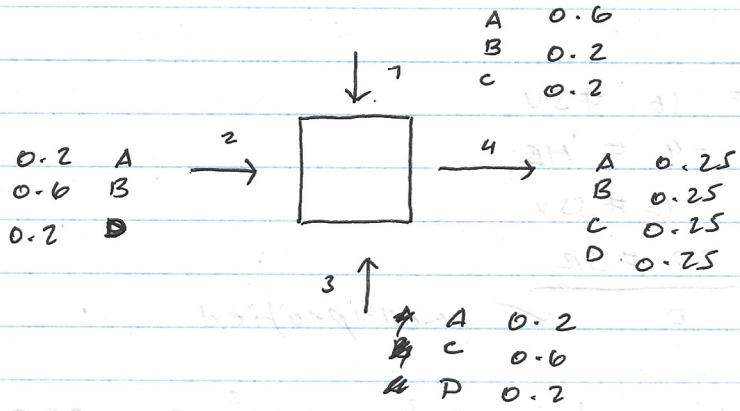
2.16

(a)

Feed Alloys (wt %)

Components	1	2	3	Desired
A	60	20	20	25
B	20	60	0	25
C	20	0	60	25
D	0	20	20	25

· yield 10 000 lbm/h of desired alloy



$F^4 = 10\,000$ lbm/h

Dof = 13 # SV	(A) $0.6F^1 + 0.2F^2 + 0.2F^3 = 0.25F^4$
− 4 # MB	(B) $0.2F^1 + 0.6F^2 = 0.25F^4$
− 10 # SSV	(C) $0.2F^1 + 0.6F^3 = 0.25F^4$
− 0 # SR	(D) $0.2F^2 + 0.2F^3 = 0.25F^4$
−1	overspecified

→ from MATLAB (week 7 Q3), we can show this is the case by presenting a contradiction

The flow rates are $F^1 = 880.28$ lbm/h

$F^2 = 4401.41$ lbm/h

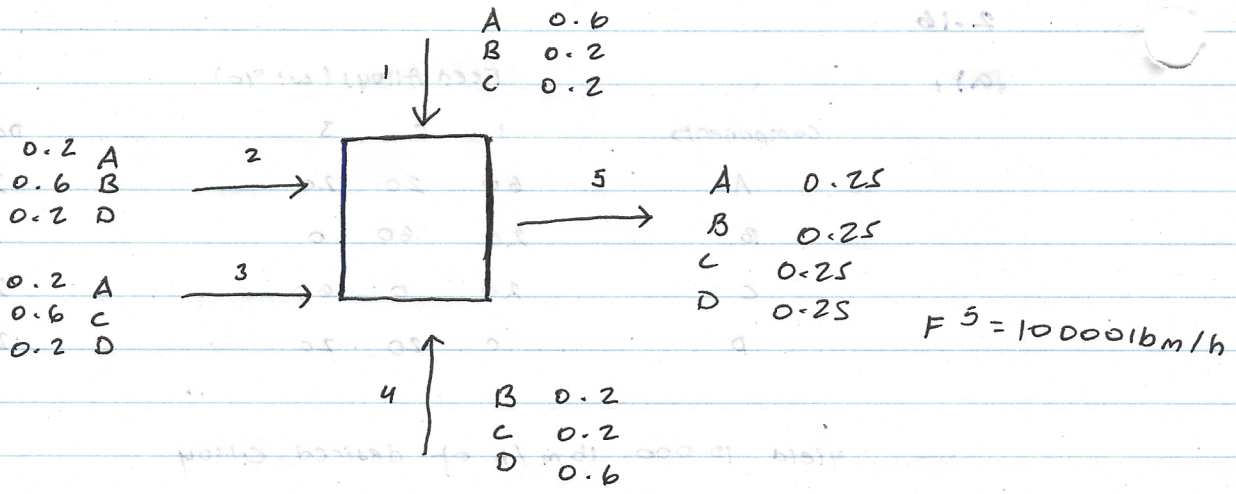
$F^3 = 4401.41$ lbm/h

However, by the conservation of mass, these must sum to F^4.

We see that $F^1 + F^2 + F^3 = 9683.10$ lbm/h $\neq 10\,000$ lbm/h

∴ The required conditions are not met.

b)



DoF = 16 # SV
- 4 # MB
- 12 # SSV
- 0 # SR
0 ✓ well-specified

(A) $0.6F^1 + 0.2F^2 + 0.2F^3 = 0.25F^5$

(B) $0.2F^1 + 0.6F^2 + 0.2F^4 = 0.25F^5$

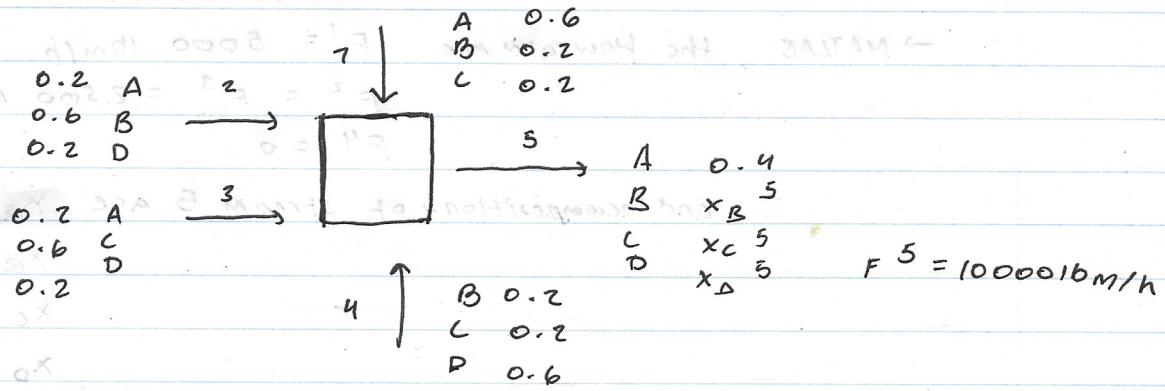
(C) $0.2F^1 + 0.6F^3 + 0.2F^4 = 0.25F^5$

(D) $0.2F^2 + 0.2F^3 + 0.6F^4 = 0.25F^5$

→ from MATLAB, the flow rates are

$$F^1 = F^2 = F^3 = F^4 = 2500 \text{ lbm/h}$$

c)



$F^5 = 1000016 M/h$

Dof = 16 # SV
- 4 # MB
- 10 # SSV
- 1 # SR

1 underspecified

(SR) $x_B^5 = x_C^5$

since we have 1 degree of freedom, lets appoint $F^4 = 0$

(A) $0.6F^1 + 0.2F^2 + 0.2F^3 = 0.4F^5$

(B) $0.2F^1 + 0.6F^2 = x_B^5 F^5$

(C) $0.2F^1 + 0.6F^3 = x_C^5 F^5$

(D) $0.2F^2 + 0.2F^3 = x_D^5 F^5$

$\Downarrow$ $x_B^5 = x_C^5$, $x_D^5 = 1 - 0.4 - 2x_B^5$

(A) $0.6F^1 + 0.2F^2 + 0.2F^3 = 0.4F^5$

(B) $0.2F^1 + 0.6F^2 - x_B^5 F^5 = 0$

(C) $0.2F^1 + 0.6F^3 - x_B^5 F^5 = 0$

(D) $0.2F^2 + 0.2F^3 + 2x_B^5 F^5 = (1 - 0.4) F^5$

→ MATLAB, the flowrates are $F^1 = 5000$ lbm/h

$F^2 = F^3 = 2500$ lbm/h

$F^4 = 0$

and the composition of stream 5 are $x_A^5 = 0.40$

$x_B^5 = 0.25$

$x_C^5 = 0.25$

$x_D^5 = 0.10$

Check: $F^1 + F^2 + F^3 + F^4 = 5000 + 2 \cdot 2500 + 0$

$= 10\,000 = F^5$ ✓