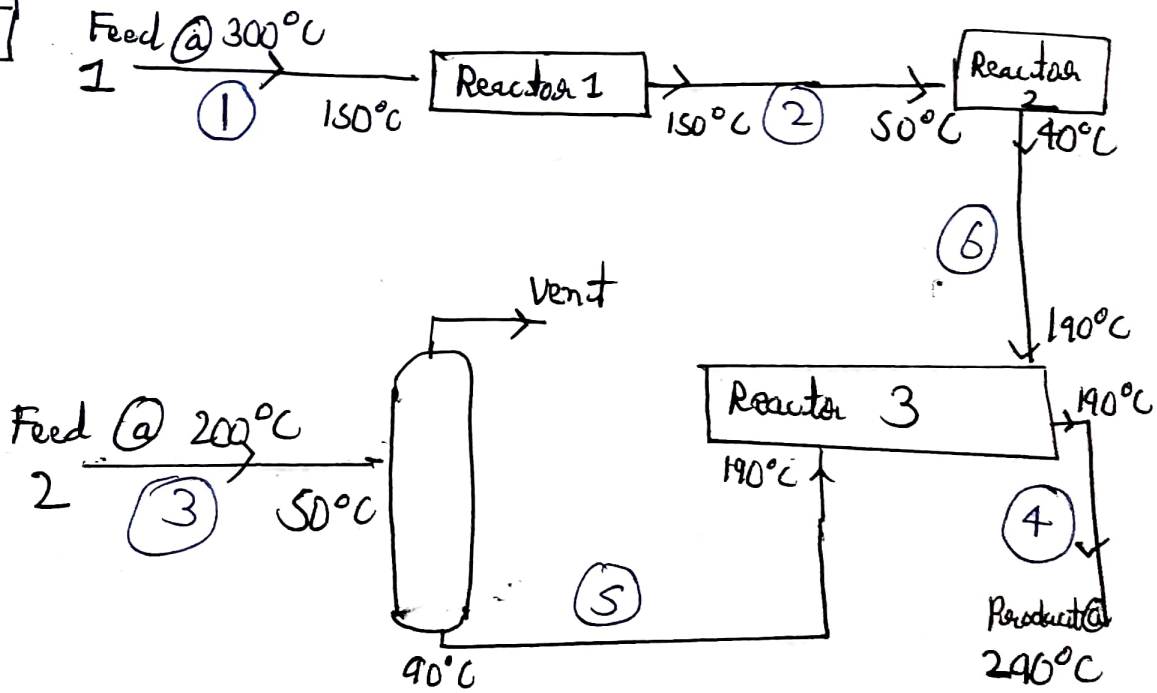
Q3)

Stream No.	Flow Rate $\dot{m}$ (kg/s)	Cp (kJ/kg °C)	T_{in} (°C)	T_{out} (°C)	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

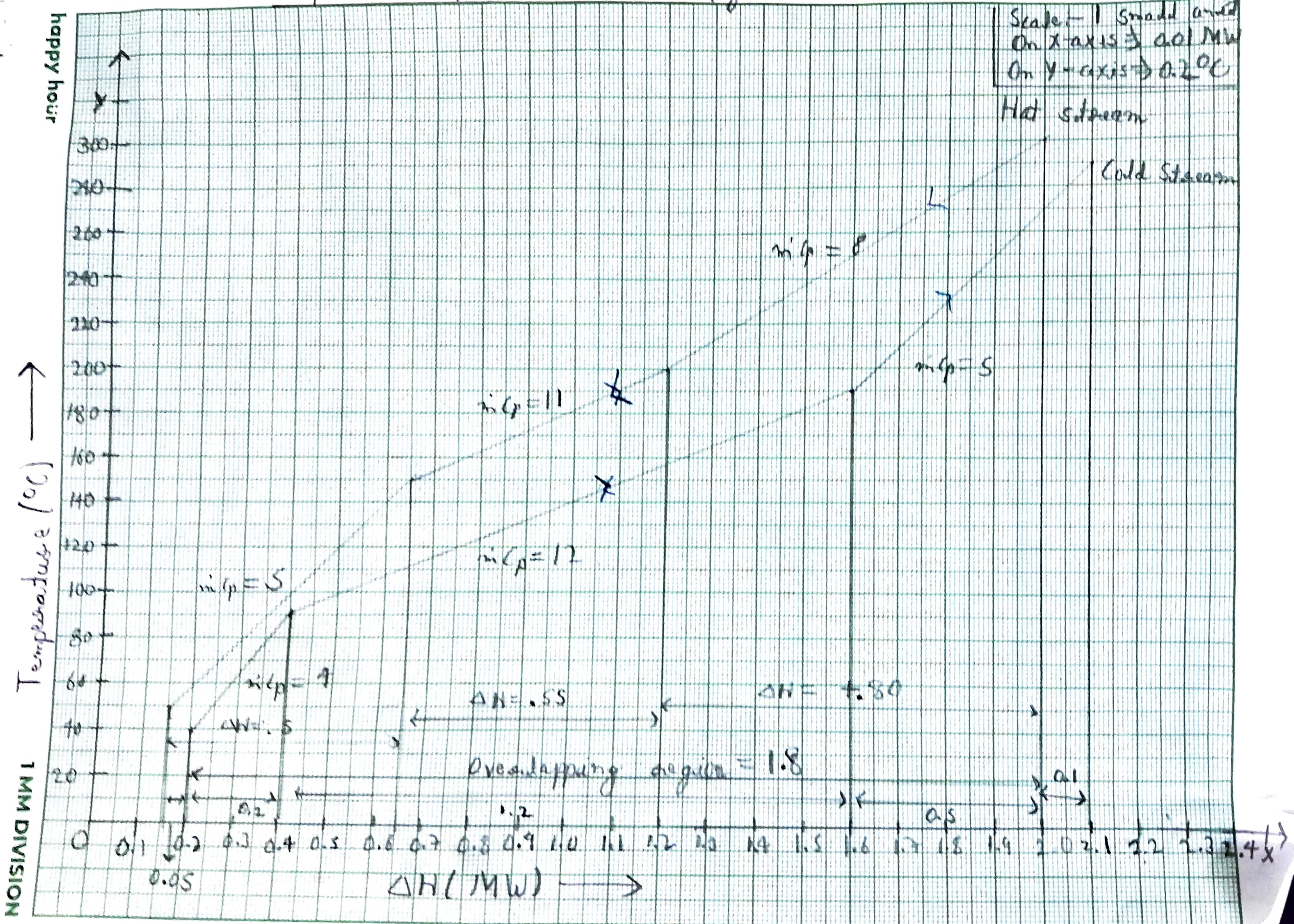
$\dot{m}Cp$
+8
+2
+3
+5
8
4

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

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



Composite Temperature - Enthalpy Curve



b) To calculate pinch temperature ...

In hot streams :-

Trange	Composite mCp	ΔH -ve coverage (MW)
200 - 300	.8	-0.800
150 - 200	11	-.550
50 - 150	5	-.500

In cold streams :-

Trange	Composite mCp	ΔH +ve coverage (MW)
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 two streams curve together.

So, Pinch temperature = 90°C

Also from the graph,

~~Heat Unit Heating Utility Unit => 0.05MW~~

~~Cooling Utility Unit => 0.1MW~~

Heat exchanger load => 1.8 MW

Hot Utility = 0.1 MW

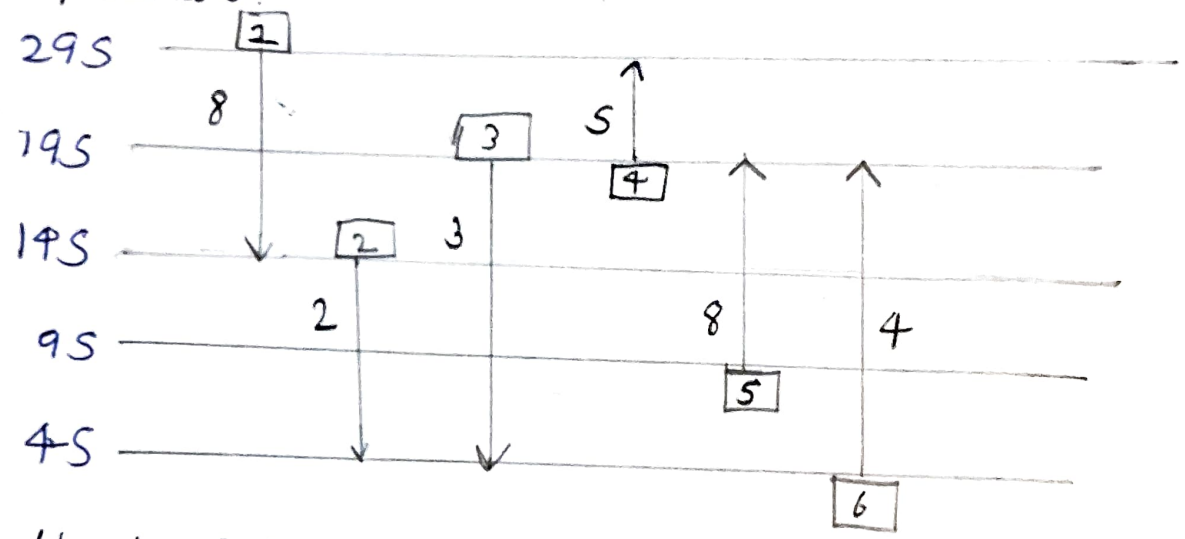
Cold Utility = 0.05MW

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° Interval Heat Balances:—

~~Temperature~~

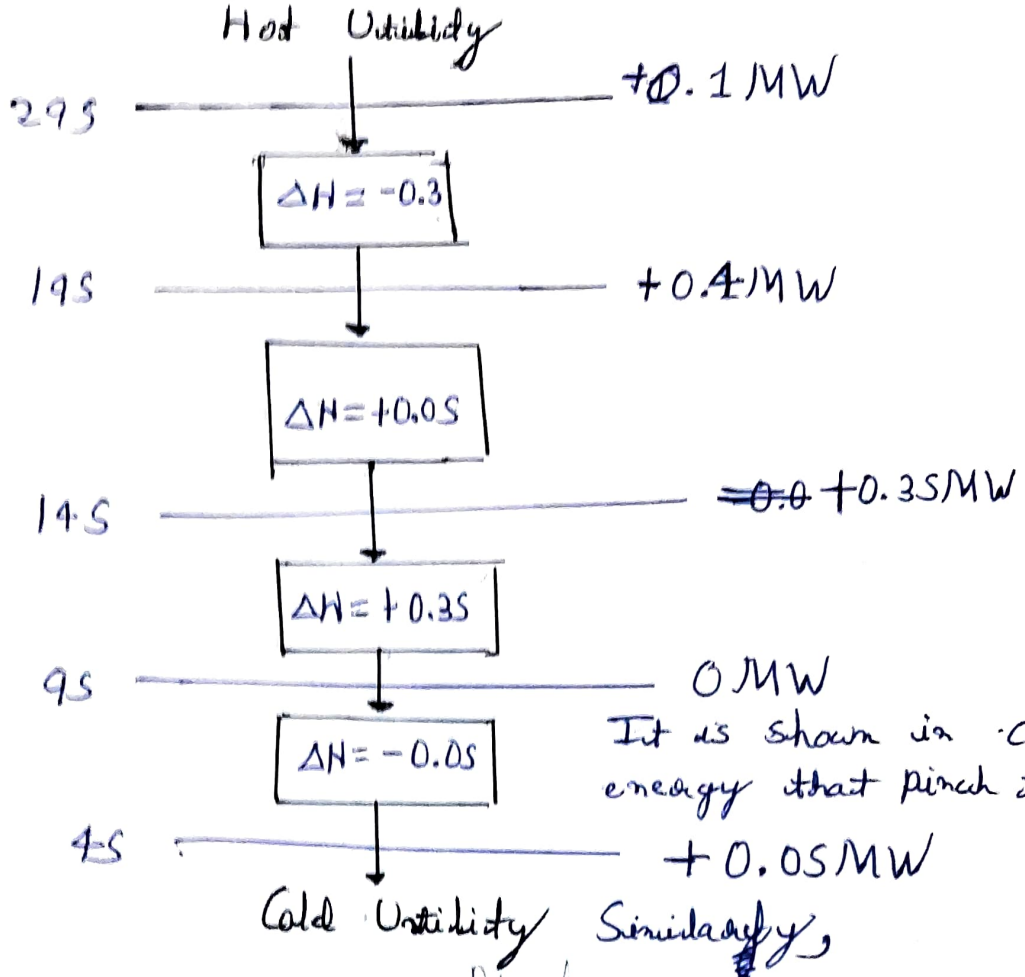


Heat Balances:—

ΔT (Interval) (°C)	$\Sigma CP_C - \Sigma CP_H$ MW °K⁻¹	ΔH Interval (MW)	Surplus/ Deficit
100	-3×10^{-3}	−0.3	Surplus
50	$+1 \times 10^{-3}$	+0.05	Deficit
50	7×10^{-3}	+0.35	Deficit
50	-1×10^{-3}	−0.05	Surplus

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

Cascade Energy from High to low temperature



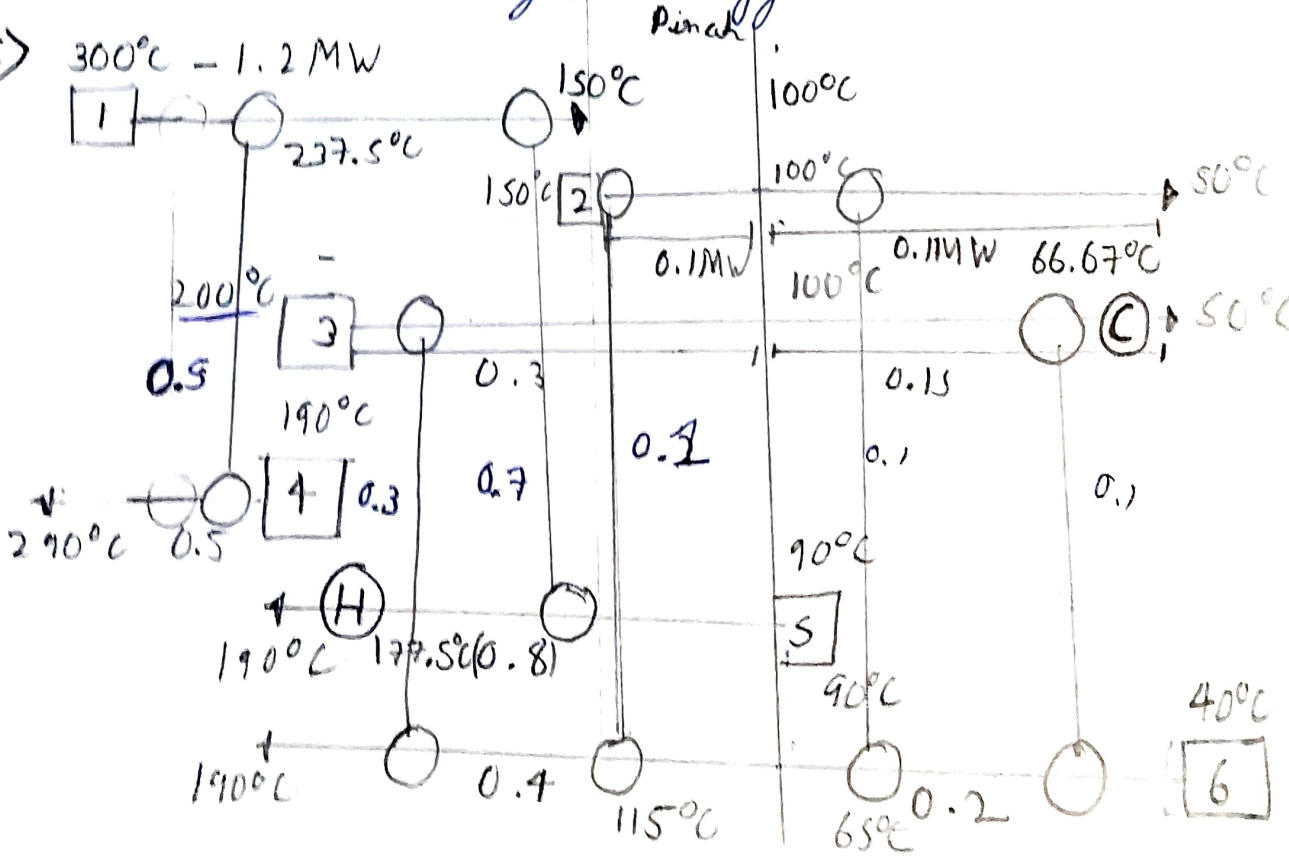
It is shown in cascade energy that pinch temp. is 90°C

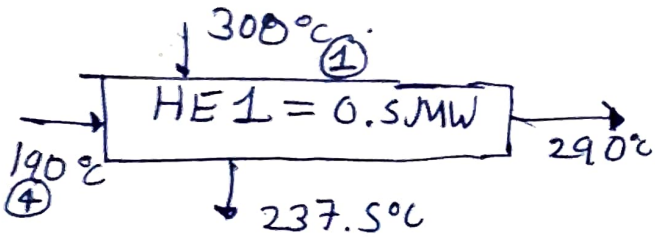
Similarly,

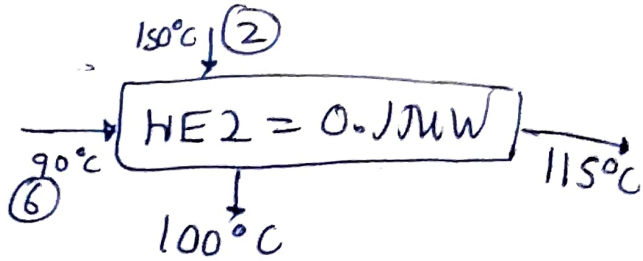
For hot utility, energy given ⇒ 0.1 MW

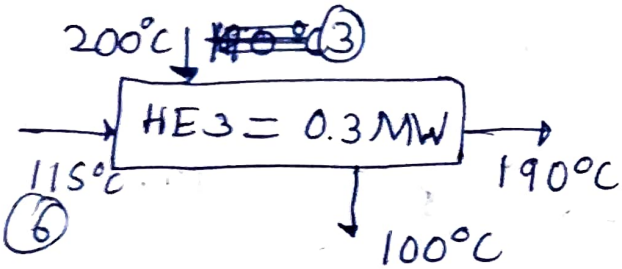
For cold utility, energy taken ⇒ 0.05 MW

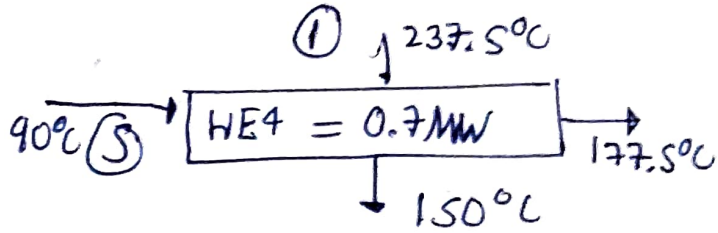
c)

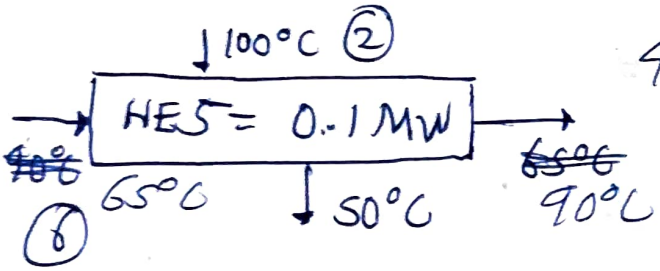


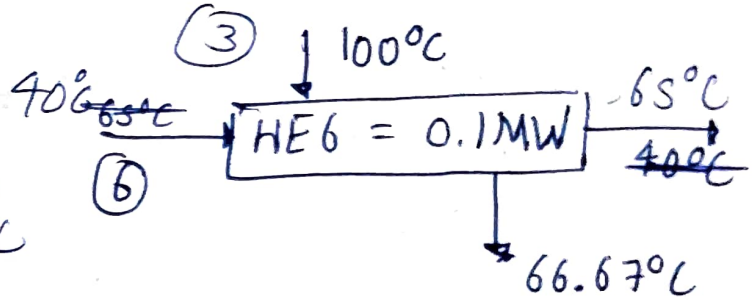

300°C
①
HE 1 = 0.5 MW
190°C
④
290°C
237.5°C

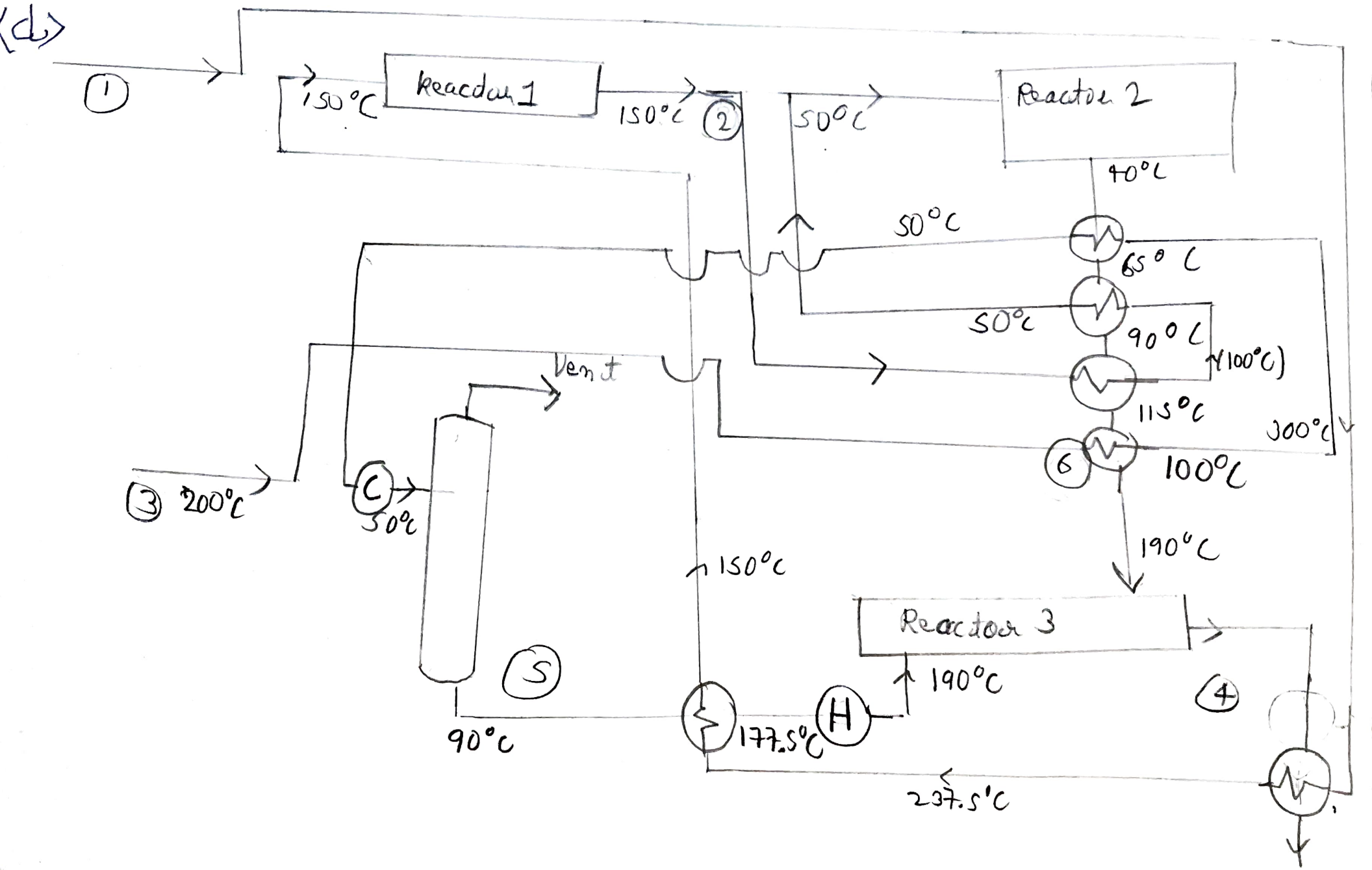

150°C
②
HE 2 = 0.1 MW
90°C
⑥
115°C
100°C


200°C
③
HE 3 = 0.3 MW
115°C
⑥
190°C
100°C


①
237.5°C
90°C
⑤
HE 4 = 0.7 MW
177.5°C
150°C


100°C
②
HE 5 = 0.1 MW
40°C
⑧
65°C
50°C
90°C


③
100°C
40°C
65°C
⑥
HE 6 = 0.1 MW
65°C
40°C
66.67°C


(d)
1
150°C
Reactor 1
150°C
2
50°C
Reactor 2
40°C
50°C
65°C
50°C
90°C
(100°C)
115°C
300°C
6
100°C
Vent
3
200°C
C
50°C
190°C
150°C
Reactor 3
190°C
4
S
90°C
177.5°C
H
237.5°C