CHAPTER 2, PART A

2.1   Given

$$[S_{ij}] = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 2 \\ 3 & 0 & 3 \end{bmatrix} \text{ and } [a_i] = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

Evaluate (a) S_{ii}, (b) $S_{ij}S_{ij}$, (c) $S_{ji}S_{ji}$, (d) $S_{jk}S_{kj}$ (e) $a_m a_m$, (f) $S_{mn}a_m a_n$, (g) $S_{nm}a_m a_n$

Ans. (a) $S_{ii} = S_{11} + S_{22} + S_{33} = 1 + 1 + 3 = 5$.

(b) $S_{ij}S_{ij} = S_{11}^2 + S_{12}^2 + S_{13}^2 + S_{21}^2 + S_{22}^2 + S_{23}^2 + S_{31}^2 + S_{32}^2 + S_{33}^2 =$
$1 + 0 + 4 + 0 + 1 + 4 + 9 + 0 + 9 = 28$.

(c) $S_{ji}S_{ji} = S_{ij}S_{ij} = 28$.

(d) $S_{jk}S_{kj} = S_{1k}S_{k1} + S_{2k}S_{k2} + S_{3k}S_{k3}$
$= S_{11}S_{11} + S_{12}S_{21} + S_{13}S_{31} + S_{21}S_{12} + S_{22}S_{22} + S_{23}S_{32} + S_{31}S_{13} + S_{32}S_{23} + S_{33}S_{33}$
$= (1)(1) + (0)(0) + (2)(3) + (0)(0) + (1)(1) + (2)(0) + (3)(2) + (0)(2) + (3)(3) = 23$.

(e) $a_m a_m = a_1^2 + a_2^2 + a_3^2 = 1 + 4 + 9 = 14$.

(f) $S_{mn}a_m a_n = S_{1n}a_1 a_n + S_{2n}a_2 a_n + S_{3n}a_3 a_n =$
$S_{11}a_1 a_1 + S_{12}a_1 a_2 + S_{13}a_1 a_3 + S_{21}a_2 a_1 + S_{22}a_2 a_2 + S_{23}a_2 a_3 + S_{31}a_3 a_1 + S_{32}a_3 a_2 + S_{33}a_3 a_3$
$= (1)(1)(1) + (0)(1)(2) + (2)(1)(3) + (0)(2)(1) + (1)(2)(2) + (2)(2)(3) + (3)(3)(1)$
$+ (0)(3)(2) + (3)(3)(3) = 1 + 0 + 6 + 0 + 4 + 12 + 9 + 0 + 27 = 59$.

(g) $S_{nm}a_m a_n = S_{mn}a_m a_n = 59$.

2.2   Determine which of these equations have an identical meaning with $a_i = Q_{ij}a_j'$.

(a) $a_p = Q_{pm}a_m'$, (b) $a_p = Q_{qp}a_q'$, (c) $a_m = a_n' Q_{mn}$.

Ans. (a) and (c)

2.3   Given the following matrices

$$[a_i] = \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix}, [B_{ij}] = \begin{bmatrix} 2 & 3 & 0 \\ 0 & 5 & 1 \\ 0 & 2 & 1 \end{bmatrix}$$

Demonstrate the equivalence of the subscripted equations and corresponding matrix equations in the following two problems.

(a) $b_i = B_{ij}a_j$ and $[b] = [B][a]$.   (b) $s = B_{ij}a_i a_j$ and $s = [a]^T[B][a]$

Ans. (a)
$b_i = B_{ij}a_j \rightarrow b_1 = B_{1j}a_j = B_{11}a_1 + B_{12}a_2 + B_{13}a_3 = (2)(1) + (3)(0) + (0)(2) = 2$
$b_2 = B_{2j}a_j = B_{21}a_1 + B_{22}a_2 + B_{23}a_3 = 2$, $b_3 = B_{3j}a_j = B_{31}a_1 + B_{32}a_2 + B_{33}a_3 = 2$.

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Wu/Han-Chin

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