**Three-Dimensional Vector and Matrix Notation**

 global position of the origin of reference frame attached to body i

 global position of point P attached to body i

**example**  global position of point B attached to body 4

 global velocity of the origin of the reference attached to body i

 global velocity of point P attached to body i

 global acceleration of the origin of the reference attached to body i

 global acceleration of point P attached to body i

 global jerk of the origin of the reference attached to body i

 global jerk of point P attached to body i

 position of point P on body i relative to the reference frame for body i measured in local body-fixed directions

**example**  location of point B on body 4 relative to the reference frame for body 4 measured in local body-fixed directions for body 4

 position of point P on body i relative to the reference frame for body i but measured in global directions

 relative location between two points on bodies i and j measured in global directions

**example**  relative location of point Q on body 4 with respect to point P on body 3 measured in global directions

 Euler parameters to describe attitude for body i

 angular velocity of body i measured in global directions

 angular velocity of body i measured in local body-fixed directions

 angular acceleration of body i measured in global directions

 angular acceleration of body i measured in local body-fixed directions

 angular jerk of body i measured in global directions

 angular jerk of body i measured in local body-fixed directions

 orthonormal rotation matrix that describes global attitude of body i

**example**  rotation matrix converts information in local body-fixed directions into global directions

 global direction of unit vector along local x axis attached to body i

 global direction of unit vector along local y axis attached to body i

 global direction of unit vector along local z axis attached to body i

 local direction of unit vector along local x axis attached to body i 

 local direction of unit vector along local y axis attached to body i 

 local direction of unit vector along local z axis attached to body i 

**example**  global unit directions for local axes attached to body i

 orthonormal rotation matrix that describes relative attitude of joint frame at point P on body i measured in local body-fixed directions

 orthonormal rotation matrix that describes global attitude of joint frame at point P on body i

**example**  rotation matrix converts information in local body-fixed directions into global directions

 global direction of unit vector along x axis at joint frame for P on body i

 global direction of unit vector along y axis at joint frame for P on body i

 global direction of unit vector along z axis at joint frame for P on body i

**example**  global unit directions for local axes at joint frame for P on body i

 local direction of unit vector along x axis at joint frame for P on body i

 local direction of unit vector along y axis at joint frame for P on body i

 local direction of unit vector along y axis at joint frame for P on body i

**example**  global unit directions for local axes at joint frame for P on body i

 joint frame direction of unit vector along x axis at joint frame for P on body i 

 joint frame direction of unit vector along y axis at joint frame for P on body i 

 joint frame direction of unit vector along z axis at joint frame for P on body i 

 force on body i acting through point P measured in global directions

force on body i acting through point P measured in local body-fixed directions

 torque on body i measured in global directions

 torque on body i measured in local body-fixed directions

**Numbering and lettering**

Bodies should be numbered consecutively beginning with 1. Body 1 is typically reserved for ground.

Points should be lettered.

Point G is typically reserved for the mass center of a body.

Point T is seldom used in that it causes confusion with the vector/matrix transpose operator.

**Subscripts and superscripts outside vector/matrix brackets**

Post-superscript prime outside vector brackets denotes information measured in local body-fixed directions.

Post-superscript letters outside vector brackets denote information related to a specific point.

Post-subscripts outside vector/matrix brackets are occasionally used for iteration or time indices.

Pre-superscripts and pre-subscripts are typically not used outside brackets.

**Subscripts and superscripts inside vector/matrix brackets**

Post-superscripts inside vector/matrix brackets are occasionally used for iteration or time indices.

Post-subscript numerals inside vector/matrix brackets are typically used for body numbers.

Post-subscript variables inside vector/matrix brackets denote partial derivative operators.

Pre-superscripts and pre-subscripts are typically not used inside brackets.

**General vector/matrix operations**

 vector/matrix transpose

 matrix inverse

 determinant of matrix

tr[ ] trace of matrix (sum of diagonal elements)

 diagonal elements of matrix rearranged into column vector

 elements of vector placed into a diagonal matrix

 matrix to power n

norm{ } scalar norm of vector (magnitude)

 unit vector

 identity matrix of order n

 vector/matrix of zeros

 skew- symmetric operator for cross products 