Let $A$ and $B$ denote 3 by 3 matrices, and let $c$ and $d$ denote real column vectors:

$$
A = \begin{pmatrix}
    a_{11} & a_{12} & a_{13} \\
    a_{21} & a_{22} & a_{23} \\
    a_{31} & a_{32} & a_{33}
\end{pmatrix}
B = \begin{pmatrix}
    b_{11} & b_{12} & b_{13} \\
    b_{21} & b_{22} & b_{23} \\
    b_{31} & b_{32} & b_{33}
\end{pmatrix}
\quad
c = \begin{pmatrix}
    c_1 \\
    c_2 \\
    c_3
\end{pmatrix}
\quad
d = \begin{pmatrix}
    d_1 \\
    d_2 \\
    d_3
\end{pmatrix}
$$

1. Specify the following in terms of matrix and vector components.

(a) Vector sum $c + d$
(b) Matrix sum $A + B$
(c) Matrix-vector product $Ac$
(d) Matrix-matrix product $AB$
(e) Determinant $|A|$
(f) Identity matrix $I$
(g) Matrix transpose $A^T$
(h) Dot product $c^T d$
(i) Outer product $cd^T$
(j) Vector cross product $c \times d$
(k) Vector Euclidean norm $\|c\|$

2. Specify the following in terms of $A$ and $B$.

(a) transpose of $AB$
(b) inverse of $AB$

3. Specify the following conditions as matrix-vector equations.

(a) $c$ is orthogonal to $d$
(b) $c$ and $d$ are orthonormal vectors
(c) $A$ is an orthogonal matrix
(d) $A$ is a symmetric matrix
(e) $A^{-1}$ is the inverse of $A$