# K. K. Wagh Institute of Engineering Education & Research, Nashik
## (An Autonomous Institute From A.Y. 2022-23)

| SUMMER-2024 | |
|---|---|
| Exam Seat No.: | |
| Academic Year:2023-2024 | Semester:IV |
| Class:SY Btech Mech | Program:B.Tech Mech |
| Branch Code:MEC | Pattern:2022 |
| Name of Course:Engineering Thermodynamics | Course Code:MEC222011 |
| Max. Marks:60 | Duration:2.30 Hrs. |

**Instructions:** Candidates should read carefully the instructions printed on the Question Paper
and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains ___03__ page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

### Question No. 1 Attempt following Question

| | | | |
|---|---|---|---|
| 1a) | Write general steady flow energy equation using a block diagram of open system and the conditions under which it could be used. Explain the terms in this equation. What is the steady flow energy equation for throttling device. | (6) | CO1 |

### Question No. 2 Attempt following Question

| | | | |
|---|---|---|---|
| 2a) | What is available energy and unavailable energy. Write the expression for increase in unavailable energy when the heat is transferred through finite temperature difference. Represent it on temp entropy diagram. | (6) | CO2 |

### Question No. 3 Attempt following Question

| | | | |
|---|---|---|---|
| 3a) | Define dryness fraction of steam. What is the value of dryness fraction of saturated liquid water. Discuss with neat sketch the apparatus used for finding the dryness fraction of system. | (8) | CO3 |

**OR**

| | | | |
|---|---|---|---|
| 3b) | Draw and discuss the temperature enthalpy diagram for steam formation indicating the vapour dome, critical point, saturated liquid line, dry saturated vapour line, superheated steam and wet steam region. What happens to saturation point and latent heat as the pressure increases? Define critical point, superheated steam and dry saturated steam. | (8) | CO3 |

| | | | |
|---|---|---|---|
| 3c) | A sample of steam generated in boiler at 10 bar is passed through separating and throttling calorimeter. The pressure of steam after throttling was 1 bar and the temperature recorded was 125 degree Celsius. Mass of steam collected through separating calorimeter was 20 gm and the mass of steam collected after throttling was 1 kg. Assuming the specific heat of steam collected after throttling as 2.1 kJ/kg K find the dryness fraction of steam.Use steam tables given in the question paper. | (8) | CO3 |

**OR**

3d) Steam power plant operates on Rankine cycle. The condition of steam at inlet to turbine is 40 bar    (8)   CO3
400 degree Celsius. The condenser pressure is 0.1 bar. . Assuming the specific heat of superheated
steam as 2.1 kJ/kg K Find pump work, turbine work and cycle efficiency

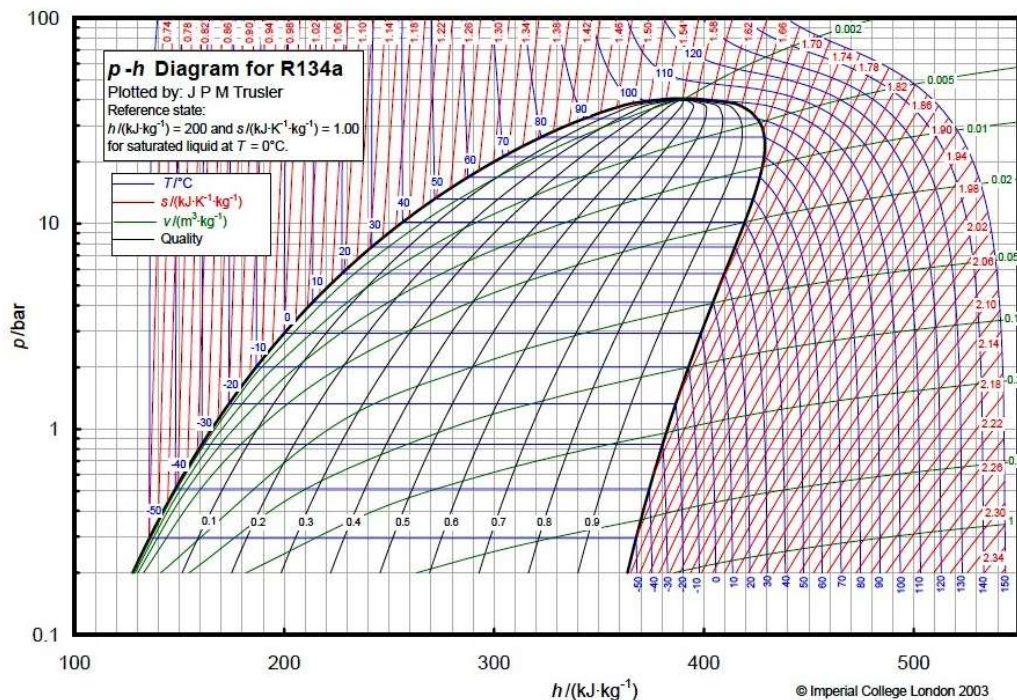| Pressure bar | Temp in celsius | $h_f$ kJ/kg | $h_g$ kJ/kg | $s_f$ kJ/kgK | $s_f$ kJ/kgK |
|---|---|---|---|---|---|
| 0.01 | 7 | 29 | 2514 | 0.106 | 8.974 |
| 0.1 | 45.8 | 192 | 2584 | 0.649 | 8.149 |
| 1 | 99.6 | 417 | 2675 | 1.303 | 7.359 |
| 2 | 120.23 | 505.7 | 2201.9 | -- | --- |
| 10 | 179.9 | 763 | 2778 | 2.138 | 6.586 |
| 20 | 212.4 | 909 | 2799 | 2.447 | 6.340 |
| 30 | 233.8 | 1008 | 2803 | 2.645 | 6.186 |
| 40 | 250.3 | 1087 | 2801 | 2.797 | 6.070 |
| 50 | 263.9 | 1155 | 2794 | 2.921 | 5.973 |
| 100 | 311 | 1408 | 2725 | 3.360 | 5.615 |

**Question No. 4 Attempt following Question**

4a) Draw block diagram of refrigeration system of split air conditioning system, list its components and   (8)   C04
processes that occur in each component. Represent vapour compression refrigeration cycle on ph
chart and temperature entropy diagram.

<div align="center">OR</div>

4b) Define DBT,WBT,specific humidity and dew point temperature. Draw a psychrometric chart and   (8)   C04
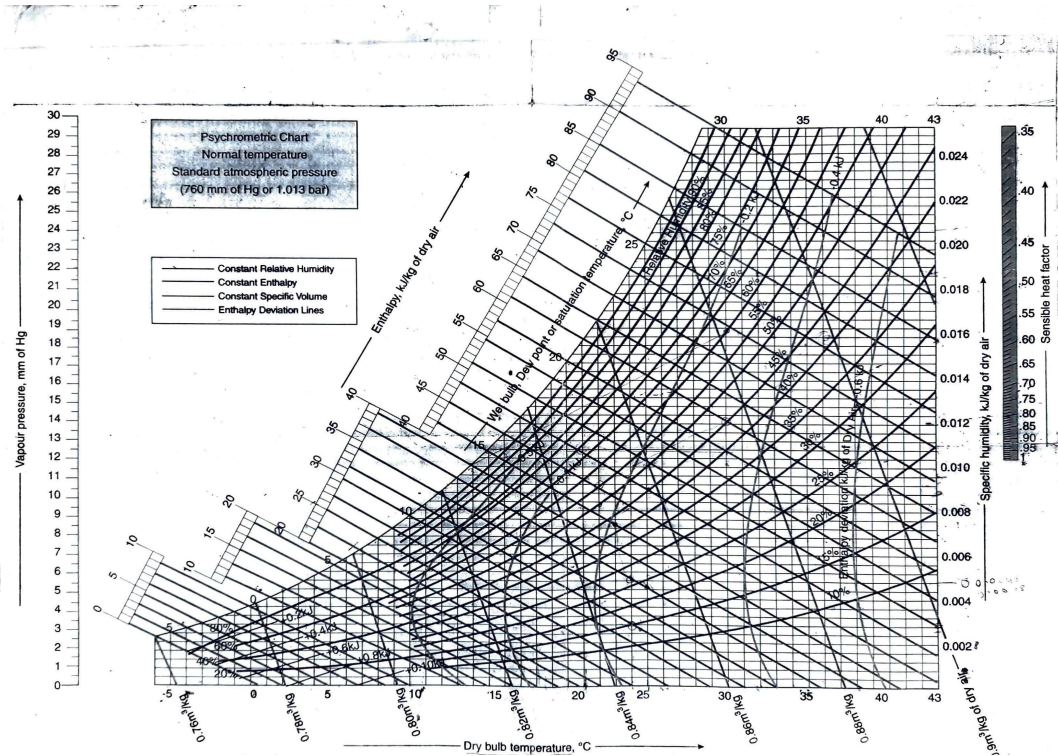represent cooling and dehumidification process.

4c) For household refrigerator using R134a as refrigerant the evaporator temperature is 5 degree   (8)   C04
Celsius and condenser temperature is 50 degree Celsius. Assume simple saturation cycle. Represent
this cycle on ph and t-s diagram. Find specific enthalpy at salient points, specific compressor work,
specific refrigerating effect and COP.



p-h Diagram for R134a
Plotted by: J P M Trusler
Reference state:
$h/(kJ \cdot kg^{-1}) = 200$ and $s/(kJ \cdot K^{-1} \cdot kg^{-1}) = 1.00$
for saturated liquid at $T = 0°C$.

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<div align="center">OR</div>

4d) If initial state of air DBT is 25 degrees Celsius, WBT is 20degree Celsius. Plot the condition on   (8)   C04
psychrometric chart. Find the specific humidity, relative humidity and specific enthalpy of air.

specific enthalpy of air at the final state and the heat added. Represent the process on psychrometric chart.



**Question No. 5 Attempt following Question**

5a) Discuss the construction and specifications of boiler you visited. Explain the expression used to calculate boiler thermal output, input and its efficiency.          (8)    CO5

<div align="center"><strong>OR</strong></div>

5b) Compare the construction and specifications of the steam generator you have studied during the industrial visit with the one found in power plants.          (8)    CO5

5c) Explain the concept of isothermal efficiency of air compressor. Explain the methods to improve isothermal efficiency .How is isothermal efficiency calculated ?What measurements would be necessary during the compressor trial to estimate?          (8)    CO5

<div align="center"><strong>OR</strong></div>

5d) Derive the expression for volumetric efficiency of compressor. How does clearance relate to volumetric efficiency.          (8)    CO5

<div align="center"><strong>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</strong></div>