1. (20 points) Using Einstein notation, work out the following quantities. For your final answers, carry out all summations.
   a. \( p \cdot v \)
   b. \( A \cdot d \)
   c. \( s + b \)
   d. \( B^T \cdot a \)
   e. \( A \cdot M \) (you may leave summation signs in this answer)

2. (10 points) What is the 23-component of this tensor:
   \( B^T \cdot A \)

3. (10 points) For the vectors given below, what are the following quantities equal to? Show your work in Einstein notation before substituting the numbers from below.
   a. \( a \cdot b \) (inner product)
   b. \( a \overline{b} \) (indeterminate vector product)

\[
a = \begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix}_{xyz}
\]
\[
b = \begin{pmatrix} -1 \\ 1 \\ 2 \end{pmatrix}_{xyz}
\]
4. (10 points) For \( \mathbf{v} = \begin{pmatrix} 0 \\ U_0 \\ 0 \end{pmatrix} \), what is \( \mathbf{v} \) in Cartesian coordinates? Note that \( U_0 \) is a constant and \( \mathbf{v} \) above is written in the cylindrical coordinate system. Your final answer should not contain \( r, \theta, z \) cylindrical coordinate variables or basis vectors but may contain \( x, y, z \) Cartesian coordinate variables and must be written with respect to Cartesian basis vectors \( \mathbf{e}_x, \mathbf{e}_y, \mathbf{e}_z \). What is \( \mathbf{v} \) at position \( x = 1, y = 2, z = 1 \)? What is \( \mathbf{v} \) at position \( x = 0, y = 0, x = 1 \)? Comment on your answer.

5. (10 points) What are the magnitudes of the tensors below? The quantities \( A \) and \( \beta \) are constants.

   a. \( \mathbf{M} = \begin{pmatrix} 1 & 1 & 1 \\ -1 & 2 & 0.5 \\ 1 & 0.5 & -1 \end{pmatrix}_{xyz} \) (answer is a number)

   b. \( \mathbf{B} = A \hat{e}_1 \hat{e}_1 + \beta x_1 x_2 \hat{e}_1 \hat{e}_2 + \beta x_2 \hat{e}_2 \hat{e}_1 + A \hat{e}_2 \hat{e}_2 \) (answer is an equation)

6. (10 points) Text #2.47 (p58)

7. (10 points) For the flow described in problem 3.18 (page 100) write the velocity boundary conditions in terms of the coordinate variables of the problem.