BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.TECH **SEMESTER : II**
BRANCH: ME **SESSION : SP/2023**

SUBJECT: ME579 DESIGN AND ANALYSIS OF HEAT EXCHANGERS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Explain the classification of the heat exchanger according to the transfer process.	[5]	1	1
Q.1(b)	Explain the working principle of Gasketed plate and double pipe heat exchangers.	[5]	1	1
Q.2(a)	What is the significance of velocity boundary layer and thermal boundary layer when fluid flows with uniform velocity and temperature (U_α and T_α) over a uniformly heated (with temperature T_b) flat plate?	[5]	2	2
Q.2(b)	Explain the common causes of fouling in heat exchangers.	[5]	1	1
Q.3(a)	Derive the expression of LMTD of counter-flow heat exchanger.	[5]	2	4
Q.3(b)	A counter flow concentric tube heat exchanger is used to cool engine oil (c_{oil}= 2130 J/kg.K) from 160°C to 60°C with water(c_{water}= 4186 J/kg.K), available at 25°C as the cooling medium. The flow rate of cooling water through the inner tube of 0.5 m diameter is 2 kg/s while the flow rate of oil through the outer annulus O.D = 0.7 m is also 2 kg/s. If the value of the overall heat transfer coefficient is 250 W/m^2.K. How long must the heat exchanger be to meet its cooling requirement?	[5]	5	4
Q.4(a)	Derive the expression of effectiveness for parallel-flow heat exchanger.	[4]	2	4
Q.4(b)	An air blast cooler with a surface area for heat transfer of 600 m^2 and an overall heat transfer coefficient of 60 W/(m^2.K) is fed with the following streams: Air: M_c= 12 kg/s, c_{pc} = 1050 J/(kg.K), $T_{c,in}$ = 20°C Oil: M_h= 3 kg/s, c_{ph} = 2000 J/(kg.K), $T_{h,in}$ = 80°C Calculate (a) the stream exit temperatures (b) F-values and (c) effectiveness for a two-pass shell and tube exchanger.	[6]	5	4
Q.5(a)	What are the design steps for designing a heat exchanger?	[3]	1	1
Q.5(b)	Consider the problem:	[7]	5	4

Consider the problem:

$$\text{Minimize } f = 2\left(x_2 - x_1^2\right)^2 + \left(1 - x_1\right)^2$$

If the base simplex is defined by the vertices

$$X_1 = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix},\ X_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix},\ X_3 = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix}$$

Find a sequence of two improved vectors after iteration 2 using reflection, expansion, and/or contraction.

Assume α=1, β = 0.1, γ = 2, and converge when ε ≈ 0.2.

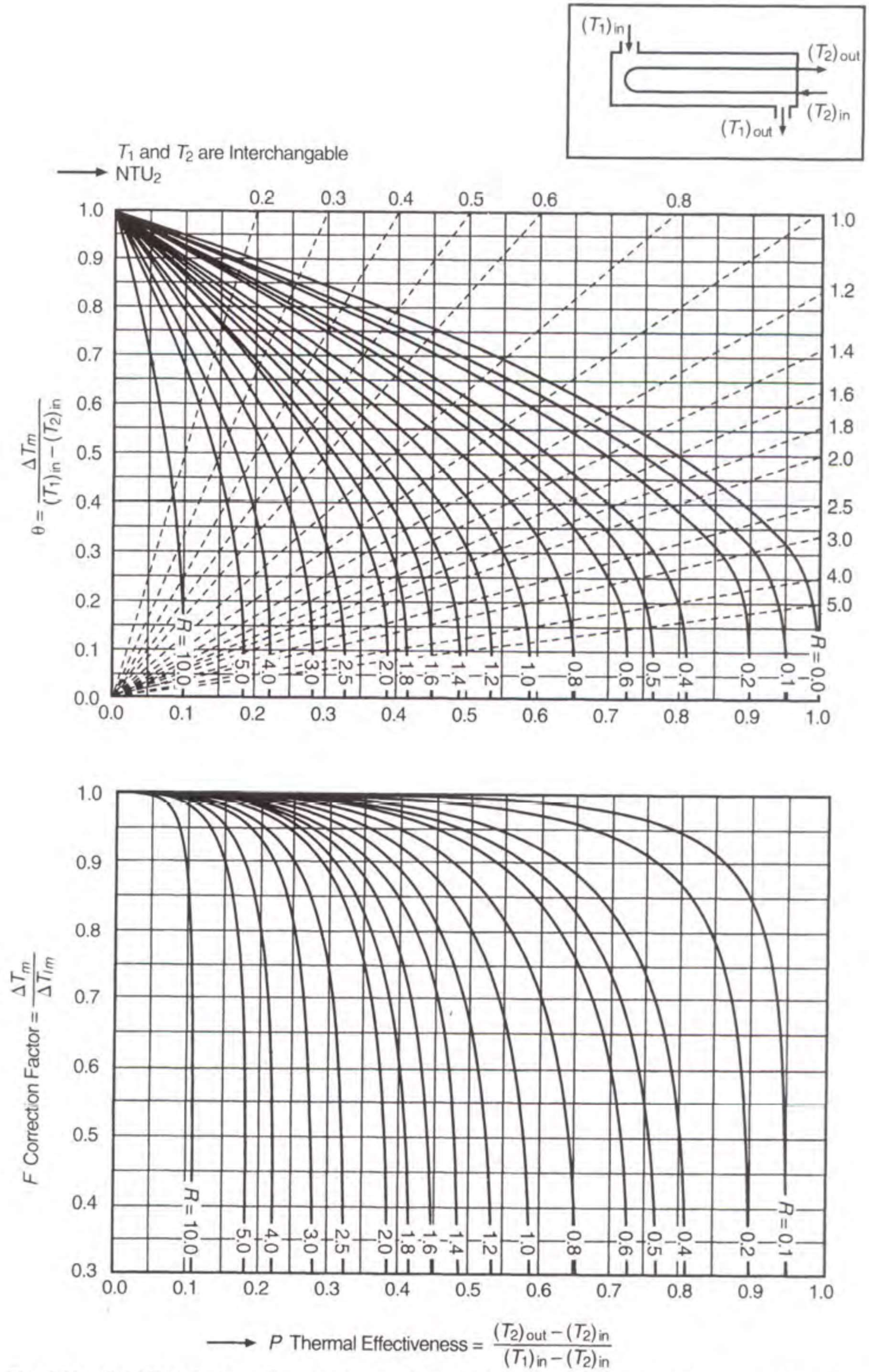

Fig. 3.22 *F*-*θ*-NTU-*P* chart for a two-pass shell-and-tube heat exchanger. The same chart can be us 4, 6, 8 ... passes. (From Taborek, 1983. With permission.)