MIN-291 Engineering Analysis and Design Autumn 2023-24
Tutorial 1
Mathematical Preliminaries and Index Notation
(All questions carry 2 marks)

---

1) Matrix ***A*** and Vector ***t*** are given below. Expand and find the following quantities:
A_{ii}, $A_{ij}t_j$

$$A=\begin{bmatrix}10 & 5 & 7\\ 5 & 3 & 9\\ 7 & 9 & 0\end{bmatrix} \qquad t=\begin{Bmatrix}1\\1\\1\end{Bmatrix}$$

2) Write the expression $c_i = A_{ij}b_j - b_i$ in the form of $c_i = B_{ij}b_j$ and hence find the expression for B_{ij}

3) Discuss the validity of the following relations*:*

1) $a_m b_s = c_m(d_r - f_r)$, 2) $a_i = b_j c_i d_i$ 3) $x_i\, x_i = r^2$ 4) $a_i b_j c_j = 3$

4) Components of a first order and second order tensor are given below. Determine the components of each tensor in a new coordinate system found through a rotation of 60^0 about x_3 axis. Choose a counter-clockwise rotation when viewing along the negative x_3 axis.

$$a_{ij}=\begin{bmatrix}1 & 0 & 3\\ 0 & 2 & 2\\ 3 & 2 & 4\end{bmatrix} \qquad a_i=\begin{Bmatrix}1\\4\\2\end{Bmatrix}$$

5) Matrix A is said to be symmetric if $A_{ij} = A_{ji}$. Matrix B is said to be antisymmetric/skew symmetric if $B_{ij} = -B_{ji}$. Prove that for the aforementioned pair of symmetric and antisymmetric matrices, $A_{ij}B_{ij} = 0$.