Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

Online End Semester Examination, May 2021

Programme Name: M.Tech-ES **Semester : II**
Course Name : Thermodynamics and Heat Transfer systems **Time : 03 hrs**
Course Code : EPEC7028 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 5 Marks**
2. **Instruction: Short Answer Type (Explain in not more than two or three lines)**

S. No.	**Questions**	**CO**
Q 1	A system of 100 kg mass undergoes a process in which its specific entropy increases from 0.3 kJ/kg- K to 0.4 kJ/kg-K. At the same time, the entropy of the surroundings decreases from 80 kJ/K to 75 kJ/K. Comments on the possibility, reversibility and irreversibility of the system.	**CO2**
Q 2	Define Extensive and Intensive properties with examples?	**CO1**
Q 3	What is the effect of temperature on thermal conductivity of metals, non-metals and gases?	**CO1**
Q.4	Identify extensive or intensive properties (a) Density (b) Molar Volume (c) Internal Energy (d) Number of moles (e) Average molecular weight	**CO1**
Q.5	Identify open system or a closed system (a) Human Being (b) Bicycle tire (c) A refrigerator (d) Planet earth	**CO1**
Q.6	Explain velocity and thermal boundary layer formation for different range of Prandtl number?	**CO1**

SECTION B

1. **Each question will carry 10 marks**
2. **Instruction: Write short / brief notes**

Q 1	**A** gas is held in a horizontal piston-and-cylinder device, as shown below. A spring is attached to the back of the frictionless piston. Initially, the spring exerts no force on the piston. The gas is heated until the pressure inside the cylinder is 650 kPa. Determine the boundary work done by the gas on the piston. Assume P_{atm} = 100 kPa.	**CO4**

<table>
<tr><td></td><td>
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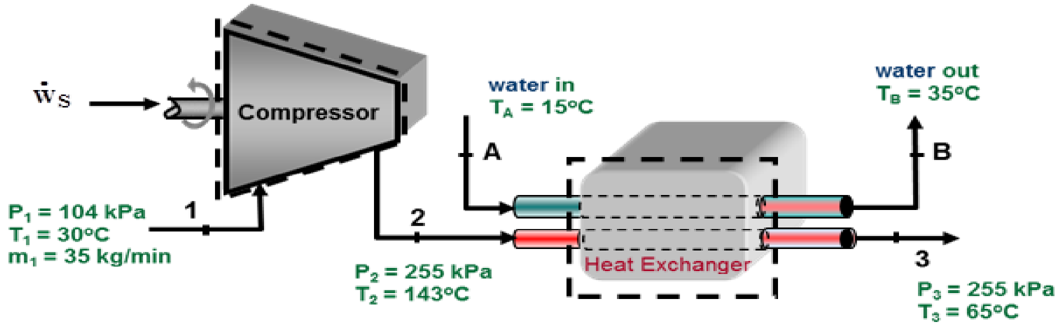
<tr><td>Q 2</td><td>A compressor, operating at steady-state, increases the pressure of an air stream from 1 bar to 10 bar while losing 4.2 kW of heat to the surroundings. At the compressor inlet, the air is at 25 ^{o}C and has a velocity of 14 m/s. At the compressor outlet, the air is at 350^{o}Cand has a velocity of 2.4 m/s. If the compressor inlet has a cross-sectional area of 500 cm^2 and the air behaves as an ideal gas, determine the power requirement of the compressor in kW.</td><td>CO3</td></tr>
<tr><td>Q.3</td><td>Water of kinematic viscosity (ϑ) equal to 9.29x10 $^{-7}$ m^2 /s is flowing steadily over a smooth flat plate at zero angle of incidence, with a velocity of 1.524 m/s. The length of the plate is 0.3048 m. Calculate:
(a) The thickness of the boundary layer at 0.1524 m from the leading edge.
(b) Boundary layer rate of growth at 0.1524 m from the leading edge.
(c) Total drag coefficient on the plate.</td><td>CO2</td></tr>
<tr><td>Q.4</td><td>Consider a large plane wall of thickness L = 0.05m. The wall surface at x=0 is insulated, while the surface at x = L is maintained at a temperature of 30^{0}C. The thermal conductivity of the wall is k = 30 W/mK, and heat is generated in the wall at a rate of 8x10^6 W/m^3. Assuming steady one-dimensional heat transfer, (a) express the differential equation and the boundary condition for heat conduction through the wall, (b) Obtain a relation for the variation of temperature in the wall by solving the differential equation.</td><td>CO3</td></tr>
<tr><td>Q.5</td><td>Complete the blank cells in the following table of properties of steam. In the last column describe the condition of steam as compressed liquid, saturated mixture, superheated vapor, or insufficient information; and, if applicable, give the quality.
<table>
<tr><th>P, kPa</th><th>T, °C</th><th>v, m^3/kg</th><th>u, kJ/kg</th><th>Condition description and quality (if applicable)</th></tr>
<tr><td>200</td><td>30</td><td></td><td></td><td></td></tr>
<tr><td>270.3</td><td>130</td><td></td><td></td><td></td></tr>
<tr><td></td><td>400</td><td>1.5493</td><td></td><td></td></tr>
<tr><td>300</td><td></td><td>0.500</td><td></td><td></td></tr>
<tr><td>500</td><td></td><td></td><td>3084</td><td></td></tr>
</table></td><td>CO2</td></tr>
<tr><td colspan="3">SECTION C
1. Each Question carries 20 Marks.
2. Instruction: Write long answer.</td></tr>
<tr><td>Q 1</td><td>The effluent from an air compressor is cooled by contacting with water in a heat exchanger. The operating parameters for this system are given in the diagram, below.</td><td>CO4</td></tr>
</table>

Assume air behaves as an ideal gas and heat losses to the surroundings are negligible.



a.) Calculate the power requirement for the compressor and the required cooling water mass flow rate for the heat exchanger.

b.) Calculate the entropy production rate for the compressor and for the heat exchanger separately.

OR

Find Unknown temperature?