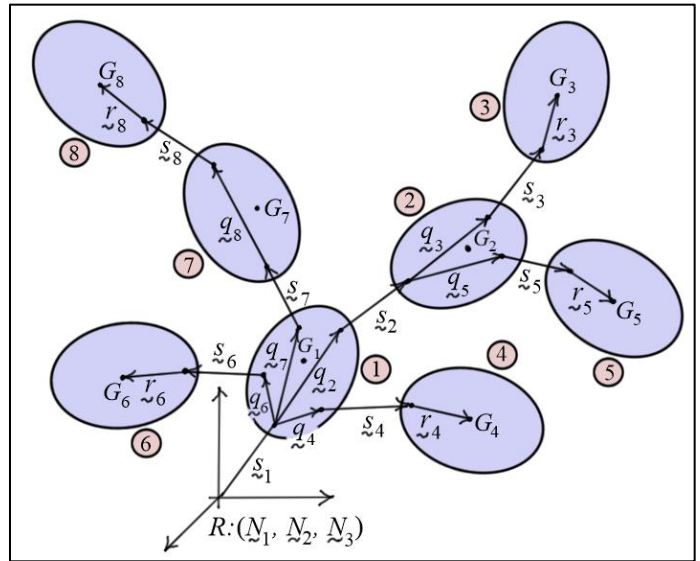


**ME 6590 Multibody Dynamics**  
**Exercises #2.1 (Continuation of Exercises #2)**

Consider the multibody system shown in the diagram. As in Exercises #2, the orientations of the bodies are specified relative to the inertial frame  $R$  (*absolute angles*) using a 3-2-1 body-fixed rotation sequence. Also, the positions of the mass centers of all the bodies are to be specified using *relative coordinates* as indicated by the vectors in the diagram. Vectors  $\underline{s}_i$  ( $i=1, \dots, 8$ ) represent translation vectors for the bodies relative to their *adjacent, lower-numbered* body and are expressed in the lower-numbered body frame.



For example, since  $B_1$  is the lower-numbered body of  $B_7$ ,

$$\underline{s}_7 = \sum_i x_{7i} \underline{n}_{1i}$$

The vectors fixed in the bodies of the system are expressed in the reference frames of the bodies in which they are fixed. For example,

$$\underline{q}_8 = \sum_i q_{8i} \underline{n}_{7i}$$

Complete the following:

- Find the inertial components of the position vector of  $G_3$  the mass-center of body  $B_3$ . Express the results in matrix-vector form.
- Find the inertial components of the velocity of  $G_3$  the mass-center of body  $B_3$ . Express the results in matrix-vector form using the body-fixed angular velocity components. Then, identify the partial velocity matrices associated with  $\dot{x}_{1i}$ ,  $\dot{x}_{2i}$ ,  $\dot{x}_{3i}$ ,  $\dot{\theta}_{1i}$ ,  $\dot{\theta}_{2i}$ , and  $\dot{\theta}_{3i}$ .