from lecture we know phase separation happens if

- G is concave down
- 2 points have same tangent line

now doing question,

$$RT \ln \gamma_1 = \alpha x_2^2 + \beta x_2^3$$
$$RT \ln \gamma_2 = \alpha x_1^2 + \beta x_1^3$$

when infinite dilution, the x present in eqns will be 1

- since γ_1 "depends" on x_2, γ_1^∞ is when x_2 approaches 1

$$RT\ (2) = \alpha_1 + \beta_1$$
$$RT\ (3) = \alpha_2 + \beta_2$$

Since this is 2 constant margules

$$\alpha_1 = A + 3B \qquad \alpha_2 = A - 3B$$
$$\beta_1 = -4B \qquad \beta_2 = 4B$$

Substitute into equations

$$2RT = (A + 3B) + (-4B) \quad (1)$$
$$3RT = (A - 3B) + (4B) \quad (2)$$

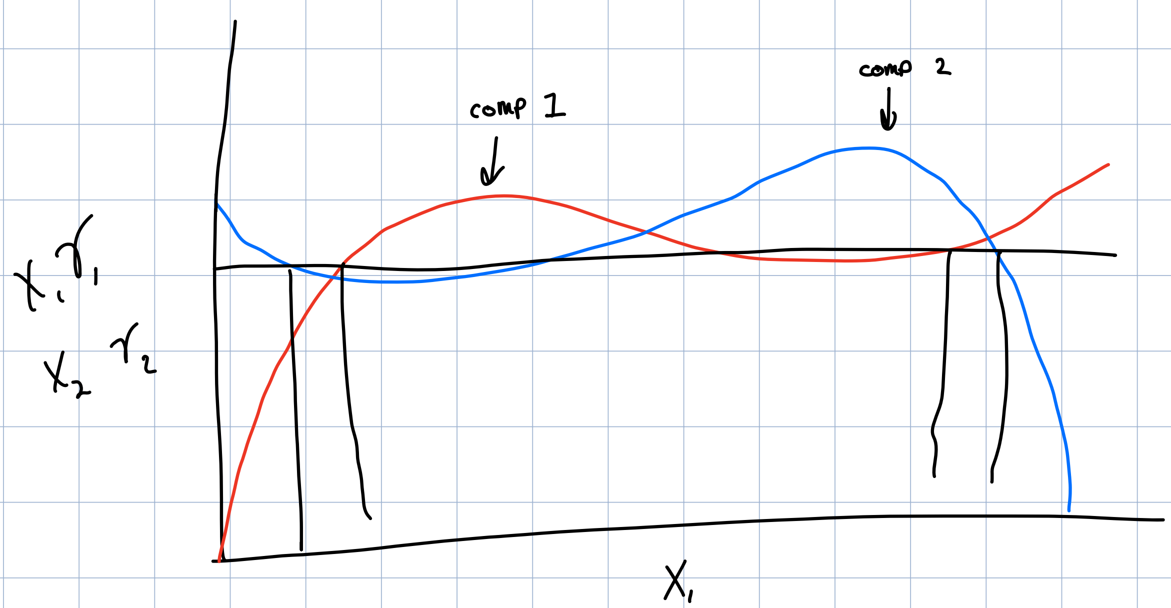
add (1) and (2)

$$5RT = 2A$$
$$A = 2.5\ RT$$

now sub into (2)

$$3RT = A + B$$
$$= 2.5RT + B$$
$$\Rightarrow \quad B = 0.5\ RT$$

now we can setup our $x\gamma$ vs x plots



essentially we need horizontal line test

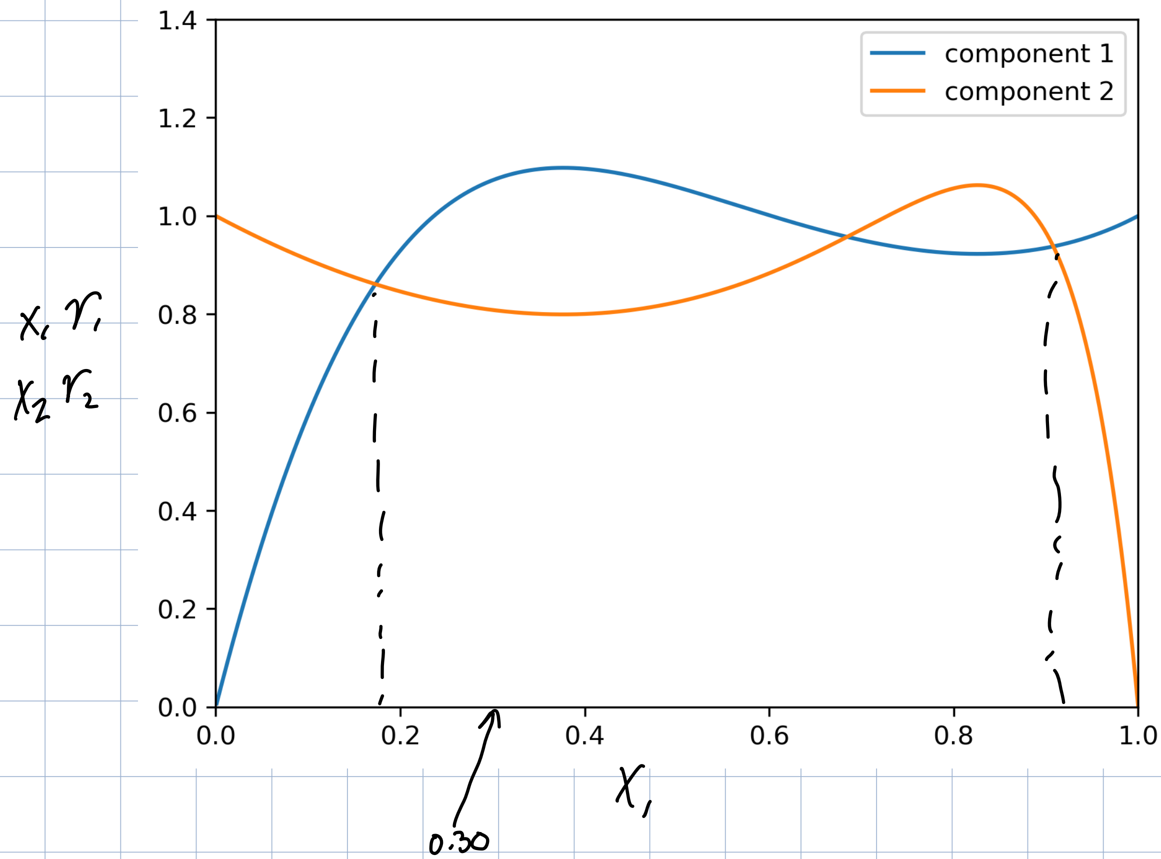
- if a horizontal line exists here s.t.

$$x_1^{I} \gamma_1^{I} = x_1^{II} \gamma_1^{II}$$

and

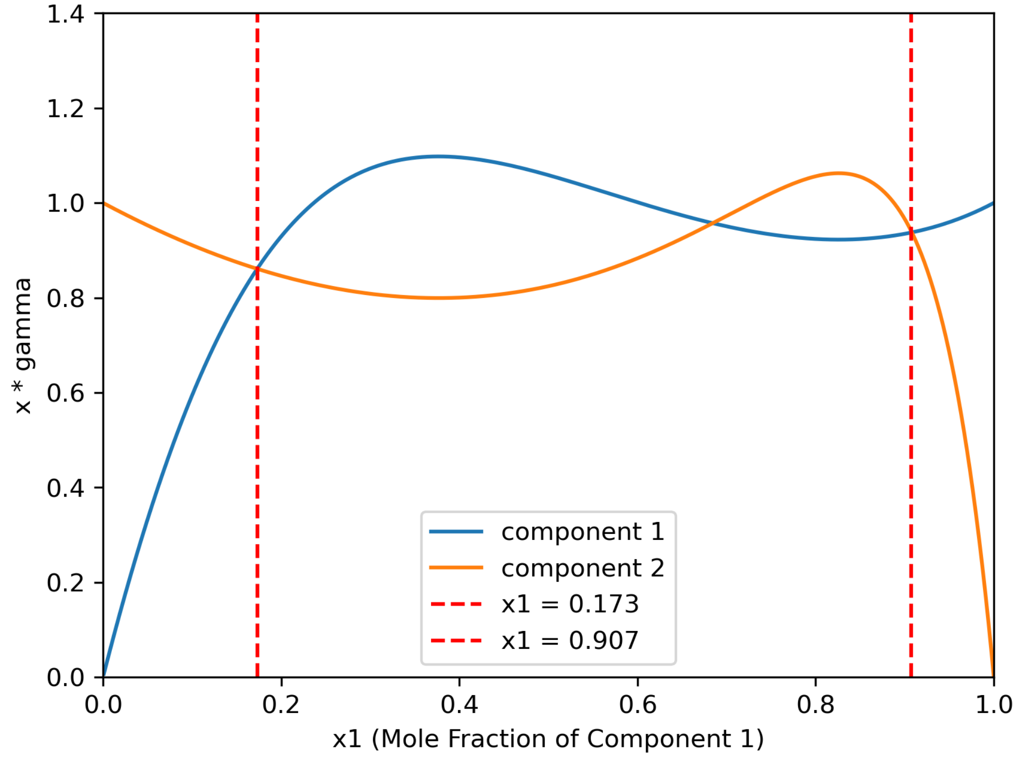
$$x_2^{I} \gamma_2^{I} = x_2^{II} \gamma_2^{II}$$

graph generated w/ Python code



right away we see LLE exists since $x_1 = 0.30$ is in between the outer intersections.

if you work out the true values of the intersections



Code :

```python
import numpy as np
import matplotlib.pyplot as plt
from scipy.constants import R

A = 2.5
B = 0.5
alpha1 = A + 3*B
alpha2 = A - 3*B
beta1 = -4*B
beta2 = 4*B

x1 = np.linspace(0.001, 0.99999,1000)
x2 = 1 - x1
ln(gamma1) = ((alpha1 * (x2**2) + beta1 * (x2**3)))
ln(gamma2) = ((alpha2 * (x1**2) + beta2 * (x1**3)))

fig,ax = plt.subplots(dpi=300)

plt.plot(x1, x1*np.exp(gamma1))
plt.plot(x1, x2*np.exp(gamma2))
plt.ylim(0,1.4)
plt.xlim(0,1)
plt.legend(['component 1', 'component 2'])
```

✓ 0.2s