1. Given the geodetic coordinates of the peak of Mt. Everest as Latitude (L_b) 27deg 59min 16sec N, Longitude (λ_b) 86deg 56min 40sec E, and height (h_b) 8850 meters (derived by GPS in 1999):

   (a) Develop a MATLAB function

   ```
   function [r_e__e_b]=llh2xyz(L_b,lambda_b,h_b)
   ```

   to convert from geodetic curvilinear lat, lon and height to ECEF rectangular x, y and z coordinates (use SI units).

      i. Attach a printout of your function or put a copy in the shared folder.
      ii. Test your llh2xyz function using coordinates of the peak of Mt Everest. What is $\vec{r}^{\,e}_{eb}$ at the peak?

   (b) Develop a MATLAB function

   ```
   function [L_b,lambda_b,h_b] = xyz2llh(r_e__e_b)
   ```

   to convert ECEF x, y, and z coordinates to lat, lon, and height (use SI units). HINT: This should be an iterative transformation (i.e., not closed form).

      i. Attach a printout of your function or put a copy in the shared folder.
      ii. Test your `xyz2llh` function with the ECEF coords obtained from part (1a).

   (c) Develop a MATLAB function

   ```
   function [C_e__n] = llh2dcm(L_b, lambda_b, h_b)
   ```

   to compute the orientation (as a rotation/cosine matrix) of the navigation frame relative to the ECEF frame given geodetic lat and lon.

      i. Attach a printout of your function or put a copy in the shared folder.
      ii. Use your function to obtain the orientation of the navigation frame at the peak of Mt Everest relative to the ECEF frame.
      iii. Given a body is on the peak of Mt Everest facing east, obtain the orientation of the body relative to the ECEF frame.

   (d) What is the acceleration due to gravity at the ellipsoid (i.e., at the ellipsoid $h_b = 0$. HINT: This should only be a function of lat—see page 70 of text)?

   (e) What is the magnitude of the centrifugal acceleration ($-\Omega^e_{ie}\Omega^e_{ie}\vec{r}^{\,e}_{eb}$) at the ellipsoid and at the peak?

   (f) What is the magnitude of the gravitational attraction at the ellipsoid and at the peak? HINT: See page 72 to compute $\vec{\gamma}^{\,e}_{ib} = \vec{\gamma}^{\,i}_{ib}|_{\vec{r}^{\,i}_{ib}=\vec{r}^{\,e}_{eb}}$.

2. Develop a MATLAB function

```
function [g_n__bD] = gravity(L_b,h_b)
```

(see eqn. 2.139 on page 71 of Groves) to approximate the "down" component of the acceleration due to gravity as a function of lat & height (Please use SI units).

   (a) Use this function to compute the acceleration due to gravity at the peak of Mt Everest.
   (b) What is the difference in m/s^2 between the answer obtained in questions 2(a) and that of 1(d)?
      i. Based on this difference how much less would you weigh at the peak than at the ellipsoid (in lbs)?

3. Develop the following MATLAB functions

   (a) `function [q] = dcm2q(C)`
   (b) `function [C] = q2dcm(q)`
   (c) `function [q] = q1xq2(q1,q2)` for $\otimes$
   (d) `function [q] = q1starq2(q1,q2)` for $\circledast$.

   Use some test cases to check they function properly, and turn in a printout of the functions or place a copy of them in the shared folder.

4. Given the quaternion $\bar{\boldsymbol{q}}\,^{a}_{ab}(t)$ describes rotation about a z-axis by time-varying angle $\theta(t)$, use the relationship $\dot{\bar{\boldsymbol{q}}}^{a}_{b}(t) = \frac{1}{2}[\breve{\omega}^{a}_{ab}\otimes]\bar{\boldsymbol{q}}\,^{a}_{b}(t)$ derived in class to find the corresponding angular velocity $\vec{\omega}$.