Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2022

Course: Fluid flow and heat transfer equipment design **Semester:** I
Program: M. Tech (Chemical Engineering) **Time: 3 hrs.**
Course Code: CHPD7005 **Max. Marks: 100**
Instructions: The question paper consists of two sections. Answer the questions section wise in the answer booklet.
Note: Assume suitable data if necessary. Data sheets will be provided.

SECTION A

<table>
<tr><th>S. No.</th><th></th><th>Marks</th><th>CO</th></tr>
<tr><td>Q 1</td><td>A 20 cm diameter pipe carrying steam is provided with 5 cm thick insulation whose thermal conductivity varies with temperature as $k(T) = 0.062\ (1 + 0.362 \text{ X } 10^{-2}\ T)$ W/m °C where T is in °C. The temperature at the pipe surface and at the outer surface of the insulation are 275°C and 65°C respectively. Calculate (a) the rate of heat transfer per unit meter length of the pipe, (b) the temperature at the mid thickness of the insulation, and (c) the temperature gradients at the pipe surface, the mid thickness of the insulation, and the outside surface of the insulation. Sketch the temperature profile.</td><td>15</td><td>CO2</td></tr>
<tr><td>Q 2</td><td>A heat exchanger network will involve the four process streams shown below:
<table>
<tr><th>Stream</th><th>Supply temperature, TS (°C)</th><th>Target temperature, TT (°C)</th><th>Heat capacity flow rate, CP (kW/°C)</th></tr>
<tr><td>1</td><td>220</td><td>150</td><td>2.0</td></tr>
<tr><td>2</td><td>240</td><td>60</td><td>3.0</td></tr>
<tr><td>3</td><td>50</td><td>190</td><td>2.5</td></tr>
<tr><td>4</td><td>100</td><td>210</td><td>4.0</td></tr>
</table>
A minimum temperature difference of 10°C will be used for design purposes. Set up the problem table for the network and use it to determine:
(a) The minimum hot and cold utility requirements
(b) The hot and cold stream temperatures at the pinch</td><td>15</td><td>CO4</td></tr>
<tr><td>Q 3</td><td>Discuss in detail about fluid moving machineries.</td><td>15</td><td>CO1</td></tr>
<tr><td>Q 4</td><td>What per cent increase in the radiant-section heat absorption may be expected in a boiler when the firing rate is increased 50 per cent? The initial ratio of absorption to liberation is 0.38, and the excess air is expected to increase from 25 to 40 per cent as a result of the increased firing rate.</td><td>15</td><td>CO5</td></tr>
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SECTION B

<table>
<tr><td>Q 5</td><td>40,000 lb/hr of a 42°API kerosene leaves the bottom of a distilling column at 390°F and will be cooled to 200°F by 141,000 lb/hr of 34°API Mid-continent crude coming from storage at l00°F and heated to 170°F. A 10 psi pressure drop is permissible on both streams, a combined dirt factor of 0.003.</td><td>40</td><td>CO3</td></tr>
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	Available for this service is a 21 $^1/_4$ in. ID exchanger having 158, 1 in. OD, 13 BWG tubes 16'0" long and laid out on 1 $^1/_4$-in. square pitch. The bundle is arranged for four passes, and baffies are spaced 5 in. apart. Will the exchanger be suitable; i.e., what is the dirt factor?		