- Generic cubic equation of state:

$$Z = 1 + \beta - q\beta \frac{Z-\beta}{(Z+\varepsilon\beta)(Z+\sigma\beta)} \quad \text{(vapour and vapour-like roots)}$$

$$Z = 1 + \beta + (Z+\epsilon\beta)(Z+\sigma\beta)\left(\frac{1+\beta-Z}{q\beta}\right) \quad \text{(liquid and liquid-like roots)}$$

$$\text{with } \beta = \Omega\frac{P_r}{T_r} \quad \text{and} \quad q = \frac{\Psi\alpha(T_r)}{\Omega T_r}$$

$$\alpha_{\text{SRK}} = \left[1 + \left(0.480 + 1.574\omega - 0.176\omega^2\right)\left(1-\sqrt{T_r}\right)\right]^2$$

$$\alpha_{\text{PR}} = \left[1 + \left(0.37464 + 1.54226\omega - 0.26992\omega^2\right)\left(1-\sqrt{T_r}\right)\right]^2$$

EOS	α	σ	ε	Ω	Ψ
vdW	1	0	0	1/8	27/64
RK	$T_r^{-1/2}$	1	0	0.08664	0.42748
SRK	α_{SRK}	1	0	0.08664	0.42748
PR	α_{PR}	$1+\sqrt{2}$	$1-\sqrt{2}$	0.07780	0.45724

- Newton-Raphson (root-finder) method: $X_i = X_{i-1} - \dfrac{\mathcal{F}(X_{i-1})}{d\mathcal{F}/dX\,(X_{i-1})}$

- Fundamental thermodynamic equations:

$$dU = dQ + dW; \quad dH = dU + d(PV); \quad dA = dU - d(TS); \quad dG = dH - d(TS)$$
$$dU = TdS - PdV; \quad dH = TdS + VdP; \quad dA = -SdT - PdV; \quad dG = -SdT + VdP$$
$$dH = C_p dT + \left[V - T\left(\frac{\partial V}{\partial T}\right)_P\right]dP; \quad dS = C_p\frac{dT}{T} - \left(\frac{\partial V}{\partial T}\right)_P dP$$
$$dU = C_v dT + \left[T\left(\frac{\partial P}{\partial T}\right)_V - P\right]dV; \quad dS = C_v\frac{dT}{T} - \left(\frac{\partial P}{\partial T}\right)_V dV$$

- Polytropic Relations:

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} ;TV^{\gamma-1} = \text{ const; } TP^{\frac{1-\gamma}{\gamma}} = \text{ const; } PV^{\gamma} = \text{ const}$$

- Raoult's Law:

$$y_i P = x_i P_i^{\text{sat}} \quad \text{and} \quad y_i P = x_i \gamma_i P_i^{\text{sat}} \quad \text{with } i = 1, 2, \cdots N$$

- Henry's Law:

$$x_i \mathcal{H}_i = y_i P \quad \text{with } i = 1, 2, \cdots N$$

- Antoine Equation:

$$\log_{10} P^\star = A - \frac{B}{T+C} \quad \text{with P}^\star \text{ in mm-Hg and T in }^\circ\text{C}$$

- Solutions:

$$M^{\text{E}} = M - \sum_{i=1}^{N} x_i M_i; \; \overline{M}_1 = M + x_2\frac{dM}{dx_1}; \; \overline{M}_2 = M - x_1\frac{dM}{dx_1}$$