Tuesday, May 15, 2023 (03:00 pm- 06:00 pm)

Max Marks = 30   **Duration 0.5 hrs**

PART - A

Instructions
- There are 15 questions in this paper. Question paper is printed on both sides.
- Only thermodynamic and refrigeration property tables should be used.

Write your answers in the given box below: (Each question carry 2 marks)

1	2	3	4	5	6	7	8	9	10
11	**12**	**13**	**14**	**15**					

1. What is a sunroom?
a) A room with a sun fitted inside it
b) A room that does not allow sunlight to pass through it
c) A room that transmits a lot of sunlight and has a scenic view
d) A room that does not pass sunlight and has a scenic view

2. Which of the following process is involved in heat transfer through building?
a) Seebeck effect
b) Peltier effect
c) Hall effect
d) Conduction

3. Which part of a house receives majority of solar radiation?
a) Roof
b) Side walls
c) Floor
d) Doors

4. A building with excessive glass cover _____
a) results in freezing
b) results in a pleasant temperature within the building
c) damages the building material
d) results in overheating

5. A solar roof constructed on a building uses water stored _____ to temper hot and cold internal temperatures of the building.
a) on building roofs
b) on building walls
c) beneath building floors
d) on an auxiliary building

6. Which of the following is not used in a passive solar heating/cooling system?
a) Building walls
b) Building roofs
c) Air conditioners
d) Building floors

7. What is solar heating and cooling?
a) Use solar energy to regulate the internal temperature of a given space
b) Use solar energy to regulate the temperature of environment
c) Use solar energy to monotonically increase the internal temperature of a given space
d) Use solar energy to monotonically decrease the temperature of a given space

8. The boiling point of ammonia is
a) -10.5°C
b) -30°C
c) -33.3°C
d) -77.7°C

9. Cooling water is required for following equipment in ammonia absorption plant
a) Condenser
b) Evaporator
c) Absorber
d) Condenser, absorber and separator (rectifier)

10. The vapour compression refrigerator employs the following cycle
a) Rankine
b) Carnot
c) Reversed Rankine
d) Reversed Carnot

11. A human body feels comfortable when the heat produced by the metabolism of human body is equal to the
a) Heat dissipated to the surroundings
b) Heat stored in the human body
c) Sum of (a) and (b)
d) Difference of (a) and (b)

12. Which of the following best describes the process of vapour compression refrigeration?
a) Warm air → compressor → condenser → expansion valve → evaporator → colder air
b) Evaporator → compressor → condenser → expansion valve → evaporator → colder air
c) Warm air → compressor → expansion valve → evaporator → colder air
d) Warm air → evaporator → compressor → condenser → expansion valve → evaporator → colder air

13. Which of the following is an example of a refrigerant?
a) Platinum
b) CFCs
c) Argon
d) Nitrogen

14. Which of the following metals are used to make pipes of low cost solar water heating system?
a) Gold
b) Copper
c) Polymer
d) Silver

15. How is the heat transferred from transfer fluid to potable water in indirect solar water heating systems?
a) By directly exposing the substance to sunlight
b) By using an electrical heater
c) By circulating potable water through the collector
d) By using heat exchanger

Tuesday, May 15, 2023 (03:00 pm- 06:00 pm)

Max Marks = 50   **Duration 2.5 hrs**

PART - B

Instructions
- There are 8 questions in this paper. Question paper is printed on both sides.
- Only thermodynamic and refrigeration property tables should be used.

1. An ammonia refrigeration works between -6.7^{o}C and 26°c. The vapour is dry-saturated at the end of compression. Calculate (a) theoretical COP, and (b) power required to drive the compressor if the cooling capacity of the refrigerator is tons.
Use of the following properties of NH$_3$.

Temperature	Liquid		Vapour	
(^{o}C)	h$_f$ (kJ/kg)	s$_f$ (kJ/kg K)	h$_g$ (kJ/kg)	s$_g$ (kJ/kg K)
-6.7	-29.26	0.1087	1262.36	4.7401
26.7	124.56	0.4264	1291.62	4.3263

[6 Marks]

2. A circular duct of 40 cm is selected to carry air in an air-conditioning space at a velocity of 440 m/min to keep the noise at desired level. If this duct is to be replaced by a rectangular duct of aspect ratio of 12.5, find out the size of rectangular duct for equal friction method when, (a) the velocity of air in two ducts is same, (b) the discharge rate of air in two ducts is same.

[6 Marks]

3. 100 m^3 of air per minute at 15°C DBT and 80% RH is heated until its temperature becomes 22°C. Find (i) heat added to air per minute, and (ii) R.H. of heated air and its WBT.

Take atmospheric pressure is 1.013 bar. Solve the above numerical without using psychrometry chart. **[6 Marks]**

4. (i) The DBT and RH of air are 35°C and 60% respectively. The pressure of the air is 1.033 bar. Determine specific humidity and vapour pressure in the air.

(ii) If 5 gms of water vapour is removed from the air and temperature is reduced to 25°C, find out the relative humidity and DPT of the air. **[6 Marks]**

5. A spray cooling coil is chosen to operate under the following conditions:

Air-inlet condition: 28°C DBT and 21°C WBT

Air-outlet condition: 10°C DBT and 6°C WBT

Total amount of air flow: 2000 m3/min

The chilled water inlet and outlet temperatures are 7°C and 12°C respectively.

Find the following:

   (a) The cooling load on the coil
   (b) Water flow rate through the coil.   **[10 Marks]**

6. In the months of May and March, without and with interior shading (dark roller shades), determine the maximum heat transfer rate through 3.0 m^2 of unshaded, plate double glass facing north-east. Location 32°N.   **[6 Marks]**

7. The city of Delhi is at 22°82'N and 88°20'E, the LSM for India is 82°30'. On October 21st, if the local standard time is 9.00 A.M., then the local solar time for Howrah on October 21st (EOT = 15 minutes) is?   **[5 Marks]**

8. Find the sunrise, sunset, and total sunshine hours at BITS Pilani, (l=22°N) on Sept, 9th.

                                                                           [5 Marks]

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ANNEX 01

Type of glass	Thickness mm	Shading Coefficient, SC				
		No internal shading	Venetian blinds		Roller shades	
			Medium	Light	Dark	Light
Single glass Regular	3	1.00	0.64	0.55	0.59	0.25
Single glass Plate	6-12	0.95	0.64	0.55	0.59	0.25
Single glass Heat absorbing	6	0.70	0.57	0.53	0.40	0.30
Double glass Regular	3	0.90	0.57	0.51	0.60	0.25
Double glass Plate	6	0.83	0.57	0.51	0.60	0.25
Double glass Reflective	6	0.2-0.4	0.2-0.33	-	-	-

Month	Orientation of the surface					
	N/shade	NE/NW	E/W	SE/SW	S	Horizontal
December	69	69	510	775	795	500
Jan, Nov	75	90	550	785	775	555
Feb, Oct	85	205	645	780	700	685
Mar, Sept	100	330	695	700	545	780
April, Aug	115	450	700	580	355	845
May, July	120	530	685	480	230	865
June	140	555	675	440	190	870