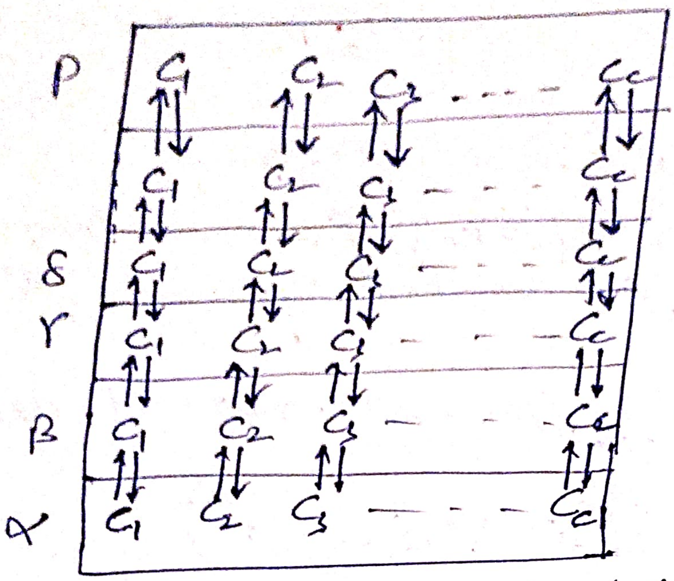
Derivation of Gibbs phase rule :-



A system of C components distributed through P phases.

Consider a system of C components ($C_1, C_2, C_3 \ldots C_c$) distributed b/w P phases ($\alpha, \beta, \gamma, \delta \ldots P$)

The state of each phase of the system is completely specified by the two variables, temperature & pressure and also by the composition of each phase.

$T, P, (x_{1,\alpha}, x_{2\alpha} \ldots x_{c,\alpha}), (x_{1,\beta}, x_{2,\beta} \ldots x_{c,\beta}) \ldots (x_{1,P}, x_{2,P}, \ldots x_{c,P})$

x_i's are the compositions of the component.

The total number of variables is thus $CP+2$

$$x_{1,\alpha} + x_{2,\alpha} + x_{3,\alpha} + \ldots = x_{1,\beta} + x_{2,\beta} + x_{3,\beta} + \ldots, \text{ etc.} = 1$$

$$\sum_i x_i P = 1 \qquad (i = 1, 2, 3 \ldots C)$$

For all the P phases separately. there are P relations of this type.

$$\mu_{1,\alpha} = \mu_{1,\beta} = \mu_{1,\gamma} = \cdots = \mu_{1,P}$$
$$\mu_{2,\alpha} = \mu_{2,\beta} = \mu_{2,\gamma} = \cdots = \mu_{2,P}$$
$$\cdots \quad \cdots \quad \cdots \quad \cdots$$
$$\mu_{c,\alpha} = \mu_{c,\beta} = \mu_{c,\gamma} = \cdots = \mu_{c,P}$$

there are P-1 separate equations for each component Hence, for C components, the number of such equations is $C(P-1)$

the chemical affinity, A_f. for each rxn at. eqlbm must be zero

$$A_{f,i} = 0 \quad (i = 1,2,3 \ldots, r')$$

Total number of restricting conditions is

$$P + C(P-1) + r'$$

$$F = (CP+2) - (P + CP - C + r') =$$
$$= 2 + (C - r') - P$$

If the system is non reactive $A_f = 0$ i.e. $r' = 0$

$$\boxed{F = C - P + 2.}$$