Help message for MATLAB function refval2.m

>> help refval2
Function refval2 determines the geometric and physical constants of the
equipotential rotational reference ellipsoid of the World Geodetic
System 1984 (WGS84) defined by:
    a - semi-major axis,
    1/f - reciprocal of flattening
    omega - angular velocity of the Earth
    GM - geocentric gravitational constant of the Earth,

For WGS84 the defining parameters are
    a = 6378137 m
    1/f = 298.257223563
    omega = 7.292115e-05 rad/s
    GM = 3.986004418e+14 m^3/s^2

Output from MATLAB function refval2.m

>> refval2

WORLD GEODESTIC SYSTEM 1984
===========================
Defining Constants (exact)
    a = 6378137 m   semi-major axis
    1/f = 298.257223563 reciprocal of flattening
    omega = 7.292115e-05 rad/s angular velocity
    GM = 3.986004418e+14 m^3/s^2 geocentric gravitational constant

Derived Geometrical Constants of Normal Ellipsoid
    b = 6356752.314245 m   semi-minor axis
    E = 521854.008423 m   linear eccentricity
    c = 6399593.625758 m   polar radius of curvature
    e2 = 6.694379990141e-03 eccentricity squared
    ep2 = 6.739496742276e-03 2nd eccentricity squared
    f = 3.352810664747e-03 flattening
    n = 1.679220386384e-03 3rd flattening
    Q = 10001965.729313 m quadrant distance
    R1 = 6371008.771415 m mean radius R1 = (2a+b)/3
    R2 = 6371007.180918 m radius of sphere of same surface area
    R3 = 6371000.790009 m radius of sphere of same volume

Derived Physical Constants of Normal Ellipsoid
    U0 = 62636851.714569 m^2/s^2 normal gravity potential
    C2 = +4.841667749599e-04 2nd degree zonal harmonic (fully normalized)
    J2 = +1.082629821257e-03 2nd degree zonal harmonic (conventional)
    m = 3.449786506841e-03
    g_e = 9.780325335903 m/s^2 normal gravity at equator
    g_p = 9.832184937865 m/s^2 normal gravity at pole
    f* = 0.005302441390 gravity flattening
    k = 0.001931852653 constant in Pizzetti's equation

>>
MATLAB function refval2.m

function refval2
% Function refval2 determines the geometric and physical constants of the
% equipotential rotational reference ellipsoid of the World Geodetic
% System 1984 (WGS84) defined by:
% a - semi-major axis,
% 1/f - reciprocal of flattening
% omega - angular velocity of the Earth
% GM - geocentric gravitational constant of the Earth,
% For WGS84 the defining parameters are
% a = 6378137 m
% 1/f = 298.257223563
% omega = 7.292115e-05 rad/s
% GM = 3.986004418e+14 m^3/s^2
%==========================================================================
% Function: refval2
% Usage: refval2;
% Author:
% Rod Deakin,
% Department of Mathematical and Geospatial Sciences,
% RMIT University,
% GPO Box 2476V, MELBOURNE VIC 3001
% AUSTRALIA
% email: rod.deakin@rmit.edu.au
% Date:
% Version 1 21 May 2014
% Functions Required:
% None
% Remarks:
% Function refval2() determines the geometric and physical constants of an
% equipotential rotational reference ellipsoid defined by:
% a     - semi-major axis,
% 1/f    - reciprocal of flattening
% omega - angular velocity of the Earth. 
% GM    - geocentric gravitational constant of the Earth,
% Given the four defining parameters above, geometric and physical
% constants can be derived by methods and formulae set out in Ref[1].
% Theory is given in Ref[2] and Ref[4].
% The following geometric constants of the ellipsoid are evaluated
% b       - semi-minor axis of ellipsoid (metres)
% c       - polar radius of curvature (metres)
% C2      - fully normalized, second degree zonal harmonic:
% C2 = J2/sqrt(5)
% e2      - eccentricity squared: e = E/a
% ep2     - second eccentricity squared: ep = E/b
% E       - linear eccentricity: E = sqrt(a^2 - b^2) = a*e
% f       - flattening of ellipsoid
% J2      - conventional second degree zonal harmonic:
% J2 = sqrt(5)*C2 J2 is also known as the dynamical form
% factor
% n       - third flattening of ellipsoid: n = f/(2-f)
% Q       - quadrant distance of ellipsoid (metres)
% R1      - radius of sphere having mean radius: R1 = (2*a + b)/3
% R2      - radius of sphere having same surface area of ellipsoid
% R3      - radius of sphere having same volume of ellipsoid
% The following physical constants of the ellipsoid are evaluated
% gamma_e - normal gravity at equator (m/s^2)
% gamma_p - normal gravity at pole (m/s^2)
% J4,J6,J8,... - coefficients of Legendre polynomials in the spherical
% harmonic expansion of the gravitational potential V.
% k       - constant in Pizetti's equation for normal gravity.
% m       - a derived physical constant: m = omega^2*a^2*b/GM
\% q0 - q(subscript zero), physical constant used in computation of
gamma_e, gamma_p
\% qp0 - q-prime(subscript zero), physical constant used in
computation of gamma_e, gamma_p
\% U0 - normal gravity potential at ellipsoid (m\(^2\)/s\(^2\))
\% Variables:
\% a - semi-major axis of ellipsoid (metres)
\% b - semi-minor axis of ellipsoid (metres)
\% c - polar radius of curvature (metres)
\% c0 - coefficient in computation of quadrant distance Q
\% C2 - fully normalized second degree zonal harmonic
\% e - (first) eccentricity of ellipsoid: e = E/a
\% e2 - (first) eccentricity squared
\% e21 - approximate value of e2
\% ep - second eccentricity: ep = E/b
\% ep2 - second eccentricity squared
\% E - linear eccentricity: E = sqrt(a^2 - b^2) = a*e
\% f - flattening of ellipsoid: f = (a-b)/a = 1-sqrt(1-e^2)
\% f1 - gravity flattening
\% flat - denominator of flattening: f = 1/flat
\% gamma_e - normal gravity at equator (m/s^2)
\% gamma_p - normal gravity at pole (m/s^2)
\% GM - geocentric gravitational constant (m^3/s^2)
\% i,j - integer counters
\% J2 - dynamical form factor (conventional 2nd degree zonal harmonic)
\% k - constant in Pizetti's equation for normal gravity.
\% m - a derived physical constant: m = omega^2*a^2*b/GM = m1/a*b;
\% ml - a derived physical constant: ml = omega^2*a^2*b/GM = m/b*a;
\% n - third flattening of ellipsoid: n = f/(2-f)
\% n, n2, n4, ... - even powers of n
\% N - size of vector Jvec
\% omega - angular velocity of earth (radians/sec)
\% q0 - q(subscript zero), physical constant used in computation of
gamma_e, gamma_p
\% qp0 - q-prime(subscript zero), physical constant used in
computation of gamma_e, gamma_p
\% Q - quadrant distance of ellipsoid (metres)
\% R1 - radius of sphere having mean radius: R1 = (2*a + b)/3
\% R2 - radius of sphere having same surface area as ellipsoid
\% R3 - radius of sphere having same volume as ellipsoid
\% sgn - sgn = 1 or sgn = -1
\% U0 - normal gravity potential at ellipsoid (m^2/s^2)
\% x - local variable

References:
\% 3. World Geodetic System 1984, NIMA TR8350.2 Amendment 1, 03-Jan-2000,
\% National Imagery and Mapping Agency (NIMA), Technical Report
\% TR 8350.2
\% 4. Deakin, R.E., 1997. 'The Normal Gravity Field', Private Notes,
\% Department of Geospatial Science, RMIT University, 38 pages.
\% Projection: Karney-Hueng equations', Presented at the Surveying
\% and Spatial Sciences Institute (SSSI) Land Surveying Commission
\% National Conference, Melbourne, 18-21 April, 2012.
\% of Mathematical & Geospatial Sciences, RMIT University, 3rd
\% printing, January 2013.
\%=================================================================================
\%=================================================================================
\% set defining constants of rotational equipotential ellipsoid for WGS84
\%=================================================================================
\% see Ref[3], Table 3.1, p.3-5
\% a = 6378137.0;
\% flat = 298.257223563;
\% omega = 7.292115e-05;
\% GM = 3.986004418e+14;
% compute GEOMETRIC constants of equipotential ellipsoid
\[ f = \frac{1}{\text{flat}}; \]
\[ e_2 = f^2(2-f); \]
\[ e = \sqrt{e_2}; \]
\[ e_2 = e^2(e^2 - 1); \]
\[ e = \sqrt{e_2}; \]
\[ b = a(1-f); \]
\[ c = a^2/b; \]
\[ n = f/(1-f); \]
\[
\begin{align*}
&\text{computation of quadrant length of ellipsoid. See Ref\[5\], eq (39).} \\
n_2 &= n^2; \quad \text{even powers of } n \\
n_4 &= n_2^2; \\
n_6 &= n_4^2; \\
n_8 &= n_6^2; \\
c_0 &= 1 + \frac{1}{4}n_2 + \frac{1}{64}n_4 + \frac{1}{256}n_6 + \frac{1}{16384}n_8; \\
Q &= a/(1+n)c_0\pi/2; \quad \text{quadrant distance}
\end{align*}
\]
% computation of radii of equivalent spheres. See Ref\[6\], pp. 86-87.
\[ R_1 = (2a+b)/3; \]
\[ R_2 = \sqrt{a^2/2(1+(1-e_2)/(2e)\log((1+e)/(1-e)))); \]
\[ R_3 = (a^2b)^{1/3}; \]

% compute PHYSICAL constants of equipotential ellipsoid
\[ U_0 = GM/E\arctan(ep) + \omega^2a^2/3; \]
\[ q_0 = ((1+(3/ep^2))\arctan(ep)-(3/ep))/2; \]
\[ q_0 = (3(1+(1/ep)^2)/(1-(1/ep)\arctan(ep)) - 1; \]
\[ \text{compute normal gravity at the equator and the pole} \]
\[ m = \omega^2a^2b/GM; \]
\[ \gamma_e = GM/a^2b^2/(1-m-(m/6ep^2)/q_0); \]
\[ \gamma_p = GM/a^2a^2/(1+(m/3ep^2)/q_0); \]
\[ \text{compute gravity flattening} \]
\[ f_1 = \gamma_p/\gamma_e - 1; \]
\[ \text{compute constant } k \text{ in Pizetti's equation for normal gravity} \]
\[ \text{compute dynamical form factor } J_2 \]
\[ J_2 = e_2/3(1-2/15m^2ep/q_0); \]

% print headings and computed data
\text{print('WORLD GEODESTIC SYSTEM 1984');}
\text{print('nDefining Constants (exact)');}
\text{print('n a = 6378137.0 m semi-major axis',a);}
\text{print('n 1/f = 298.2929118815 reciprocal of flattening',flat);}
\text{print('n omega = 88.5179313118 rad/s angular velocity',omega);}
\text{print('n GM = 3986004418002 cm^3/s^2 geocentric gravitational constant',GM);}
Derived Geometrical Constants of Normal Ellipsoid

- $b = 15.66 \text{ m}$, semi-minor axis
- $E = 15.66 \text{ m}$, linear eccentricity
- $c = 15.66 \text{ m}$, polar radius of curvature
- $e^2 = 15.12 \text{e}$, eccentricity squared
- $ep^2 = 15.12 \text{e}$, 2nd eccentricity squared
- $f = 15.12 \text{e}$, flattening
- $n = 15.12 \text{e}$, 3rd flattening
- $Q = 15.66 \text{ m}$, quadrant distance
- $R_1 = 15.66 \text{ m}$, mean radius $R_1 = (2a+b)/3$
- $R_2 = 15.66 \text{ m}$, radius of sphere of same surface area
- $R_3 = 15.66 \text{ m}$, radius of sphere of same volume

Derived Physical Constants of Normal Ellipsoid

- $U_0 = 15.66 \text{ m}^2/\text{s}^2$, normal gravity potential
- $C_2 = +15.12 \text{e}$, 2nd degree zonal harmonic (fully normalized)
- $J_2 = +15.12 \text{e}$, 2nd degree zonal harmonic (conventional)
- $m = 15.12 \text{e}$, normal gravity at equator
- $g_e = 15.12 \text{f}$, normal gravity at equator
- $g_p = 15.12 \text{f}$, normal gravity at pole
- $f^* = 15.12 \text{f}$, gravity flattening
- $k = 15.12 \text{f}$, constant in Pizzetti's equation
