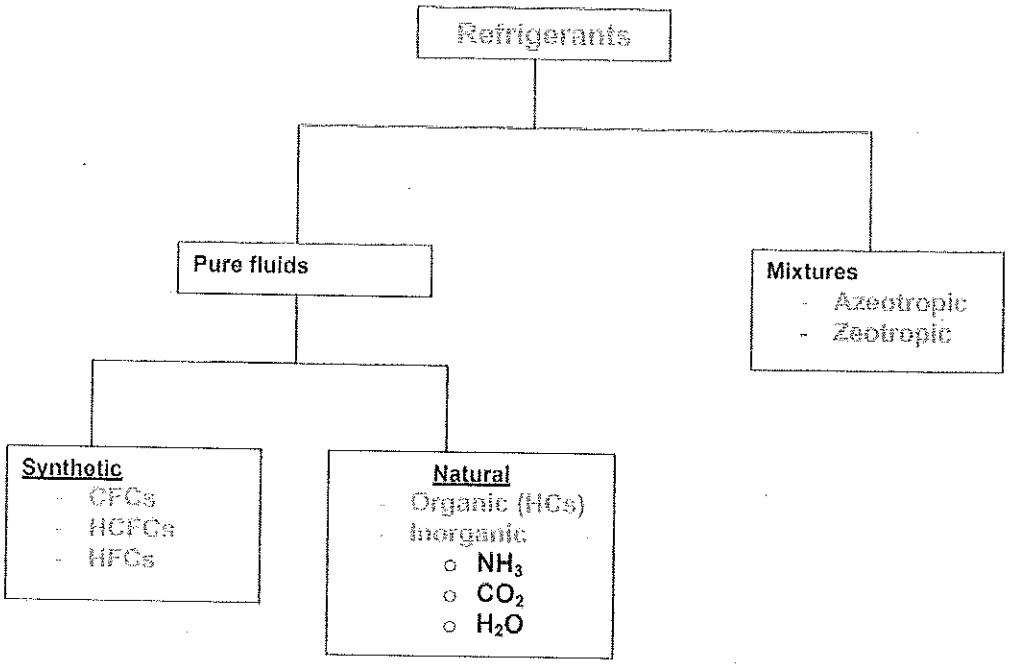
Section – B

4X4 = 16 Marks

4 short answer type questions, each question carries 04 marks.

Q. 1: Classified the refrigerants with examples.

Ans.



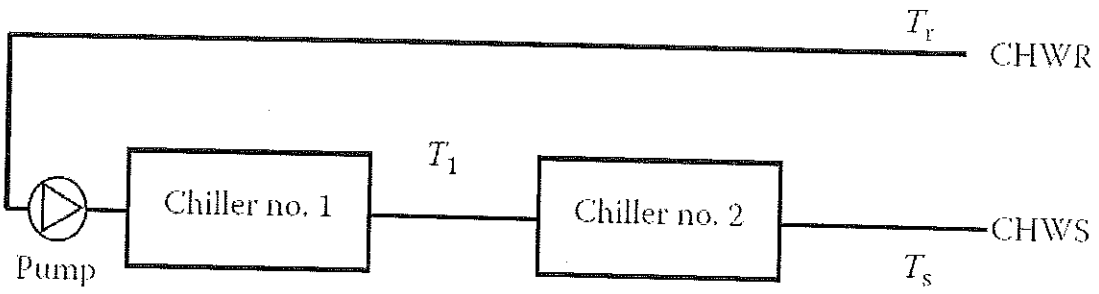
Q. 2: Explain line mounted and base mounted pumps.

Ans. Line-mounted pumps: These pumps can be installed directly in the piping since the suction and discharge connections are arranged 180° apart. The motor and pump shafts, typically, are mounted vertically. The pump may be supported by the piping and/or by additional hangers or a foot stand.

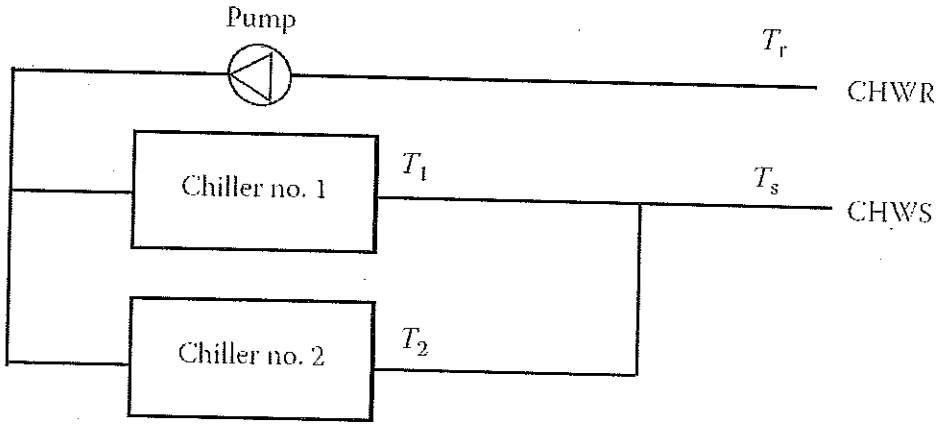
Base-mounted pumps: Base-mounted pumps have the motor and pump shafts mounted horizontally, with both the pump and the motor bolted to a common frame or base. These pumps are available in two configurations.

Q. 3: Explain series and parallel chiller system with neat sketch.

Ans. Series chiller system: In a series configuration with two chillers, each chiller is selected to produce half of the required cooling at the full system flow rate. Thus, half of the total design range is produced by each chiller. Series chiller systems are rarely utilized in present times because this configuration requires a constant chilled water flow rate at all times, resulting in high pumping costs. But, if a relatively large temperature difference is required or if there is a very steady base cooling load, the series configuration may offer some advantages.

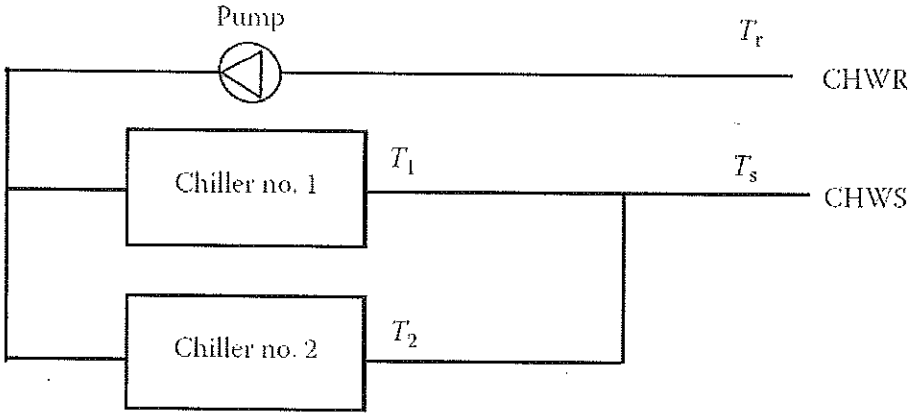


Parallel chiller system: The parallel chiller configuration is far more common. In a two-chiller configuration, each chiller is typically selected to operate with the same design range, but with only a half of the total system flow requirement. This again results in a 50/50 load split, but other load ratios may be selected if dictated by operational requirements. And, there is no real limitation on the number of parallel chillers that can be utilized in one system.



Q. 4: Explain one-pump parallel chiller configuration.

Ans. With this configuration, there is an inherent problem. If both machines were operated for the full-load range (15–100% of peak capacity), by the time the total system load drops to 30% of full load, each individual chiller would be operating very inefficiently. Thus, most designers utilize controls to shut off one chiller when the total system load, as evidenced by the return chilled water temperature, falls below 40% of full load. However, with this piping arrangement, if one chiller is not in operation, chilled water from the operating chiller will mix (blend) with the return water passing through the nonoperating chiller, effectively raising the system's chilled water supply temperature.



Section – C

04X06 = 24 Marks

04 essay type questions, each question carries 06 marks.

Q. 1: Compare the vapour absorption refrigeration system over vapour compression refrigeration system.

Ans.

Advantages of VARS over VCRC

1. In the VARS, the only moving part of the entire system is a pump which has a small motor. Thus, the operation of this system is essentially quiet and is subjected to little wear. The vapour compression system of the same capacity has more wear, tear and noise due to moving parts of the compressor.
2. VARS system uses heat energy to change the condition of refrigerant from the evaporator. The VCRC system uses mechanical energy to change the condition of refrigerant from the refrigerant.
3. The VARS system are usually designed to use steam, either at high pressure or low pressure. The exhaust heat from furnaces and solar energy may also be used. Thus, this system can be used where the electric power is difficult to obtain or is very expensive.
4. The space requirements and automatic control requirements favor the absorption system more and more as the desired evaporator pressure drops.
5. The VARS system can be built in capacities well above 1000 tons of refrigeration each, which is the largest size for single compressor units.
6. The load variations do not affect the performance of VARS system. The performance of a vapour compression system at partial loads is poor.

7. In the VARS system, the liquid refrigerant leaving the evaporator has no bad effect on the system except that of reducing the refrigerating effect. In the VCRC system, it is essential to superheat the vapour refrigerant leaving the evaporator so that no liquid may enter the compressor.

Disadvantage:

1. Less COP
2. More space required
3. More amount of refrigerant is circulated, which increase the running cost.

Q. 2: Explain vapour absorption refrigeration cycle with neat sketch.

Ans. In this system, the vapour refrigerant from the evaporator is drawn into an absorber where it is absorber by weak solution of the refrigerant forming a strong solution. This strong solution is pumped to the generator where it is heated by some external source (waste heat or solar energy). During the heating process, the vapour refrigerant is driven off by the solution and enters into the condenser where it is liquified. The liquid refrigerant then flows into the evaporator and thus the cycle is completed. The vapour absorption system uses heat energy, instead of mechanical energy as in VCRC. In VARS, the compressor is replaced by an absorber, a pump, a generator and a pressure reducing valve. These components in VARS perform the same function as that of a compressor in VCRC system.

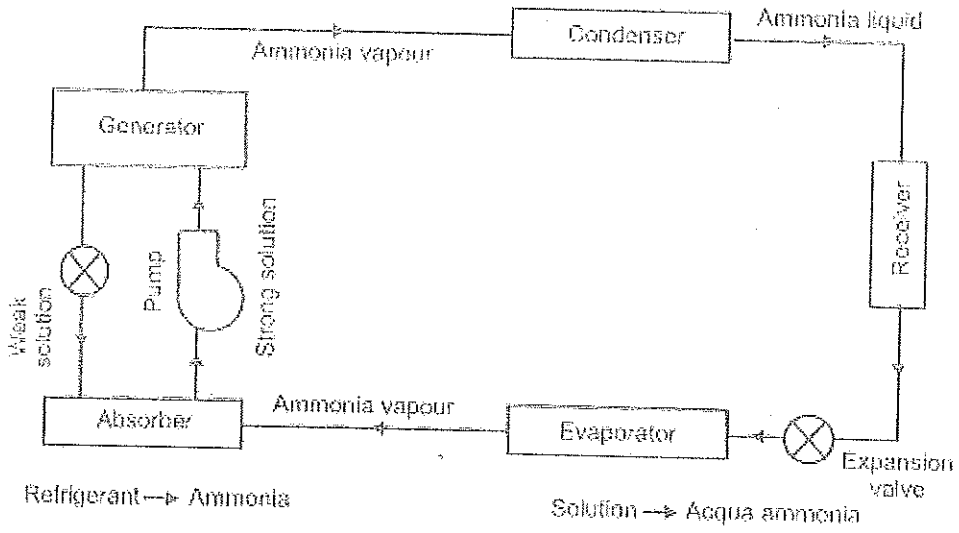


Fig. Vapour absorption refrigeration system

Q. 3: Write down the various piping materials used in chiller plant.

Ans. Chilled water distribution systems are assembled from commercially available piping materials, most commonly steel and copper.

Steel pipe: This is the most common above-ground piping type and is defined by its wall thickness, called schedule, and its finish. Up through 10″ pipe size, Schedule 40 piping is normally used for chilled water (and condenser) water applications.

Copper tubing: The cost of copper tubing is higher than that of a steel pipe, but the installation labor cost for smaller sizes, 2″ and smaller, is much less than that of steel. Therefore, most designers will allow copper tubing to be used in water systems for these smaller sizes at the contractor's option.

The wall thickness of copper tubing is indicated by its *type*, defined as Types K, L, and M in decreasing order of wall thickness. Typically, Type K or L tubing can be used for chilled water piping, but Type M copper tubing is not rated as for pressure service and can be used only for drain lines or other atmospheric pressure applications.

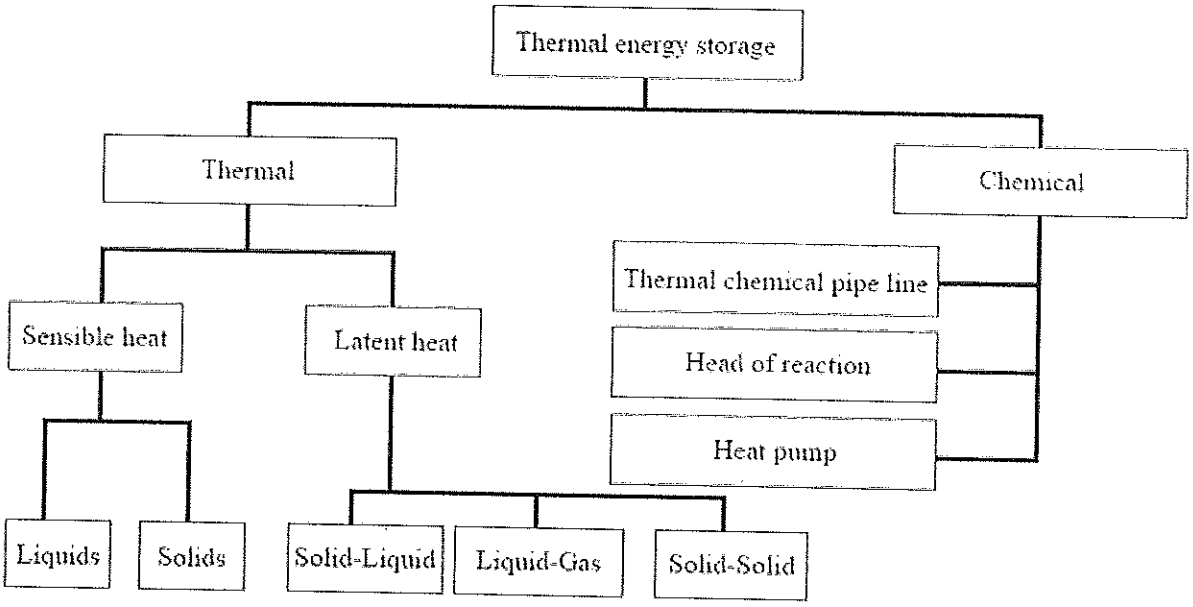
PVC or CPVC: As an alternative to iron piping for underground chilled water distribution, polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) piping can be used. PVC and CPVC piping wall thickness is defined in terms of schedules, much like steel pipe.

Cast or ductile iron

- For underground piping, cast iron piping or ductile iron piping is routinely used.
- Iron piping is rated for application in terms of "pressure class".
- for most chilled water systems, Class 350 is used up through 12″ pipe size,
- Class 250 for 14–20″ pipe, and
- Class 150 for piping 24″ and larger.
- Fittings are cast gray or ductile iron and the fittings and piping are assembled with gasketed mechanical pressure joints.

Q. 4: Explain thermal energy storage system with classification. Define the terms with respect to chiller:- off peak period, on peak period, charging and discharging.

Ans. Thermal energy storage (TES) allows the storage of heat and cold, which is used later. TES is also known as heat or cold storage. TES can aid in the efficient use and provision of thermal energy whenever there is a mismatch between energy generation and use. This mismatch can be in terms of time, temperature, power, or site. Cool thermal energy storage (CTES) has recently attracted increasing interest in industrial refrigeration applications, such as process cooling, food preservation, and building air-conditioning systems.



Off peak period represents when the system is not in use while on peak period represent when system is working. Charging represents the off-peak period production of cooling energy by the chiller that is stored, while discharging is the use of that stored energy during the on-peak period.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

(A)

Registration No.: .....

School of Refrigeration & Air conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V-Semester,

End Sem. Examination

Course Code: Hva1504 **Time: 2 Hour**

Course Name: AC system & Testing **Max. Marks: 50**

Instruction:

1. 1. Answer all questions from section A, each question carries one mark.
2. Answer all questions from section B, each question carries four mark.
3. Answer all questions from section C, each question carries six mark.
4. Calculator are allowed
5. Take given dimensions in Inches or convert them.

Section – A

10X01 = 10 Marks

Q1. What is NACPH _____?
a) Number of air change per hour

Q2. The condition of refrigerant after passing through the condenser in a vapor compression system is?
a) Saturated liquid

Q3. NBC Stands for_____ ?
d) National building codes

Q4. BIS-277 is for _____?
a) Sheet Metal Specification (GI).

Q5. Making decisions about when to turn chillers on and off is commonly referred to as chiller?
a) Sequencing

Q6. Fire dampers are certified by_____ ?
a) Under writer's laboratory

Q7. Compressor with screws are known as_____?
a) Positive displacement

Q8. GPM determines_____?
b) Flow rate

Q9. An _____in the condenser approach temperature (that is, the temperature difference between the water and the refrigerant inside the condenser)?
a) Increase

Q10. Q10. In a pressure duct class 2 will be having _____ "W.C?
b) 3 ¼"-6 ½"

Section – B 04X04 = 16 Marks

A11 Duct shapes
1. Round-
2. Square-
3. Rectangle-

4. flat oval shape-

According to Duct velocity

1. Low – up to 1500 FPM
2. Medium -1500-2500 FPM
3. High 2500-4500 FPM

Velocity reduction Method – Velocity

Equal friction method- Friction constant-

Static pressure regains- Static pressure of air to be constant

Q12. Name the types of Fitting used in Central HVAC systems ducts specific and used where?

A12.

Name of fittings	Types	Application
Tee	Single tee,double tee	To provide A 2way or 4 way flow
Shoe piece	Equal unequal	Used for sharp turn and damping air
Elbows	30,45,60,90	For a single way turn in uni-direction
Trouser	Three-way, two way trouser	Used for air direction and duct to duct joint with different directions.
Mitter elbow	15,30,45	For higher angle joints sharp turns
Reducer	Duct width (equal ,unequal)	Large to Small duct
Enlarger	Duct width (equal ,unequal)	Small to larger duct

Q13.

1)132 sq. ft. 2)529 sq. inches 3) 625 sq. ft. 4) 225 sq. inches

Q=VXA 132=11x11 2) Q=VXA 529=23 X 23 3) 25x 25 4)15x15

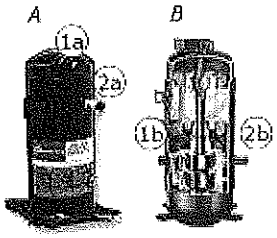
Q14. What are the Types of compressors used in central plant (Chiller) with Neat and diagram?

A14.Reciprocating Compressors

Reciprocating compressors use a piston and cylinder to compress incoming refrigerant. As the piston moves downward, refrigerant is drawn into the cylinder. The piston then moves upwards compressing the refrigerant and discharging it downstream to the condenser. Intake and exhaust valves ensure that the refrigerant does not flow backwards.

Centrifugal Compressor Rotary vane compressors typically are quieter than other options. They consist of vanes or blades that are attached to a core rotor. The rotor is positioned off-centre within its cylinder, creating multiple areas of varying sizes.

Scroll compressors work by compressing the refrigerant between two spiral plates, one stationary and one orbiting.



A. Scroll compressor

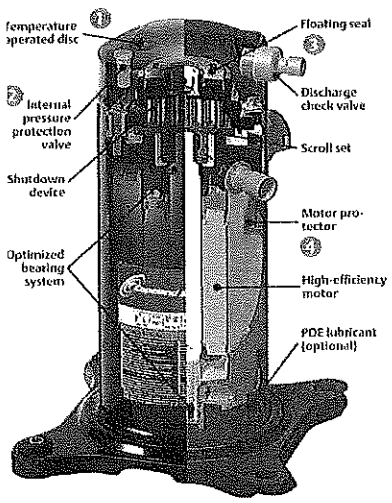
(1a) Outlet at top. Note the cap like construction

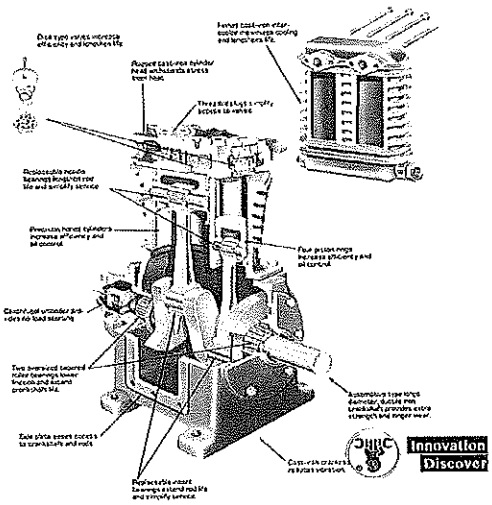
(2a) Inlet

B. Rotary compressor

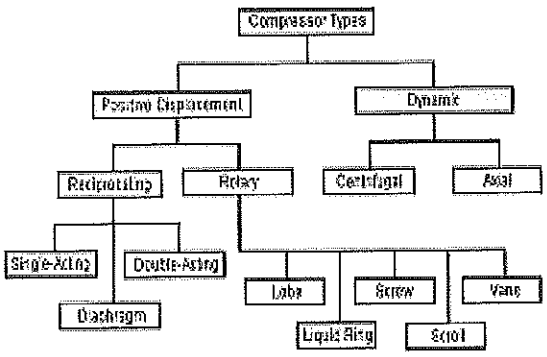
(1b) Outlet at bottom

(2b) Inlet





Types of compressors



Screw Rotary screw compressors have two interlocking helical rotors mounted inside a casing. As the rotors turn, the gas is forced from the suction end of the casing to the discharge end. The available space between the rotors and the casing becomes

increasingly smaller as the gas moves along the length of the screw, increasing the pressure.

Section – C 06X04 =24Marks

Q15. List down the Problems with Chillers & Corrective actions for it?

Problem	*Possible Causes*
Chiller Does Not Power Up	Improper line voltage or loose connection
	Incorrect phase connection (three-phase units)
	Blown circuit breaker or fuse
	Power switch in "off" position
No Pumping or Insufficient Fluid Flow	Improper or fluctuating line voltage
	Insufficient fluid in reservoir
	Pinched or restricted process line
	Closed or partially closed process valve
	Coolant fluid unsuitable for temperature requirements
	Blocked fluid filter
	Process piping too small
	Process restriction
	Pump failure
No Cooling or Insufficient Cooling	Improper or fluctuating line voltage
	Clogged air filter or condenser
	Coolant fluid unsuitable for temperature requirements
	Heat transfer properties of the coolant fluid have deteriorated
	Refrigerant leak
	High ambient temperature
	Evaporator iced up

Q16. Classify the duct based on

1. Shapes-Round , Square & Rectangle

2. Velocity with Range

High above 2500 fpm, medium-1400-2500 Fpm & low-800fpm

3. Pressure- Class I- ¼ W.C ,Class II- 3 ½-6 ¼ "W.C & Class III - Above 6 ¼ " W.C

Q17. For ducts of following Size: -

Find number of sheets used 8' X3'-

List down the number of fittings along with dimensions.

Ducts with velocity are designed for Silent & Slow space ducts

Duct	Fittings Name	Number of sheet
132"X132" -	Enlarger unequal	-0.381 number of sheet
12'X4'	Enlarger unequal	2 sheet
16"X16"	Reducer unequal	0.074 sheet
12'X16'	End cap.	8 sheet

So total number of sheet 11 sheets

A17. Natural Ventilation

1) single – side ventilation

2) cross flow ventilation

3) stack ventilation

4) Top - down ventilation

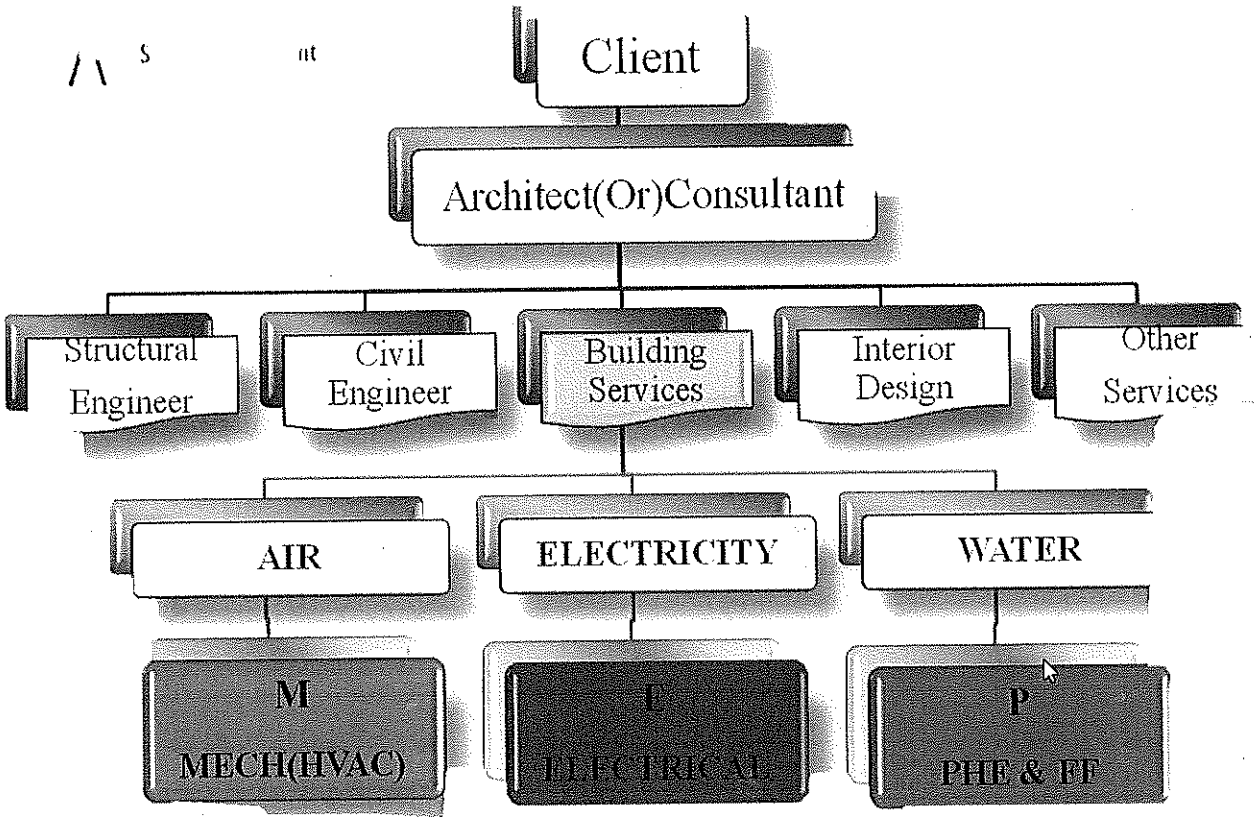
□ Forced ventilation.

1) positive pressure

2) Horizontal Mechanical

3) Hydraulic

A18.



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

Course Code: Hva1504 **Time: 2 Hour**

Course Name: AC system & Testing **Max. Marks: 50**

Instruction:

1.Read the Question Carefully.
2.Calculator are allowed
3.Take given dimensions in Inches or convert them.

Section – A

10X01 = 10 Marks

Q1. What is NACPH _____?
a) Number of air change per hour b) Number of volume change per hour
c) Number of air distributed per hour d) None of the above

Q2. The condition of refrigerant after passing through the condenser in a vapor compression system is?
a) Saturated liquid b) Saturated vapor
c) Liquid + vapor d) All of the above

Q3. NBC Stands for_____ ?
a) National boiler codes b) National BIM Codes
c) National bureau of standard d) National building codes

Q4. BIS-277 is for _____?
a) Sheet Metal Specification (GI). b) BIS-655 Sheet Metal Fabrication and Erection Installation
c) Sheet Metal Work Safety Standards. d)Duct work

Q5. Making decisions about when to turn chillers on and off is commonly referred to as chiller?
a) Sequencing b) Alternative
c)Throttling d) Lagging

Q6. Fire dampers are certified by_____ ?
a) Under writer's laboratory b) Ashrae
c)Ishrae d) Duct work Q7. Chiller can be classified based on application

Q7. Compressor with screws are known as_____?
Positive displacement b) Dynamic compressor
Roto compressor d) Linear

Q8. GPM determines_____?
Flow b) Flow rate
Velocity d) Space

Q9 . An _____in the condenser approach temperature (that is, the temperature difference between the water and the refrigerant inside the condenser)?
a) Increase b) Decrease
c)Remain constant d) Rate of change

Q10. Q10. In a pressure duct class 2 will be having _____ "W.C?

a) 1/2"-3 1/4 b) 3 ¼"-6 ½"

c) 5/4"-7/4" d) None of the above

Section – B 04X04 = 16 Marks

Q11. How ducts are Designed, Name the methods along with variable to control?

Q12. Name the types of Fitting used in Central HVAC systems ducts specific and used where?

Q13. Using the continuity equation calculate the sizes of duct?

whose area is.

1)132 sq. ft. 2)529 sq. inches 3) 625 sq. ft. 4) 225 sq. inches

Q14. What are the Types of compressors used in central plant (Chiller) with Neat and diagram?

Section – C 06X04 =24Marks

Q15. List down the Problems with Chillers & Corrective actions for it?

Q16. Classify the duct based on

1. Shapes 2. Velocity with Range 3.Pressure

Q17 For ducts of following Size: (A)

Find number of sheets used 8' X3'

List down the number of fittings along with dimensions.

Ducts with velocity are designed for _____ & _____ ducts?

Duct	Fittings Name	Number of sheet
132"X132"		
12'X4'		
16"X16"		
12'X16'		

(B) ~~Q17.~~ What are the types of Air Ventilation Explain with the help of A neat sketch?

Q18. Draw the flow chart for building survey/Project ?

Source : ASHRAE Handbook 2013

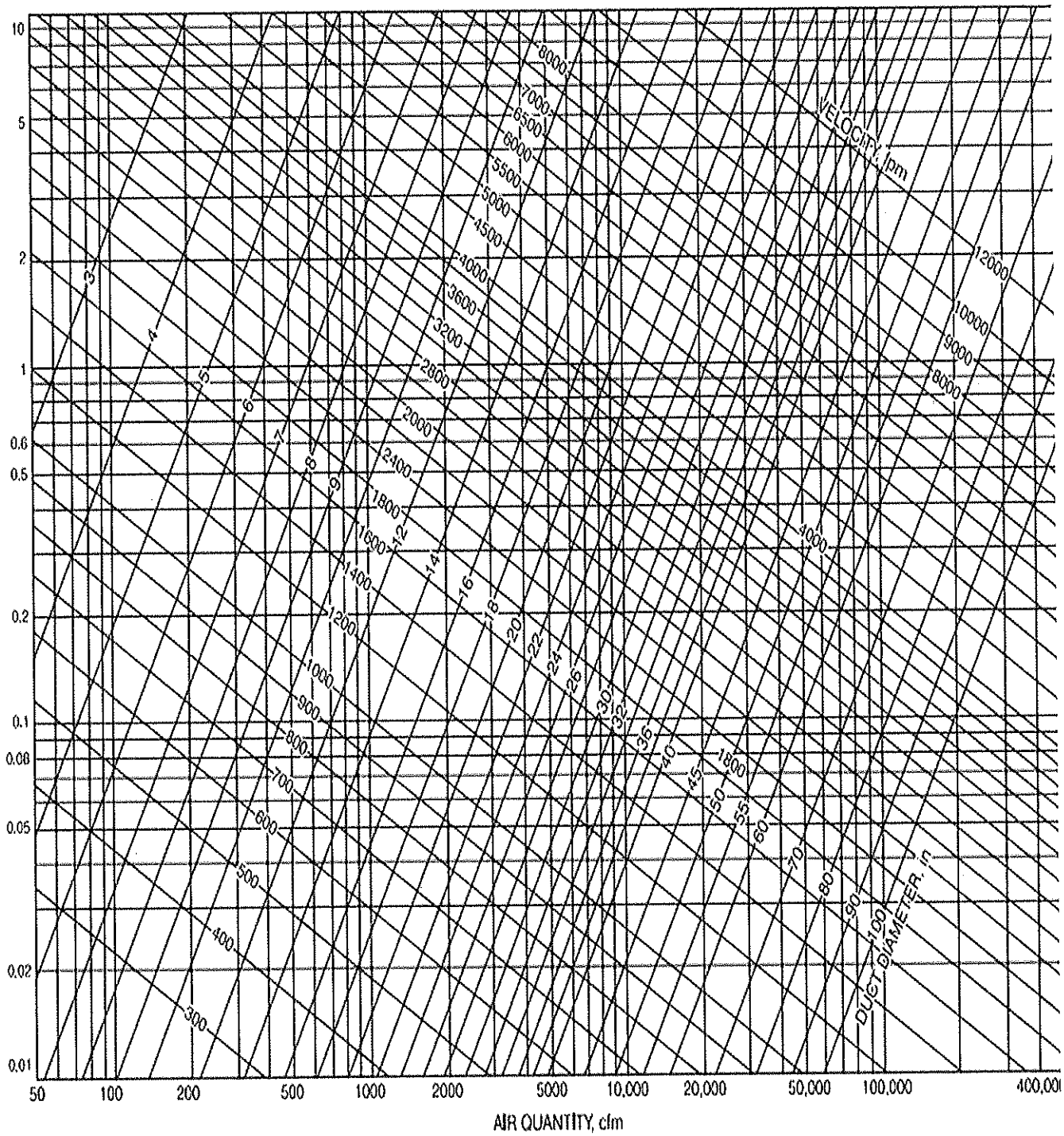
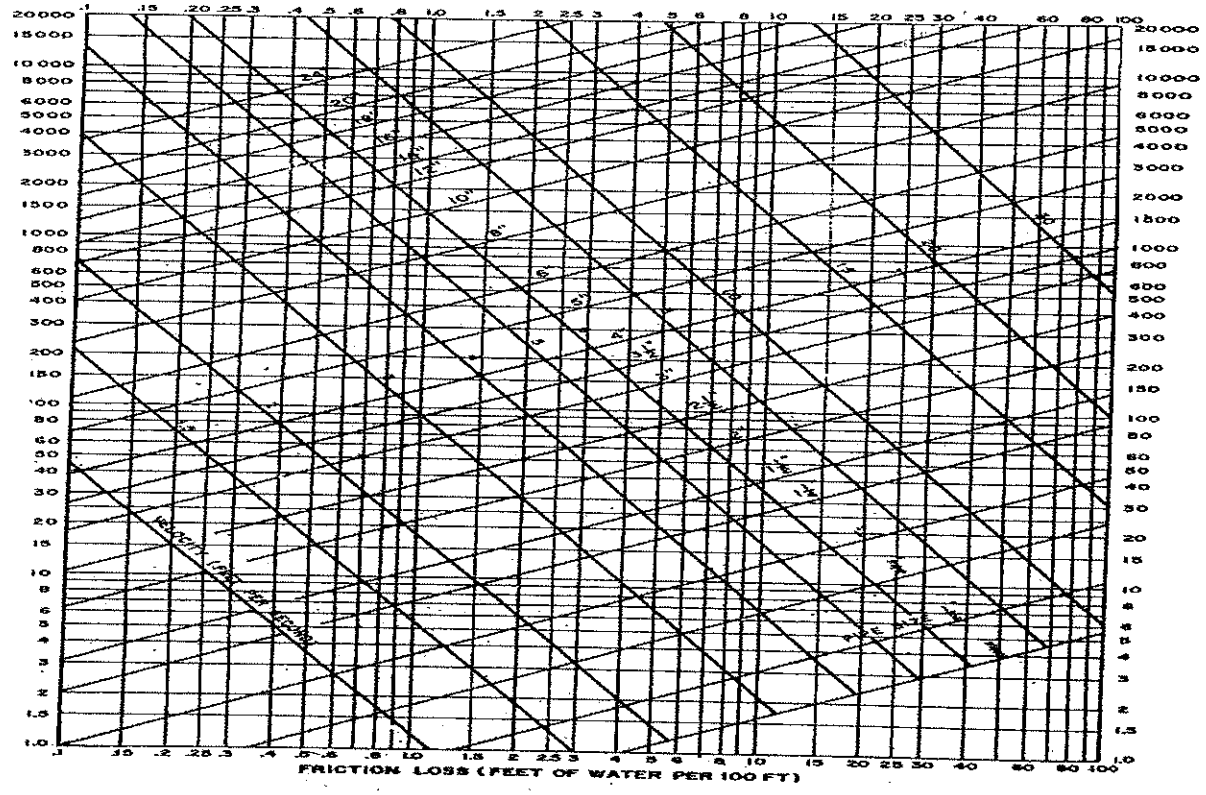


Figure 2.7 : Rigid Duct Design - Friction Chart
Friction chart for Round Duct, Air Density = 0.075 lb/ft3 and ε =0 0.003 ft.

Chart 1 - Friction Loss for Closed Piping Systems (Water)
Schedule 40 Pipe



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End Sem. Examination

Course Code: Hva1504 **Time: 1 Hour**

Course Name: AC System & Testing **Max. Marks: 50**

1. **Instruction:** Answer all questions from section A, each question carries one mark.
2. Answer all questions from section B, each question carries four mark.
3. Answer all questions from section C, each question carries six mark.
4. Use of Calculator is allowed

Section – A

10 X 01 = 10 Marks

05 objective type questions, each question carries 01 mark.

Q1. _____ Heat load calculation in excel is known as?
a) E-20 form b) B.O.Q
c)R.F.I d) HLC HAP
Q2. BIS-277 is for _____?
a) Sheet Metal Specification (GI). b) BIS-655 Sheet Metal Fabrication and Erection Installation (GI).
c) Sheet Metal Work Safety Standards d) DUCT WORK
Q3. Chiller can be classified based on application as_____?
a) Process & Comfort Chiller b) Power Chiller
c)Screw Chiller d) Absorption Chiller
Q4. Fire dampers are certified by?
a) Under writer's laboratory b) Ashrae
c)Ishrae d) Duct work
Q5. To select a filter _____ is most critical parameter?
a) Ppm (Parts per Million) b) Pressure drop
c)Discharge d) All of the above
Q6. Making decisions about when to turn chillers on and off is commonly referred to as chiller?
a) Sequencing b) Alternative
c)Throttling d) Lagging
Q7. Deficit flow in the bypass pipe of a primary-secondary system is an indication to turn an additional chiller _____ (on or off)?
a) Turn on b) Turn off
c) Shutdown both d) Operate at 50 %
Q8. An _____in the condenser approach temperature (that is, the temperature difference between the water and the refrigerant inside the condenser)?
a) Increase b) Decrease
c)Remain constant d) Rate of change
Q9. Condenser are designed according to _____?
a) Dry & wet b) Fin & tube
c)Tube in tube d) None of the above

Q10. In a pressure duct class 2 will be having _____ "W.C?

a) 1/2"-3 1/4 b) 3 ¼"-6 ½"

c) 5/4"-7/4" d) None of the above

Section – B

04X04 = 16 Marks

03 short answer type questions, each question carries 04 marks.

Q11.What are the types of compressor used in central plant (Chiller)?

Q12. Difference between F.CU and A.H.U List any three?

Q13.Types of evaporator used in chillers with diagram?

Q14. Common Chiller Problems and Possible Causes?

Section – C

06X04 = 24 Marks

03 Essay type questions, each question carries 06 marks.

Q15. Name the Types of fitting in a duct along with their application?

Calculation for reducer Length Duct of size

1. 32"X22" to a Duct of 22"X 22"
2. 40X40 to a Duct of 40"X 36"

Dimensions are in inches

Q16. With a neat diagram explain the Scroll compressor.

Q17.Using the continuity equation calculate the sizes of duct?

Take Q=AV where Q/V as constant

1) 36 sq. ft. 2) 169 sq inches equivalent rectangular sizes?
3)441 sq. ft. 4)900 sq. in.

b. What are the Advantages of velocity design in a system and why it is typical?

How is duct classified as?

a) Velocity b) Shapes

Q18) Calculate the required CFM and design the Duct for given building? Height to take 10.'

1) CFM of air required 2) Line diagram for duct design using EFM

DUCT	CFM	VELOCITY	PRESSURE AT	Square size duct(eq.diameter)
Room 1	200		0.08"	
Room 2	500		0.08"	
Room 3	600		0.08"	

Note for Q18: ROOM Dimension 12X12 FT,14X10,12X10

Take NACPH as 4,5,6

DRAW duct run – in answer copies

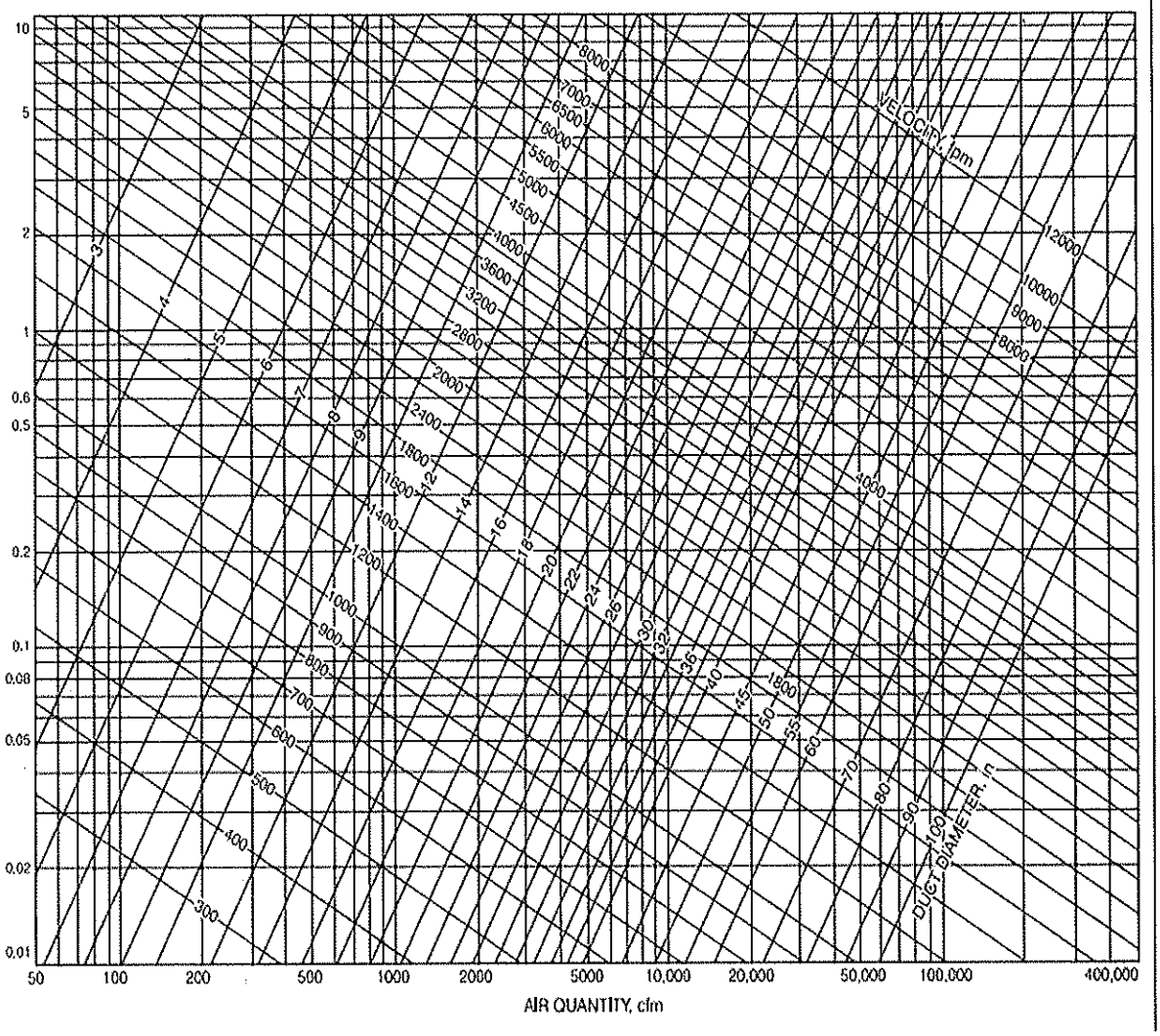


Figure 2.7 : Rigid Duct Design - Friction Chart
Friction chart for Round Duct, Air Density = 0.075 lb/ft3 and ε = 0 0.003 ft.

Source : ASHRAE Handbook 2013

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air conditioning Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End Sem. Examination

Course Code: Hva 1504 **Time: 1 Hour**

Course Name: AC System & Testing **Max. Marks: 50**

1. **Instruction:** Answer all questions from section A, each question carries one mark.
2. Answer all questions from section B, each question carries four mark.
3. Answer all questions from section C, each question carries six mark.
4. Use of Calculator is allowed

Section – A

10 X 01 = 10 Marks

05 objective type questions, each question carries 01 mark.

A1. a) E-20 form
A2. a) Sheet Metal Specification (GI).
A3. a) Process & Comfort Chiller
A4. a) Under writer's laboratory
A5. b) Pressure drop
A6. a) Sequencing
A7. a) Turn on
A8. a) Increase
A9. d) None of the above
A10b) 3 ¼"-6 ½"

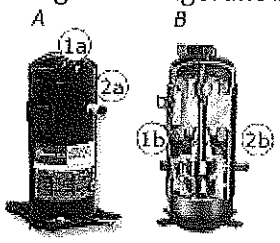
Section – B

04X04 = 16 Marks

03 short answer type questions, each question carries 04 marks.
Q11.What are the types of compressor used in central plant (Chiller)?
A11. **A14.Reciprocating Compressors**
Reciprocating compressors use a piston and cylinder to compress incoming refrigerant. As the piston moves downward, refrigerant is drawn into the cylinder. The piston then moves upwards compressing the refrigerant and discharging it downstream to the condenser. Intake and exhaust valves ensure that the refrigerant does not flow backwards.

Centrifugal Compressor Rotary vane compressors typically are quieter than other options. They consist of vanes or blades that are attached to a core rotor. The rotor is positioned off-centre within its cylinder, creating multiple areas of varying sizes.

Scroll compressors work by compressing the refrigerant between two spiral plates, one stationary and one orbiting.



A. Scroll compressor

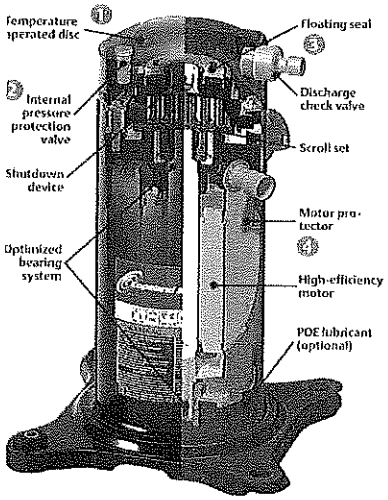
(1a) Outlet at top. Note the cap like construction

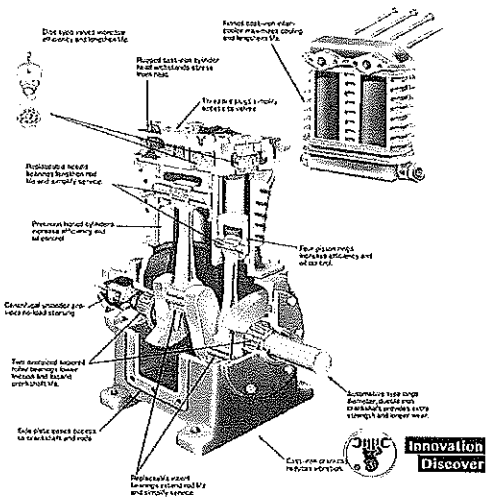
(2a) Inlet

B. Rotary compressor

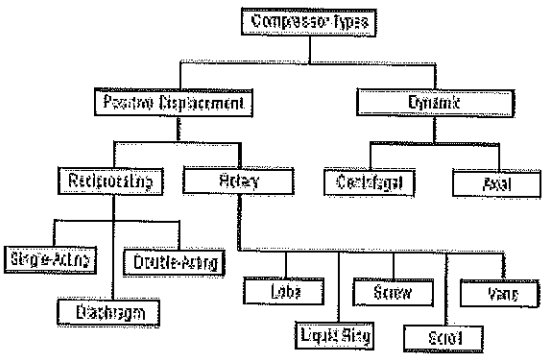
(1b) Outlet at bottom

(2b) Inlet





Types of compressors



Screw Rotary screw compressors have two interlocking helical rotors mounted inside a casing. As the rotors turn, the gas is forced from the suction end of the casing to the discharge end. The available space between the rotors and the casing becomes increasingly smaller as the gas moves along the length of the screw, increasing the pressure.

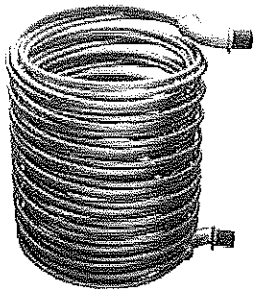
A12. Difference between F.CU and A.H.U List any three?

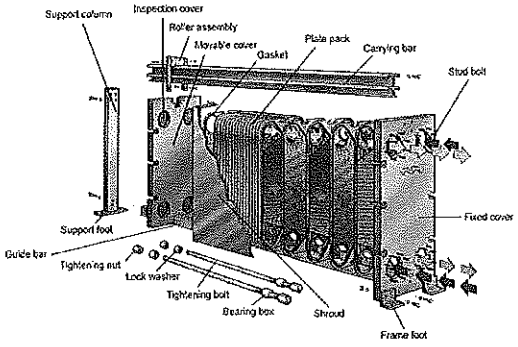
F.C.U	A.H.U
SMALL SIZE	BIGGER SIZE
CAN be used in direct and indirect cooling	Only indirect
Parameters cannot be handle such as Oxygen circulation and exhaust	Parameters can be handle such as Oxygen circulation and exhaust

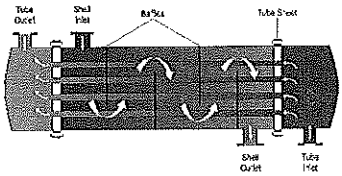
A13 Shell Type-Used where the load is low with space constrain spiral tube in form of coil is shaped to cool the secondary refrigerant

2.Plate heat exchanger type- here two concentric plates are sandwiched between the tube where aluminum plates used as a fin to increase area for heat transfer

3.Flooded shell and tube- here tubes carry refrigerant or secondary refrigerant and as per the application shell part are exposed to these number of tubes for better heat transfer coefficient.







A14. Common Chiller Problems and Possible Causes

P.T.O

Problem	*Possible Causes*
Chiller Does Not Power Up	Improper line voltage or loose connection
	Incorrect phase connection (three-phase units)
	Blown circuit breaker or fuse
	Power switch in "off" position
No Pumping or Insufficient Fluid Flow	Improper or fluctuating line voltage
	Insufficient fluid in reservoir
	Pinched or restricted process line
	Closed or partially closed process valve
	Coolant fluid unsuitable for temperature requirements
	Blocked fluid filter
	Process piping too small
	Process restriction
	Pump failure
No Cooling or Insufficient Cooling	Improper or fluctuating line voltage
	Clogged air filter or condenser
	Coolant fluid unsuitable for temperature requirements
	Heat transfer properties of the coolant fluid have deteriorated
	Refrigerant leak
	High ambient temperature
	Evaporator iced up

Section – C

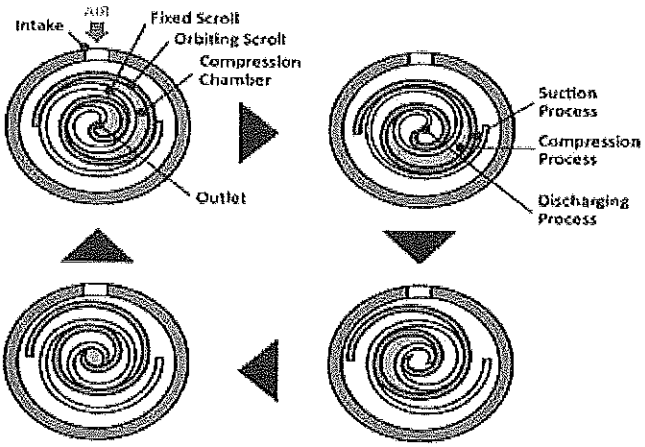
06X04 = 24 Marks

03 Essay type questions, each question carries 06 marks.

Q15. Name the Types of fitting in a duct along with their application?
Calculation for reducer Length Duct of size
1. 32"X22 to a Duct of 22"X 22"—30"
2. 40X40 to a Duct of 40"X 36"----12"
Dimensions are in inches

Q16. With a neat diagram explain the Scroll compressor.

A16.



A17.Using the continuity equation calculate the sizes of duct?
Take Q=AV where Q/V as constant

1) 36 sq. ft.—6x6,12x3 2) 169 sq. inches 16X10
3)441 sq. ft. 21x21- 16 x20 4)900 sq. in.- 60X15 ,30X30