## Assignment 6

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment.

**1.** Find the Eigenvalues of the following ternary interdiffusivity matrix:

\[
D = \begin{bmatrix} 1.4 & -1.8 \\ -0.5 & 2 \end{bmatrix} \times 10^{-12} \text{ m}^2/\text{s}
\]

- (0.562, 0.567) \times 10^{-12} \text{ m}^2/\text{s}
- (0.522, 3.451) \times 10^{-12} \text{ m}^2/\text{s}
- (0.761, -2.695) \times 10^{-12} \text{ m}^2/\text{s}
- (2.799, 0.657) \times 10^{-12} \text{ m}^2/\text{s}

No, the answer is incorrect. Score: 0

Accepted Answer:
\[ (0.562, 0.567) \times 10^{-12} \text{ m}^2/\text{s} \]

**2.** Find the similarity transformation matrix \( P \) for the interdiffusivity matrix in Problem 1 such that \( P^T D P = \lambda \) where \( \lambda \) is the diagonal matrix of Eigenvalues of \( D \).

- \( \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \)
- \( \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix} \)
- \( \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \)
- \( \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \)

No, the answer is incorrect. Score: 0

Accepted Answer:
\[ \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix} \]

**3.** A single-phase alloy of component 1-2-3 exhibits micro-segregation with a sinusoidal pattern of period 100 pm. The average composition and amplitudes of the initial sinusoidal pattern are given in the table below. Determine the composition at a location of \( x = 20 \) pm after homogenization of the alloy at 700°C for 12 hours. Assume that the molar volume and interdiffusivity matrix are independent of composition. The interdiffusivity matrix at 700°C is given as follows:

\[
D = \begin{bmatrix} 1.4 & -1.8 \\ -0.5 & 2 \end{bmatrix} \times 10^{-12} \text{ m}^2/\text{s}
\]

<table>
<thead>
<tr>
<th>Compositions (in atom%)</th>
<th>Component-1</th>
<th>Component-2</th>
<th>Component-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average composition (c)</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Amplitudes (c')</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

- \( (c_1, c_2, c_3) = (0.3, 0.3, 0.4) \) atom% each
- \( (c_1, c_2, c_3) = (0.2, 0.2, 0.1) \) atom% each
- \( (c_1, c_2, c_3) = (0.4, 0.3, 0.2) \) atom% each
- \( (c_1, c_2, c_3) = (0.2, 0.2, 0.1) \) atom% each

No, the answer is incorrect. Score: 0

Accepted Answer:
\( (c_1, c_2, c_3) = (0.2, 0.2, 0.1) \) atom% each

**4.** In Problem 3 above, what should be the amplitudes of the profiles at the end of 12 hours of homogenization at 700°C?

- \( (c_1, c_2, c_3) = (0.3, 0.2, 0.5) \) atom%
- \( (c_1, c_2, c_3) = (0.4, 0.3, 0.2) \) atom%
- \( (c_1, c_2, c_3) = (0.2, 0.4, 0.5) \) atom%
- \( (c_1, c_2, c_3) = (0.3, 0.2, 0.5) \) atom%

No, the answer is incorrect. Score: 0

Accepted Answer:
\( (c_1, c_2, c_3) = (0.2, 0.2, 0.1) \) atom%

**5.** A single-phase binary alloy exhibits an initial concentration profile given by the following periodic function with period \( 2 \lambda \), amplitude \( b \), and average concentration \( C \).

\[
C(x, 0) = C + 2b \sin \left( \frac{2\pi x}{2\lambda} \right) \text{ mol/m}^3
\]

If the alloy is subjected to homogeneous heat treatment for time \( t \), derive the equation for the concentration profile as a function of distance coordinate \( x \) and homogenization time \( t \). Assume constant interdiffusion coefficient and constant molar volume. The concentration at \( x = 0 \), \( t = 0 \) remains constant at \( C \) at all times.

- \( x(t) = C + b \sin \left( \frac{2\pi x}{2\lambda} \right) \exp (-D\tau) \text{ mol/m}^3 \)
- \( x(t) = C + b \sin \left( \frac{2\pi x}{2\lambda} \right) \exp (-2D\tau) \text{ mol/m}^3 \)
- \( x(t) = C + b \sin \left( \frac{2\pi x}{2\lambda} \right) \exp (-D\tau) \text{ mol/m}^3 \)
- \( x(t) = C + b \sin \left( \frac{2\pi x}{2\lambda} \right) \exp (-2D\tau) \text{ mol/m}^3 \)

No, the answer is incorrect. Score: 0

Accepted Answer:
\( x(t) = C + b \sin \left( \frac{2\pi x}{2\lambda} \right) \exp (-D\tau) \text{ mol/m}^3 \)