BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH205

Department of Engineering and Physics

Bachelor of Science (Honours) Degree in Agricultural Engineering

Thermodynamics and Heat Transfer

3 HOURS (100 Marks)

INSTRUCTIONS

NOV 2024

This paper contains 6 questions.

Answer any **FOUR** questions. Each carries **25 marks**

Question 1

A steam turbine operates with 1.6 MPa and 350 °C steam at its inlet and saturated vapor at 30 °C at its exit. The mass flow rate of the steam is 22 kg/s , and the turbine produces 12,350 kW of power.

Determine the rate at which heat is lost through the casing of this turbine. **[25 marks]**

Question 2

Humid air at 101.3 kPa , 36 °C dry bulb and 65 percent relative humidity is cooled at constant pressure to a temperature 10 °C below its dew-point temperature.

a) Sketch the psychrometric diagram for the process and determine the properties of the air in each state. **[13 marks]**

b) Determine the heat transfer from the air, in kJ/kg dry air. **[12 marks]**

Question 3

In the locality of Mazowe it is desired to build a cold chamber of 32 tons of refrigeration, for the conservation of orange at 4 °C . The proposed system will operate according to the real vapor compression refrigeration cycle, with an overheating of 10 °C and an ambient temperature equal to 35 °C .

a) Represent the real vapor compression cycle in the pressure-enthalpy diagram. **[5 marks]**

b) Calculate:

i. Mass flow of refrigerant flowing through the system. **[5 marks]**

ii. Total heat given up in the condenser. **[5 marks]**

iii. Total power consumed in the compression. **[5 marks]**

iv. Efficiency of the second law of the cycle. **[5 marks]**

$T_L = T_c - 9\ ^\circ C$ $\qquad$ $T_H = T_{air} + 10\ ^\circ C$

Question 4

One kmol of ethane (C_2H_6) is burned with an unknown amount of air during a combustion process. An analysis of the combustion products reveals that the combustion is complete, and there are 3 kmol of free O_2 in the products.

a) Write the stoichiometric combustion equation. **[6 marks]**

b) Write the balanced reaction equation for complete combustion. **[6 marks]**

c) Determine the air-fuel ratio. **[7 marks]**

d) Determine the percentage of theoretical air used during this process. **[6 marks]**

Question 5

An air-standard Diesel cycle has a compression ratio of 16 and a cutoff ratio of 2. At the beginning of the compression process, air is at 95 kPa and 27 °C. Accounting for the variation of specific heats with temperature, determine:

a) The temperature after the heat-addition process **[8 marks]**

b) The thermal efficiency **[9 marks]**

c) The mean effective pressure. **[8 marks]**

Question 6

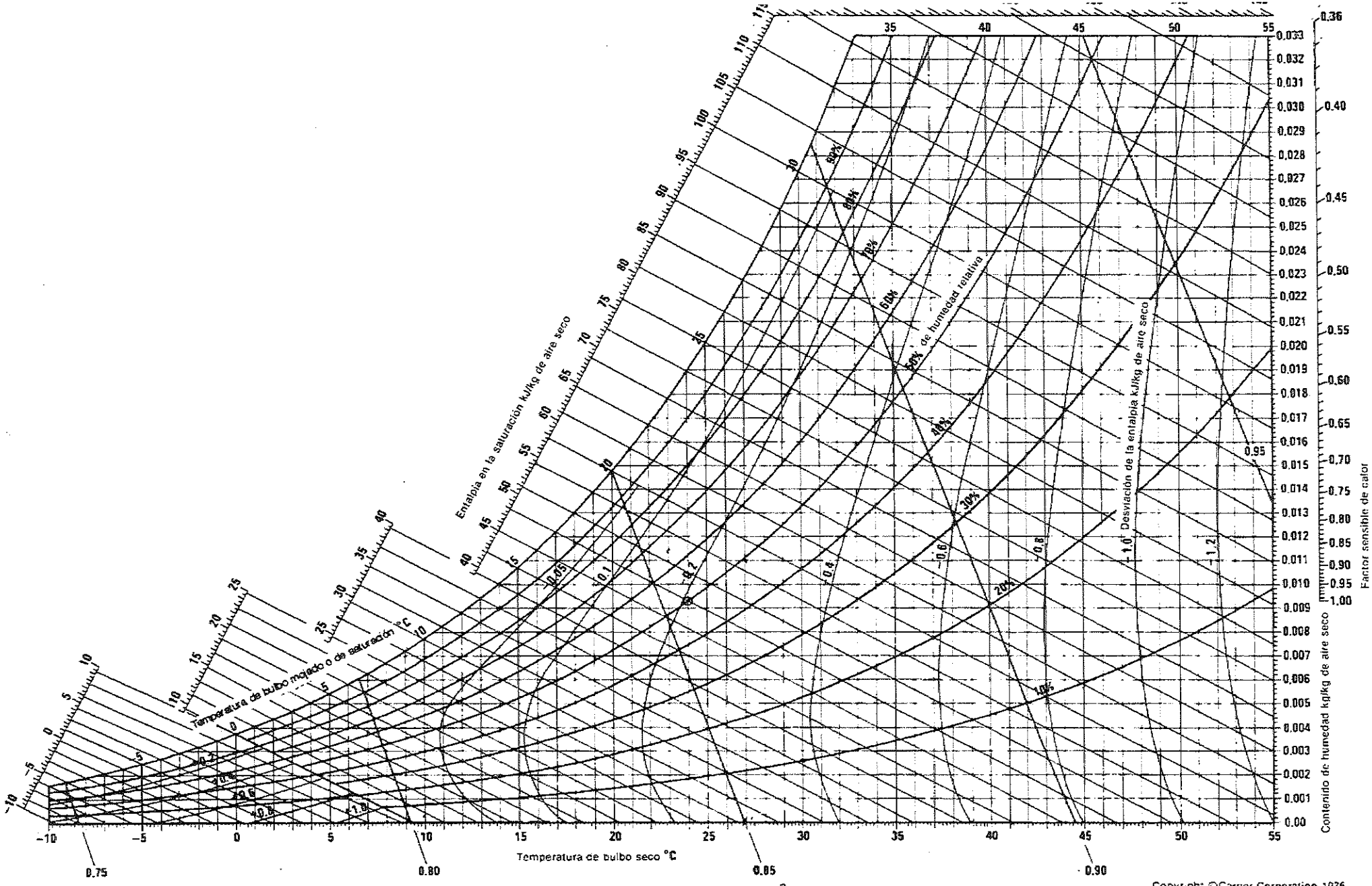
A steam power plant operates on an ideal reheat Rankine cycle between the pressure limits of 15 MPa and 10 kPa . The reheat section at 2 MPa . The mass flow rate of steam through the cycle is 2 kg/s . Steam enters at first stages of the turbine at 500 °C . If the moisture content of the steam at the exit of the low-pressure turbine is not to exceed 10 percent, determine:

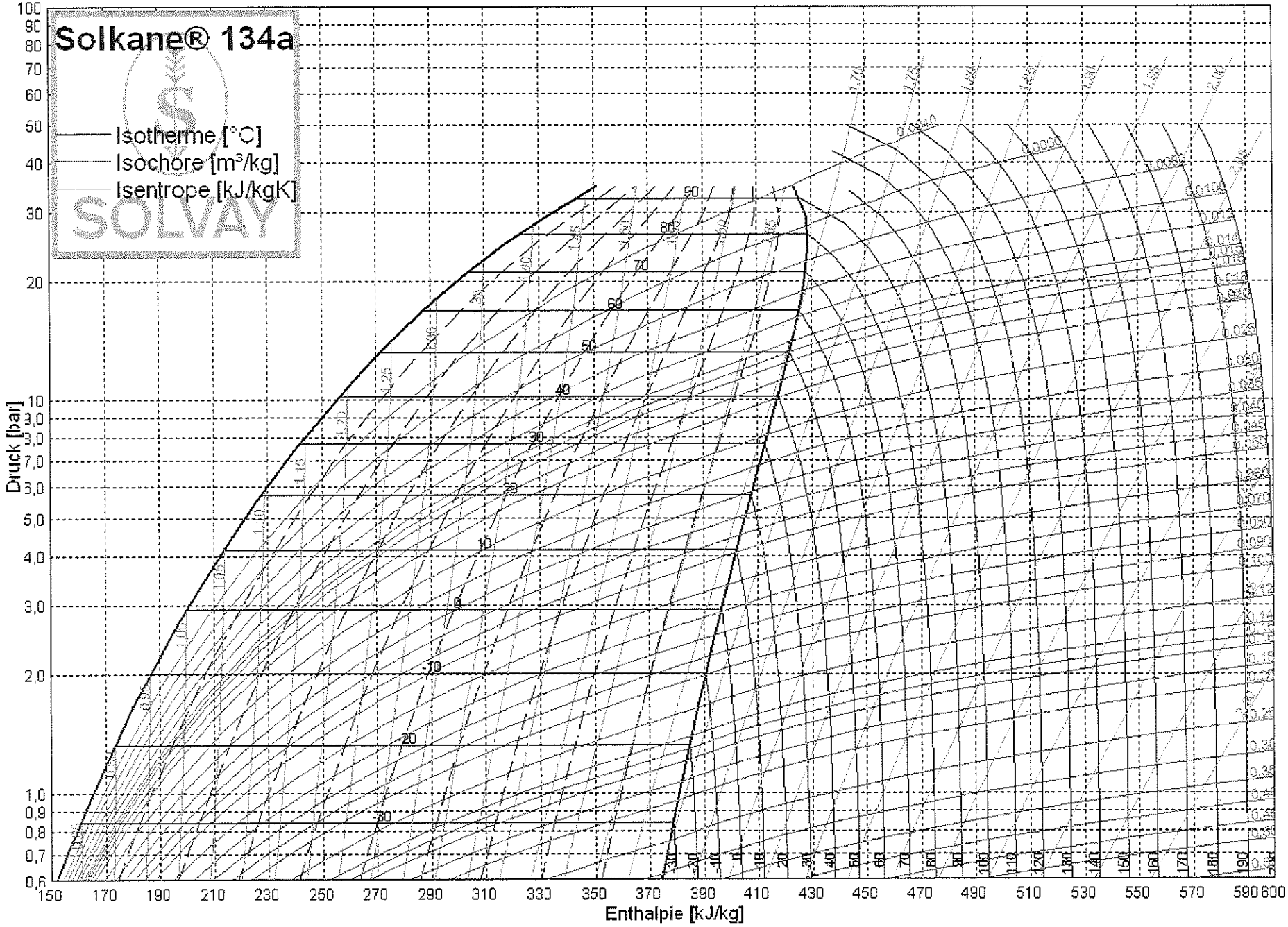
a) The temperature at which reheating takes place. **[7 marks]**

b) The total rate of heat input in the boiler. **[7 marks]**

c) The thermal efficiency of the cycle. **[7 marks]**

d) Show the cycle on a T-s diagram with respect to saturation lines. **[4 marks]**




Solkane® 134a
Isotherme [°C]
Isochore [m³/kg]
Isentrope [kJ/kgK]
SOLVAY
Druck [bar]
Enthalpie [kJ/kg]