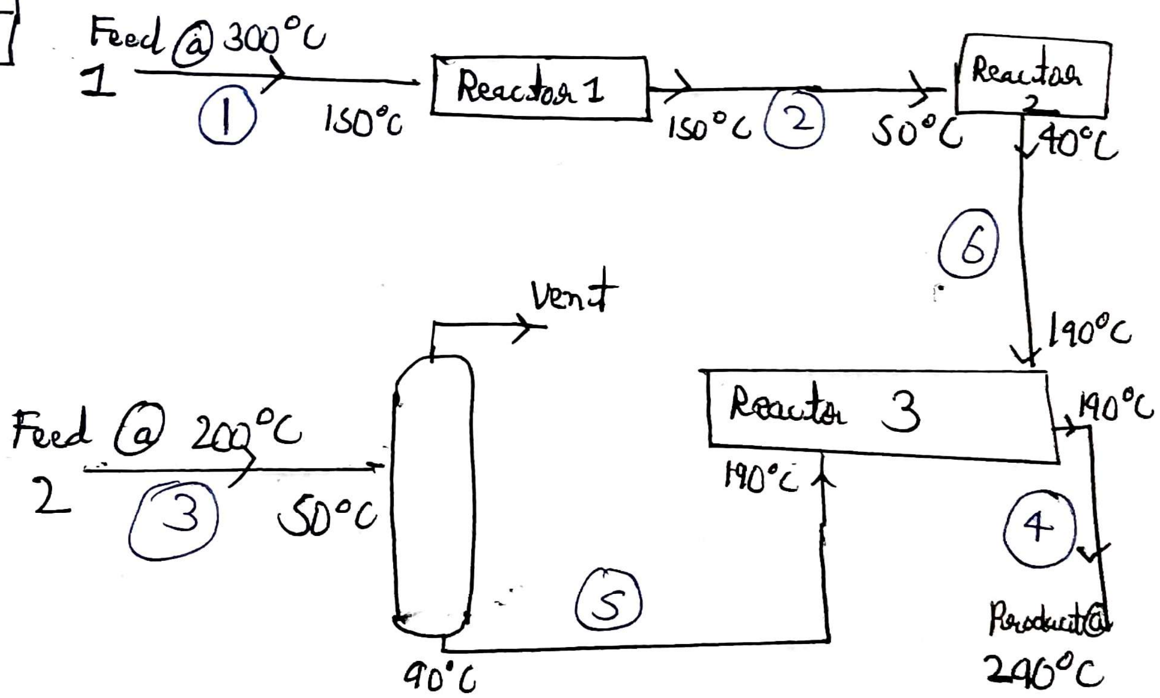
Q3)

Stream No.	Flow Rate $\dot{m}$ (kg/s)	Cp (kJ/kg °C)	Tin (°C)	Tout (°C)	Type	ΔH (kW) ~~(kJ)~~
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	140	Cold	+600

$\dot{m}Cp$
+8
+2
+3
+5
8
4

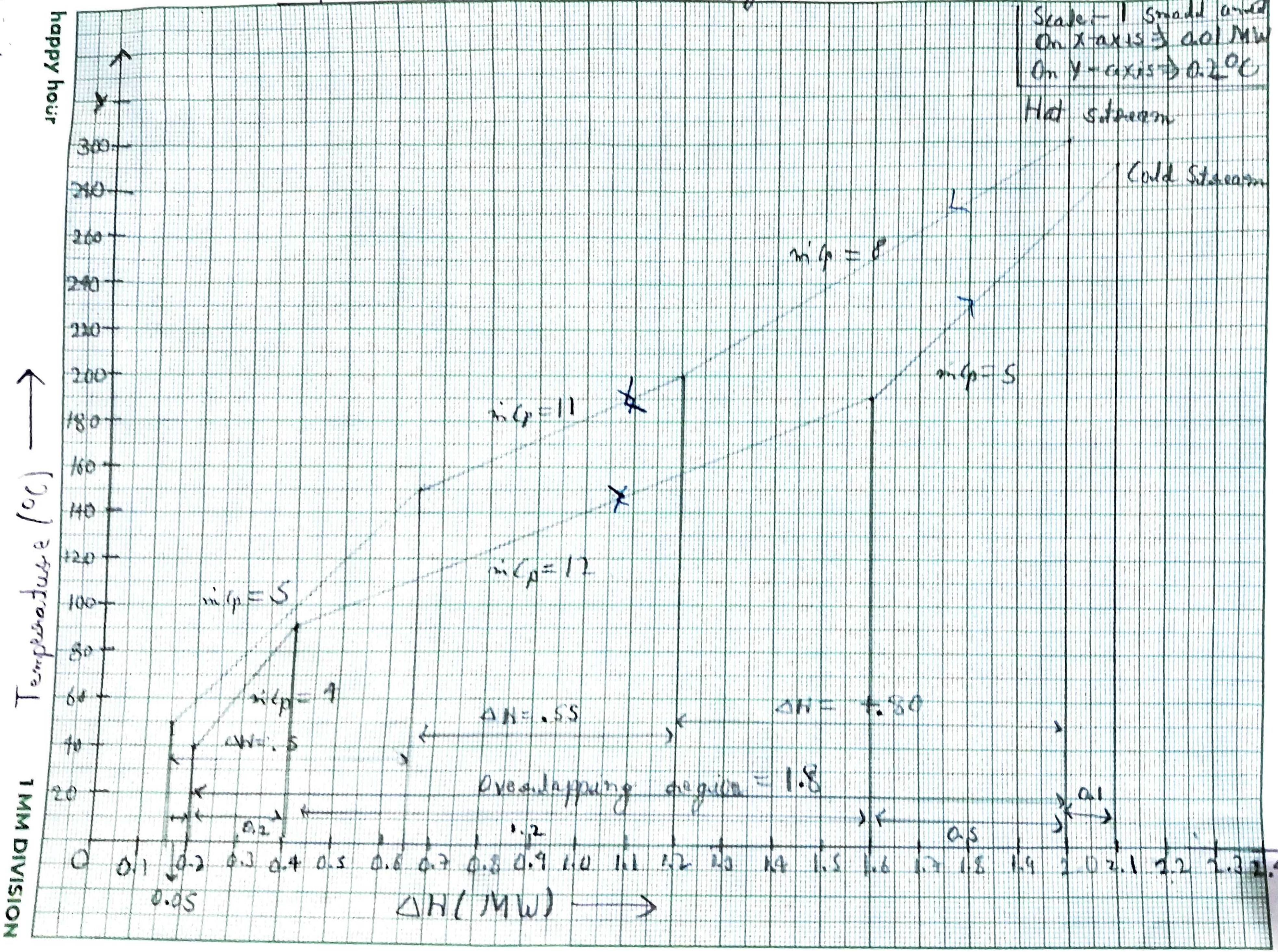
$$\Delta H_{-ve} = -1850$$

$$\Delta H_{+ve} = +1900$$



...from | Composite $\dot{m}C_p$ | ΔH-ve coverage

Composite Temperature - Enthalpy Curve



b) To calculate pinch temperat...

In hot streams:-

(MW)

T range	Composite $\dot{m}C_p$	ΔH-ve coverage
200 − 300	8	− 0.800
150 − 200	11	−.550
50 − 150	5	−.500

In cold streams:-

(MW)

T range	Composite $\dot{m}C_p$	ΔH+ve coverage
190 − 290	5	0.500
90 − 190	12	1.200
40 − 90	4	0.200

From the graph,

We can see that $\Delta T_{min} = 10°C$ first occur at the point when cold stream is at 90°C when we are bringing closer ~~to~~ two streams curve together.

So, Pinch temperature $= 90°C$

Also from the graph,

~~Heat Unit Heating Utility Unit~~ ~~$\rightarrow$ 0.05 MW~~

~~Cooling Utility Unit~~ ~~$\rightarrow$ 0.1 MW~~

Heat exchanger load $\rightarrow$ 1.8 MW

Hot Utility $= 0.1$ MW

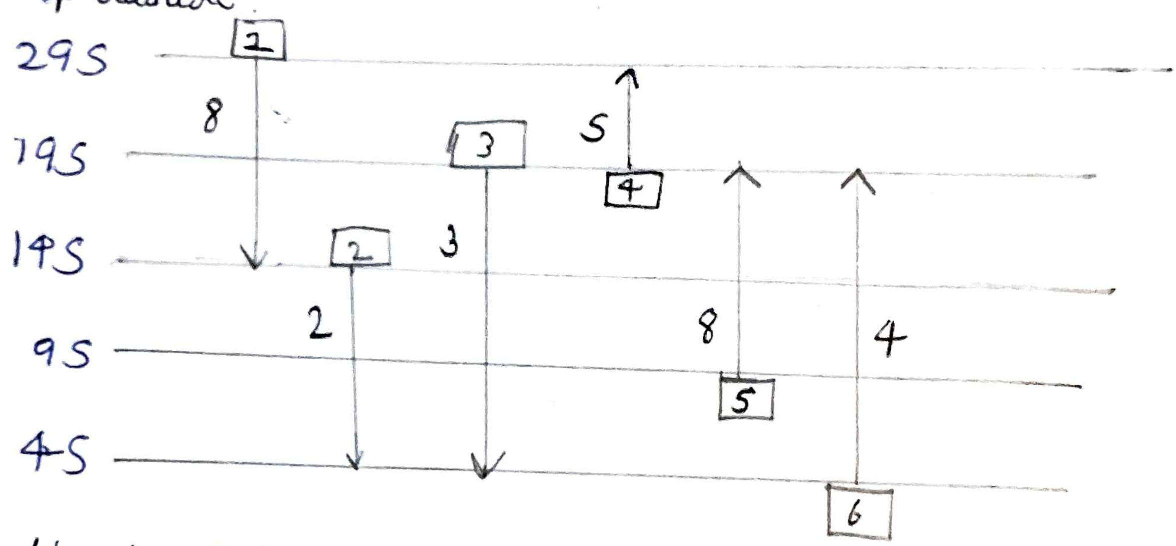
Cold Utility $= 0.05$ MW

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

T^0 Interval Heat Balances :-

~~Temperature~~

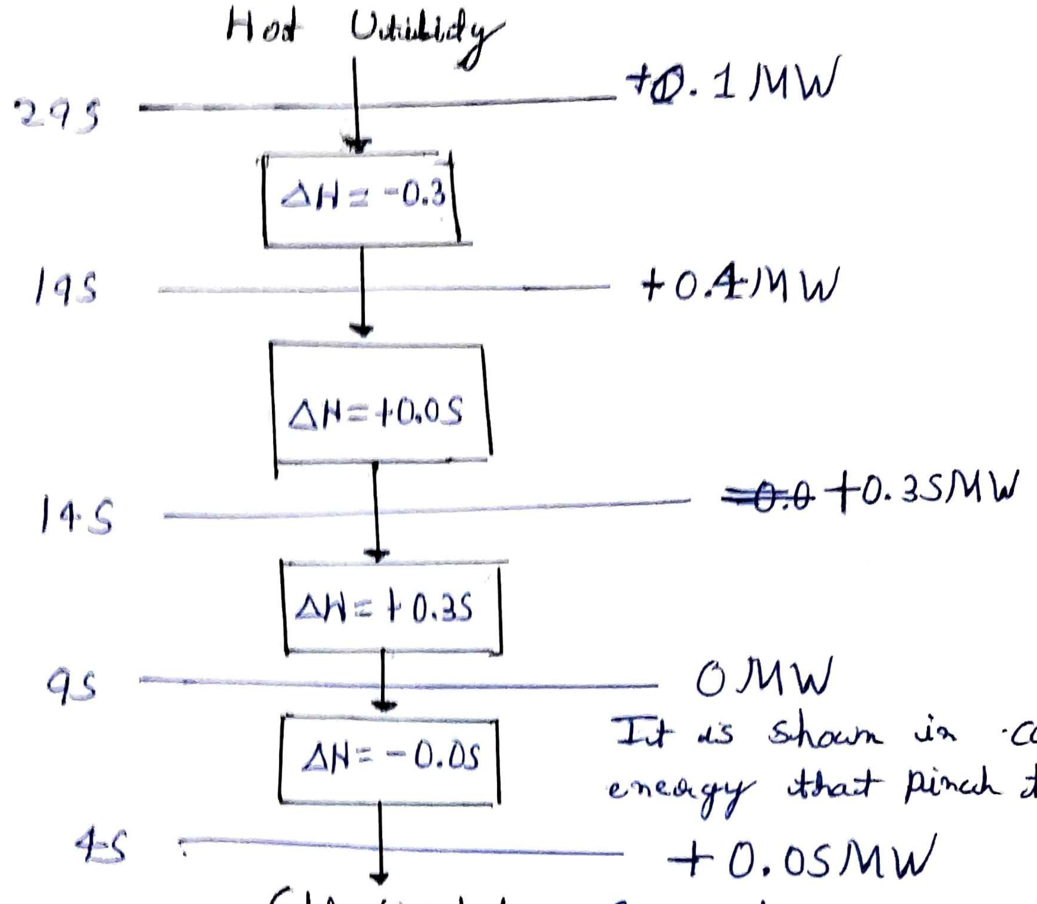


Heat Balances :-

ΔT(Interval) (°C)	$\Sigma CP_C - \Sigma CP_H$ MW/K	$\Delta H_{Interval}$ (MW)	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

$\cancel{T_S^* = T_S + \frac{\Delta T_{min}}{2}}$

Cascade Energy from High to low temperature

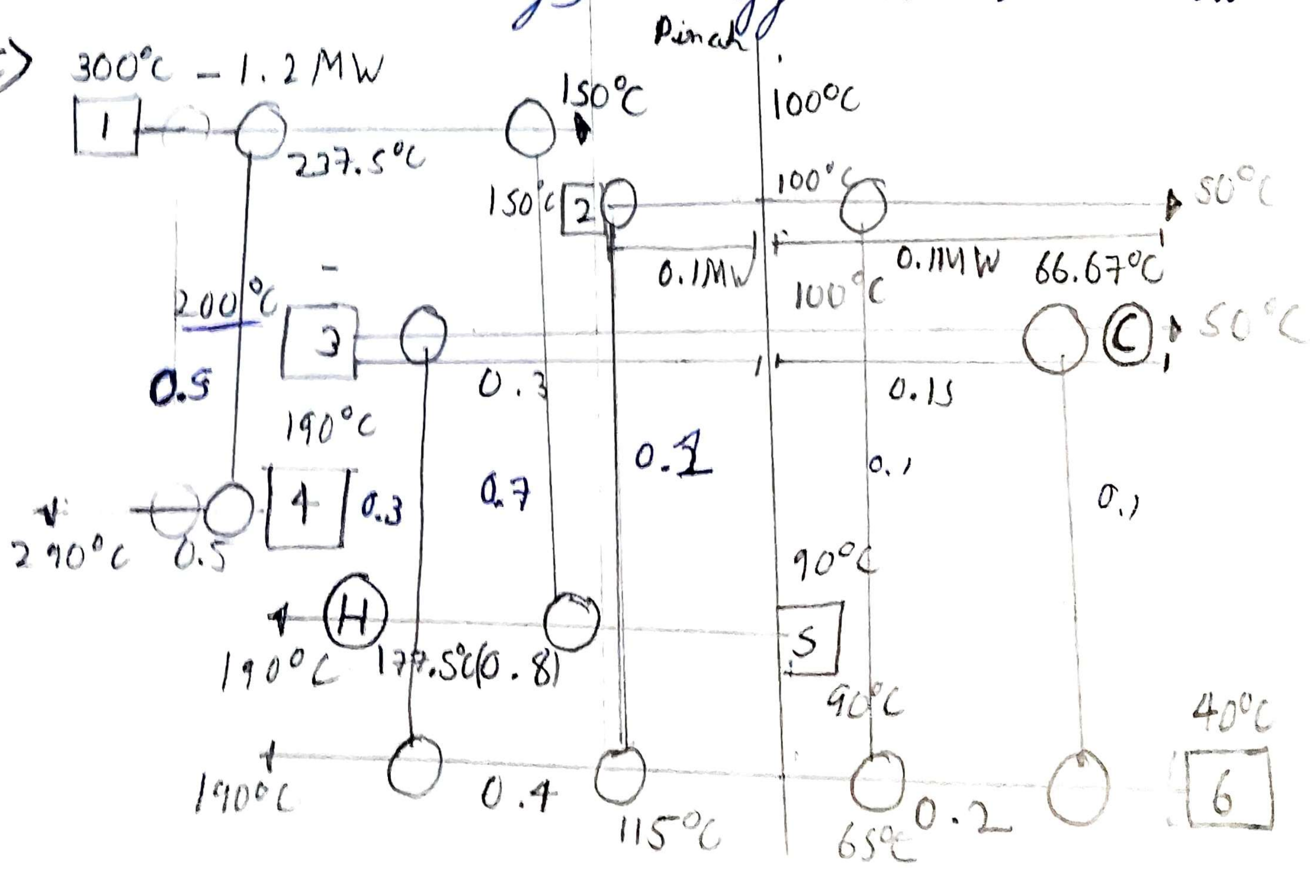


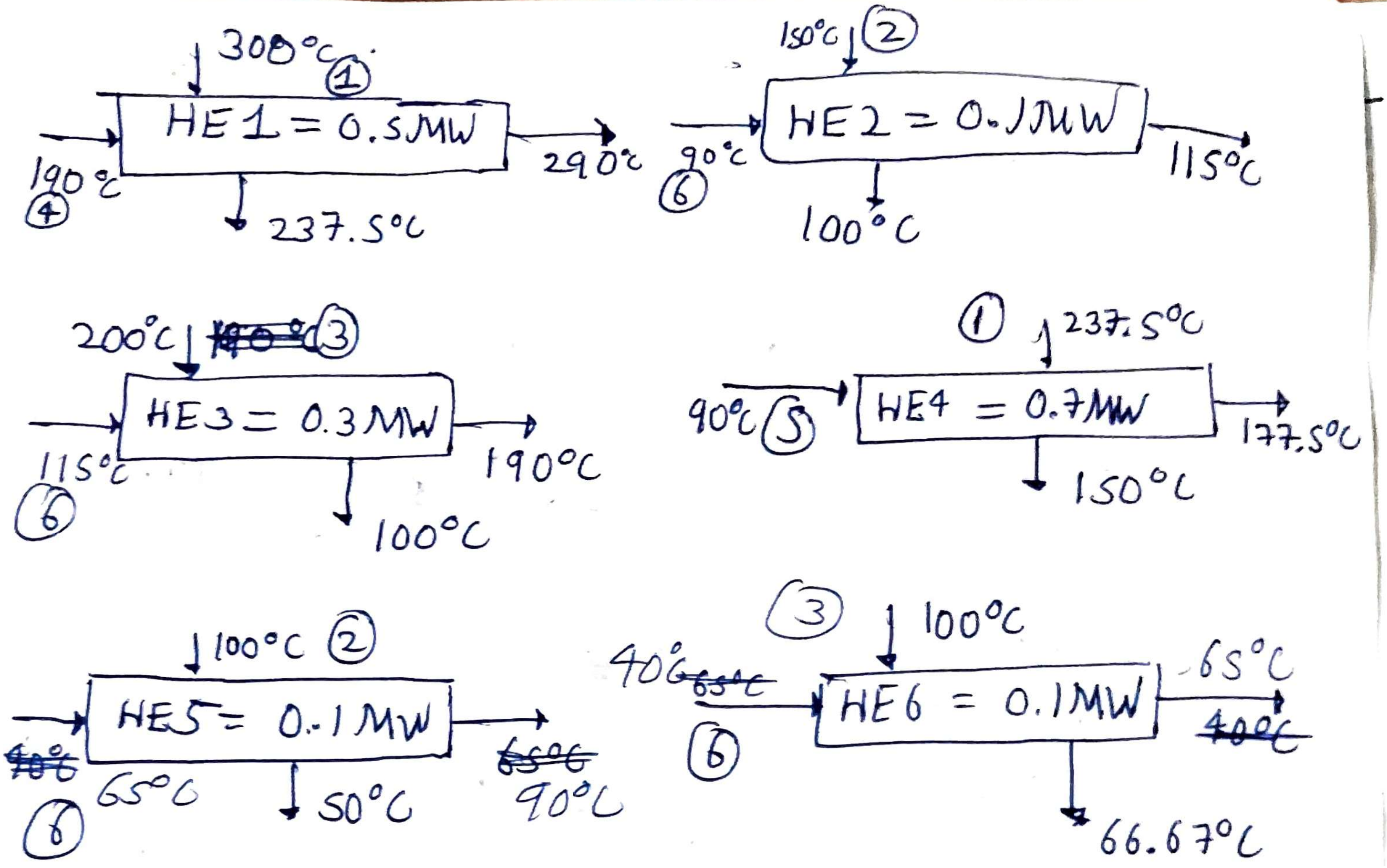
It is shown in cascade energy that pinch temp. is 90°C

Similarly,

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

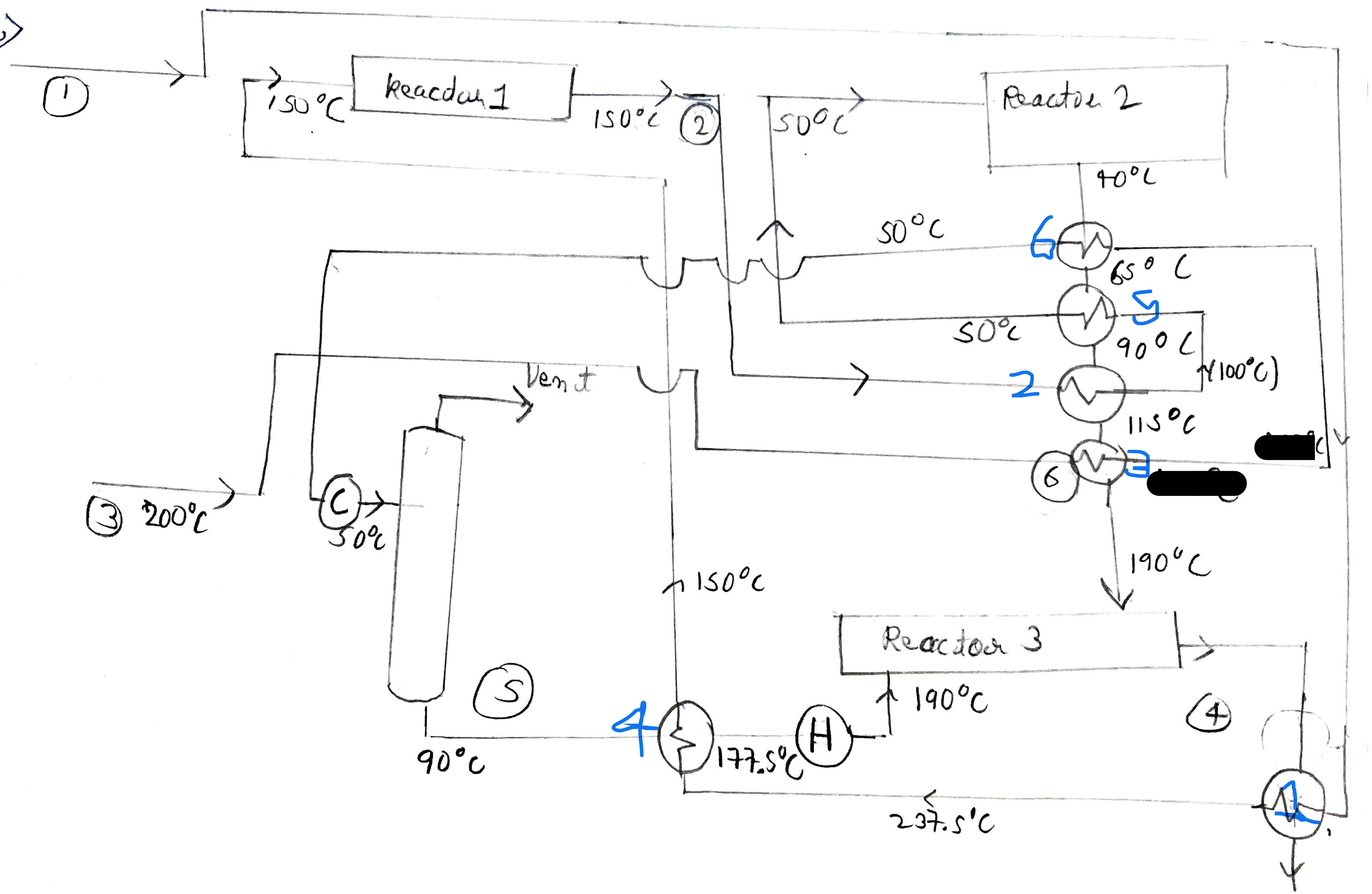
c)





HE1 = 0.5MW
300°C
1
190°C
4
290°C
237.5°C
HE2 = 0.1MW
150°C
2
90°C
6
115°C
100°C
HE3 = 0.3MW
200°C
3
115°C
6
190°C
100°C
HE4 = 0.7MW
1
237.5°C
90°C
5
177.5°C
150°C
HE5 = 0.1MW
100°C
2
~~40°C~~
65°C
6
~~65°C~~
90°C
50°C
HE6 = 0.1MW
3
100°C
40°C
~~65°C~~
6
65°C
~~40°C~~
66.67°C

(d)



1
150°C
Reactor 1
150°C
2
50°C
Reactor 2
40°C
50°C
6
65° C
5
50°C
90° C
(100°C)
2
115°C
[redacted]
6
3
[redacted]
3
200°C
C
50°C
Vent
150°C
190°C
Reactor 3
190°C
S
4
H
90°C
177.5°C
237.5°C
4
1