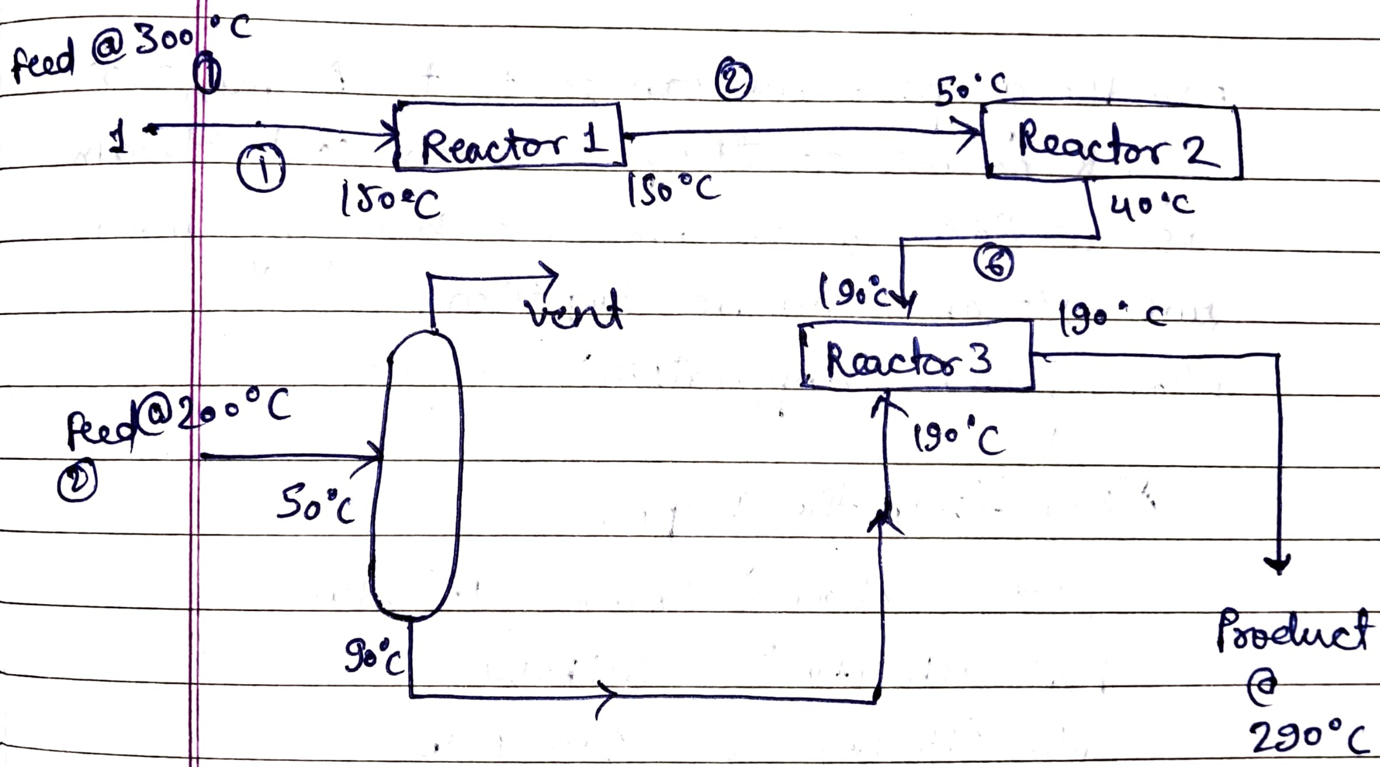
Solution Q. 3

Stream No.	Flow Rate	Cp	Tin	Tout	Type	(ΔH)(KW)
1	10.00	0.8	300	150	Hot	−1200
2	2.50	0.8	150	50	Hot	− 200
3	3.00	1.0	200	50	Hot	−450
4	6.25	0.8	190	290	Cold	+500
5	10.00	0.8	90	190	Cold	+800
6	4.00	1.0	40	190	Cold	+ 600

$\dot{m}$ Cp	8	2	3	5	8	4
Stream No.	1	2	3	4	5	6



In hot stream :-

ΔT	composite $\dot{m}C_p$	ΔH-ve ~~coverage~~ coverage
200-300	8	-800
150-200	11	-550
50-150	5	-500

In cold streams :-

ΔT	Composite $\dot{m}C_p$	ΔH +ve coverage (MW)
190-290	5	0.500
90-190	12	01.200
40-90	4	0.200

From the graph, we can see that $\Delta T_{min} = 10°C$ first occurs at the point when cold stream is at 80°C when we are bringing closer two streams curve together.

So, pinch temperature = 90°C

Also, from the graph.

Heat exchange load = 1.8 MW

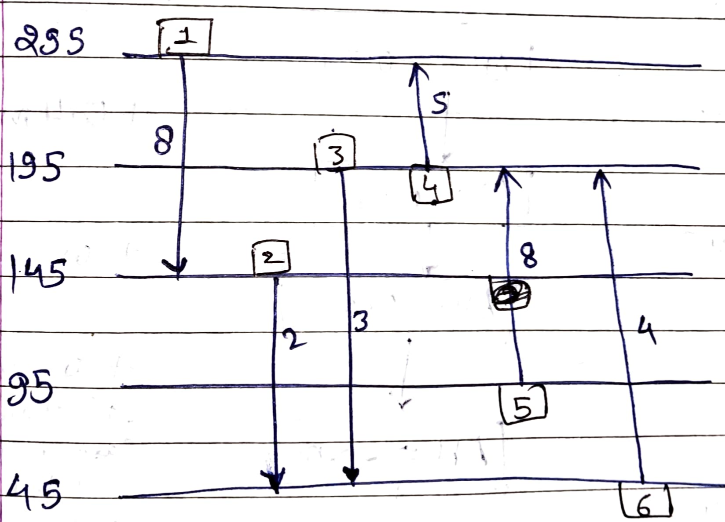
Hot utility = 0.1 MW

Cold Utility = 0.05 MW

b) To calculate pinch temperature using cascade procedure :→

Stream	Type	T_s	T_T	T_s^*	T_T^*
1	Hot	300	150	295	145
2	Hot	150	50	145	45
3	Hot	200	50	195	45
4	Cold	190	290	195	295
5	Cold	90	190	95	195
6	Cold	40	190	45	195

Temperature interval :-



Heat balances :→

ΔT (Interval)	$(MW\,K^{-1})$ $m\cdot\sum CP_C - \sum CP_H$	(MW) ΔH interval	Surplus/Deficit
100	-3×10^{-3}	-0.3	Surplus
50	$+1\times10^{-3}$	$+0.05$	Deficit
50	7×10^{-3}	$+0.35$	Deficit
50	-1×10^{-3}	-0.05	Surplus.

Cascade Energy from high to low temperature

~~hot utility~~

Hot Utility

295 ———— $+0.1$ MW

$\boxed{\Delta H = -0.3}$

195 ———— $+0.4$ MW

$\boxed{\Delta H = 0.05}$

145 ———— $+0.35$ MW

$\boxed{\Delta H = 0.35}$

95 ———— $+0$ MW

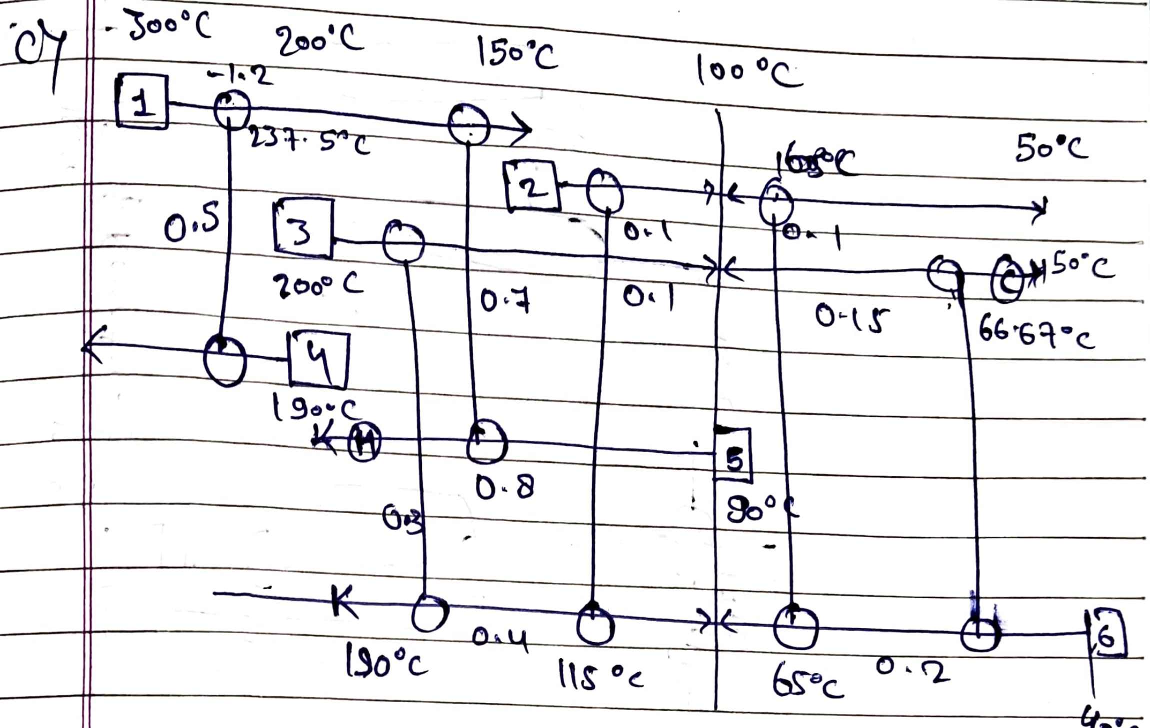
It is shown in Cascade energy that pinch temp is $90°C$

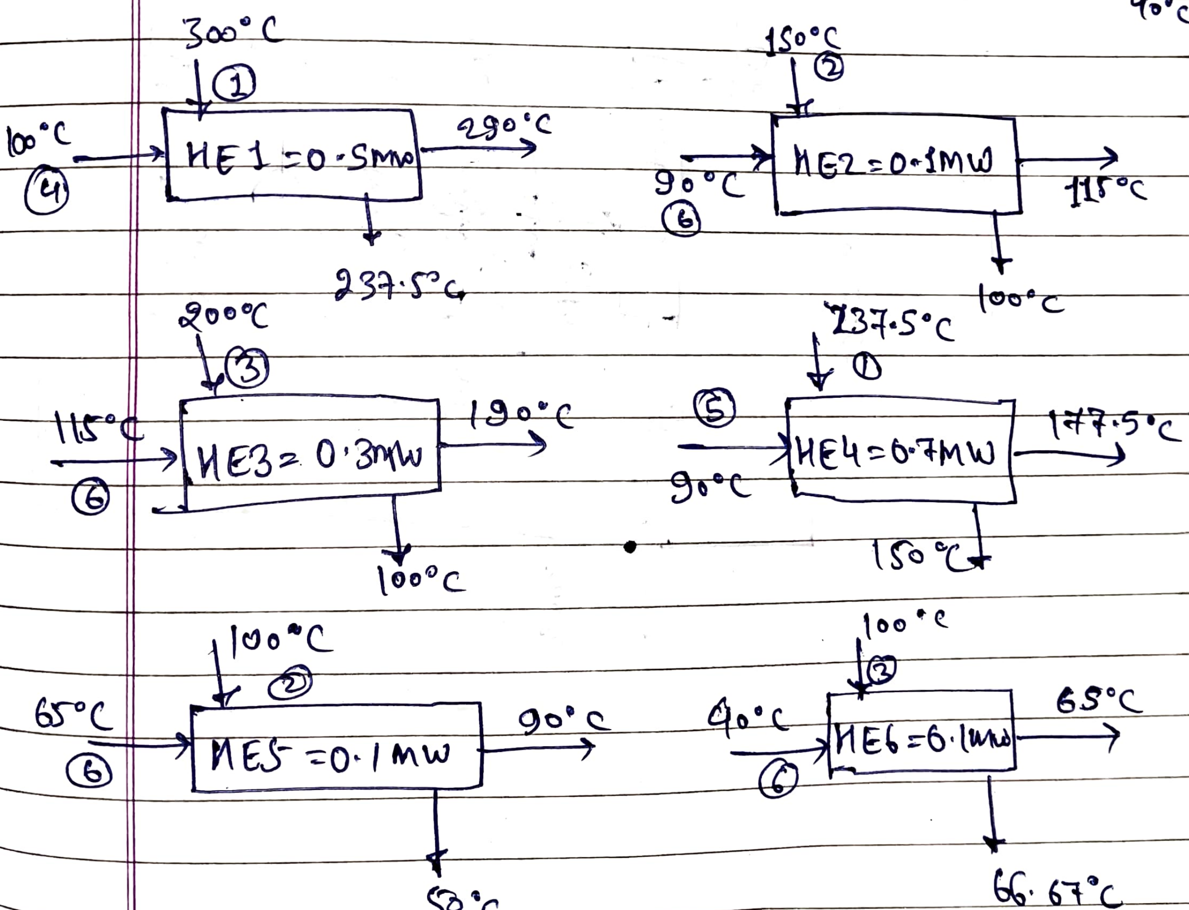
$\boxed{\Delta H = -0.05}$

45 ———— $+0.05$ MW

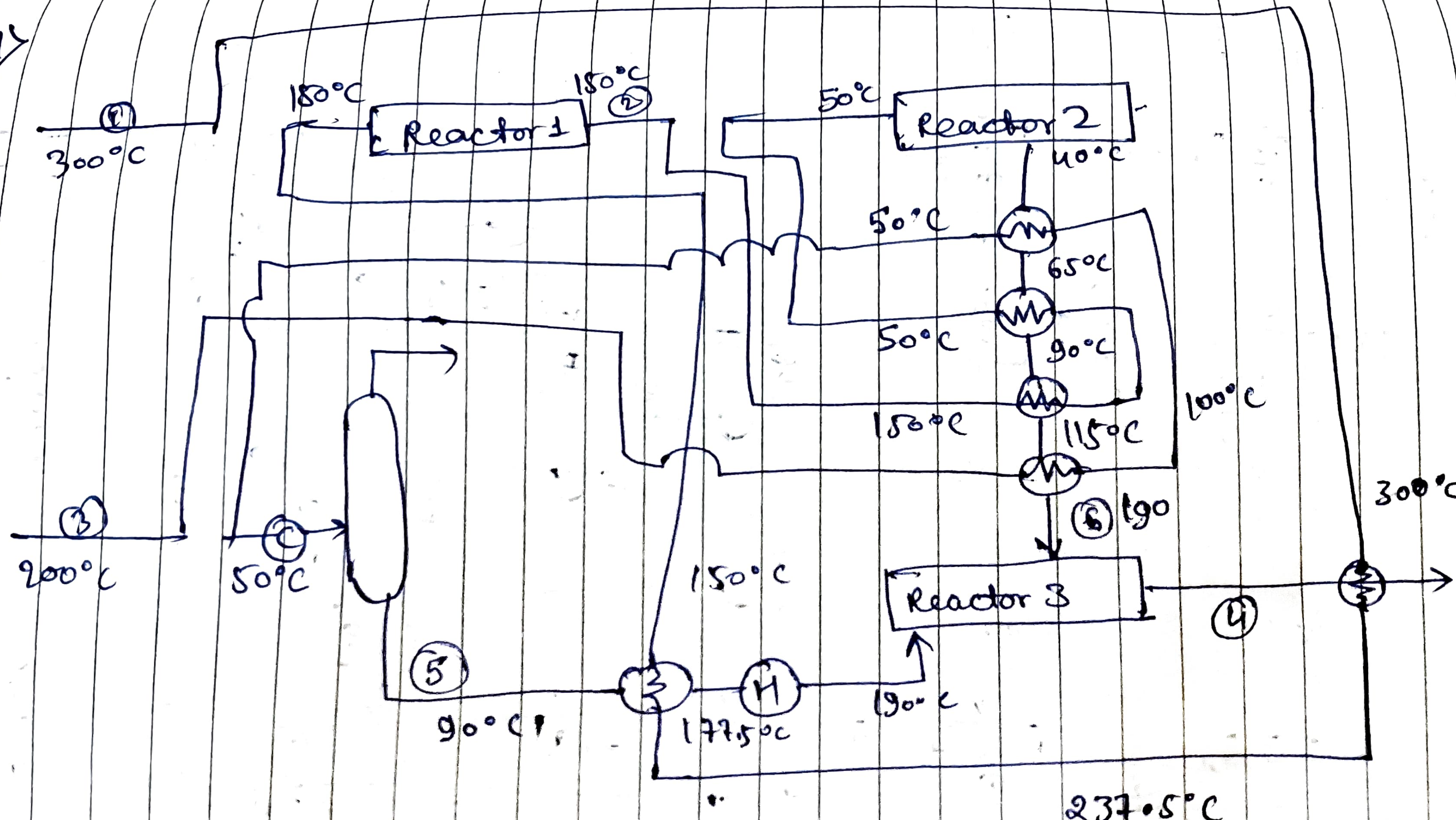
Cold Utility

For hot utility, energy given ⇒ 0.1 MW
For cold Utility, energy taken ⇒ 0.05 MW





d)



300°C
1
180°C
Reactor 1
150°C
2
50°C
Reactor 2
40°C
50°C
65°C
50°C
90°C
150°C
115°C
100°C
3
200°C
C
50°C
6
190
300°C
150°C
Reactor 3
4
5
90°C
H
190°C
177.5°C
237.5°C