J. Basic. Appl. Sci. Res., 3(1)504-511, 2013
© 2013, TextRoad Publication

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

The Prediction of Motion of an Artificial Satellite

Z. M. Hayman

Department of Astronomy, Faculty of faculty of Science, Cairo University, Giza, 12613, Egypt

ABSTRACT

In this paper the solution of an artificial satellite motion under the influence of J_2-Earth's gravitational field in terms of Euler parameters that was solved using recurrent power series solution which is one of the semi-analytical solutions. Applications of the method enable anyone to predict the motion of the artificial satellite in any conic section. This expected because the only force affecting on the motion of artificial satellite is Earth's gravitational field.

KEYWORDS: satellite- semi analytical solution- Euler parameters.

INTRODUCTION

Orbit prediction of artificial satellites become one of the most important problems at present, due to their wide applications in scientific researches, mission planning and military purposes, … etc.

There are many transformations have emerged in the literature in the recent past, one of the famous of them is the set of Eulerain redundant parameters
[1], [2],[3] [4],[5]and [6] These parameters combine between orbit dynamics and rigid body dynamics, and they are valid for any type of orbital motion.

In this paper, we use a recurrent power series solution of the Eulerian perturbed differential equations of motion depending on Taylor series expansion to get the classical elements of the satellite at any time.

FORMULATION OF THE PROBLEM

Generally, the equations of motion of an artificial satellite are given generally as

$$\ddot{\vec{x}} + \frac{\mu}{r^3}\,\vec{x} = \vec{P} \qquad (2.1)$$

where $\vec{x}$ is the relative position vector, $r = |\vec{x}|$, μ is the Earth's gravitational constant, $\vec{P}$ is the all perturbing forces, which equals to $\left(-\frac{\partial V}{\partial \vec{x}} + \vec{P}^* \right)$, hence $\vec{P}^*$ is the resultant of all non-conservative perturbing forces, and V is the perturbed time-independent potential, which can be expressed as

$$V = \mu \sum_{i=2}^{\infty} R^i\, J_i \,(1/r)^{i+1}\, L_i(x_3/r)$$

where R is the Earth's equatorial radius, J_i is the non-dimensional coefficient of the Earth's potential and L_i is the Legendre polynomial of order i.

In our case the only force acting on an artificial satellite is that due to the Earth's oblateness, so we have

$$\vec{P}^* = 0, \qquad (2.2.1)$$

$$V = \frac{3}{2} q_2\, x_3^2\, r^{-5} - \frac{1}{2} q_2\, r^{-5} \qquad (2.2.2)$$

where $q_2 = \mu R^2 J_2$, $r = \sqrt{x_1^2 + x_2^2 + x_3^2}$.

Eq.(2.1) are the basic classical equations of motion of artificial satellites and the corresponding one in terms of the Euler parameters with $\tilde{\phi}$ (perturbed true anomaly) as independent variable [3],

$$y_1' = 0.5\,(\;\; w_1\, y_4 + w_3\, y_2), \qquad (2.3.1)$$

$$y_2' = 0.5\,(\;\; w_1\, y_3 - w_3\, y_1), \qquad (2.3.2)$$

$$y_3' = 0.5\,(- w_1\, y_2 + w_3\, y_4), \qquad (2.3.3)$$

Corresponding author: Z.M.Hayman, Department of Astronomy, Faculty of Science, Cairo University, Giza, 12613, Egypt zmhayman@yahoo.com

$$y_4' = 0.5\,(-\,w_1\; y_1 - w_3\; y_3), \tag{2.3.4}$$

$$y_5' = y_6\,, \tag{2.3.5}$$

$$y_6' = -\,y_5 + \frac{1}{y_7} - \frac{P_\xi}{\mu\; y_5^2\; y_7} + \frac{2\,V}{\mu\; y_5\; y_7} - \frac{g_2\; y_6}{2\; y_7}, \tag{2.3.6}$$

$$y_7' = g_2 = \frac{2\,w_1\,P_\eta^*}{\mu\,y_5^3} + \frac{2}{y_5^4\,\sqrt{\mu^3\;y_7}}\,\frac{\partial V}{\partial t} - \frac{2\,y_6}{\mu\,y_5^3}\left(\left[\frac{\partial V}{\partial \vec{x}}\cdot\vec{x}\right] + 2\,V\right), \tag{2.3.7}$$

$$y_8' = \frac{1}{y_5^2\;\sqrt{\mu\;y_7}}, \tag{2.3.8}$$

where

$$w_1 = \frac{P_\zeta}{\mu\;w_3\;y_5^3\;y_7}, \tag{2.4.1}$$

$$w_3 = \sqrt{1 - \frac{2\,V}{\mu\;y_5^2\;y_7}}\,, \tag{2.4.2.}$$

$$P_\xi = C_{11}\,P_1 + C_{12}\,P_2 + C_{13}\,P_3\,, \tag{2.5.1}$$

$$P_\eta^* = C_{21}\,P_1^* + C_{22}\,P_2^* + C_{23}\,P_3^*\,, \tag{2.5.2}$$

$$P_\zeta = C_{31}\,P_1 + C_{32}\,P_2 + C_{33}\,P_3\,, \tag{2.5.3}$$

$$C_{11} = y_1^2 - y_2^2 - y_3^2 + y_4^2\,, \tag{2.6.1}$$

$$C_{12} = 2(y_1\,y_2 + y_3\,y_4), \tag{2.6.2}$$

$$C_{13} = 2(y_1\,y_3 - y_2\,y_4), \tag{2.6.3}$$

$$C_{21} = 2(y_1\,y_2 - y_3\,y_4), \tag{2.7.1}$$

$$C_{22} = -\,y_1^2 + y_2^2 - y_3^2 + y_4^2\,, \tag{2.7.2}$$

$$C_{23} = 2(y_2\,y_3 + y_1\,y_4), \tag{2.7.3}$$

$$C_{31} = 2(y_1\,y_3 + y_2\,y_4), \tag{2.8.1}$$

$$C_{32} = 2(y_2\,y_3 - y_1\,y_4), \tag{2.8.2}$$

$$C_{33} = -\,y_1^2 - y_2^2 + y_3^2 + y_4^2\,, \tag{2.8.3}$$

$$x_i = r\,C_{1i} = C_{1i}\,/\,y_5\,, \tag{2.9}$$

hence we denote the differentiation with respect to the independent variable $(\tilde{\phi})$ by a prime ('), since

$$(') = \frac{d}{d\tilde{\phi}}(\;\;).$$

RECURRENT POWER SERIES SOLUTION:

In this section, recurrent power series solution of Eqs.(2.3) will be gone in the three following steps.

Rewriting the equations of motion in terms of y's only as

$$\begin{aligned}
y_1' = {} & 3Q_2\, y_1^5\, y_3\, y_4\, y_5\, y_9 - 3Q_2\, y_1^4\, y_2\, y_4^2\, y_5\, y_9 + \\
& 6Q_2\, y_1^3\, y_2^2\, y_3\, y_4\, y_5\, y_9 - 6Q_2\, y_1^2\, y_2^3\, y_4^2\, y_5\, y_9 + \\
& 3Q_2\, y_1\, y_2^4\, y_3\, y_4\, y_5\, y_9 - 3Q_2\, y_2^5\, y_4^2\, y_5\, y_9 - \\
& 3Q_2\, y_1\, y_3^5\, y_4\, y_5\, y_9 + 3Q_2\, y_2\, y_3^4\, y_4^2\, y_5\, y_9 - \\
& 6Q_2\, y_1\, y_3^3\, y_4^3\, y_5\, y_9 + 6Q_2\, y_2\, y_3^2\, y_4^4\, y_5\, y_9 - \\
& 3Q_2\, y_1\, y_3\, y_4^5\, y_5\, y_9 + 3Q_2\, y_2\, y_4^6\, y_5\, y_9 - \\
& 3Q_2\, y_1^2\, y_2\, y_3^2\, y_5\, y_9 + 6Q_2\, y_1\, y_2^2\, y_3\, y_4\, y_5\, y_9 - \\
& 3Q_2\, y_2^3\, y_4^2\, y_5\, y_9 + 0.25Q_2\, y_2\, y_5\, y_9 + 0.5\, y_2\,,
\end{aligned} \tag{3.1.1}$$

$$\begin{aligned}
y_2' = {} & 3Q_2\, y_1^5\, y_3^2\, y_5\, y_9 - 3Q_2\, y_1^4\, y_2\, y_3\, y_4\, y_5\, y_9 + \\
& 6Q_2\, y_1^3\, y_2^2\, y_3^2\, y_5\, y_9 - 6Q_2\, y_1^2\, y_2^3\, y_3\, y_4\, y_5\, y_9 + \\
& 3Q_2\, y_1\, y_2^4\, y_3^2\, y_5\, y_9 - 3Q_2\, y_2^5\, y_3\, y_4\, y_5\, y_9 - \\
& 3Q_2\, y_1\, y_3^6\, y_5\, y_9 + 3Q_2\, y_2\, y_3^5\, y_4\, y_5\, y_9 - \\
& 6Q_2\, y_1\, y_3^4\, y_4^2\, y_5\, y_9 + 6Q_2\, y_2\, y_3^3\, y_4^3\, y_5\, y_9 - \\
& 3Q_2\, y_1\, y_3^2\, y_4^4\, y_5\, y_9 + 3Q_2\, y_2\, y_3\, y_4^5\, y_5\, y_9 + \\
& 3Q_2\, y_1^3\, y_3^2\, y_5\, y_9 - 6Q_2\, y_1^2\, y_2\, y_3\, y_4\, y_5\, y_9 + \\
& 3Q_2\, y_1\, y_2^2\, y_4^2\, y_5\, y_9 - 0.25Q_2\, y_1\, y_5\, y_9 - 0.5\, y_1\,,
\end{aligned} \tag{3.1.2}$$

$$\begin{aligned}
y_3' = {} & -3Q_2\, y_1^5\, y_2\, y_3\, y_5\, y_9 + 3Q_2\, y_1^4\, y_2^2\, y_4\, y_5\, y_9 - \\
& 6Q_2\, y_1^3\, y_2^3\, y_3\, y_5\, y_9 + 6Q_2\, y_1^2\, y_2^4\, y_4\, y_5\, y_9 - \\
& 3Q_2\, y_1\, y_2^5\, y_3\, y_5\, y_9 + 3Q_2\, y_2^6\, y_4\, y_5\, y_9 + \\
& 3Q_2\, y_1\, y_2\, y_3^5\, y_5\, y_9 - 3Q_2\, y_2^2\, y_3^4\, y_4\, y_5\, y_9 + \\
& 6Q_2\, y_1\, y_2\, y_3^3\, y_4^2\, y_5\, y_9 - 6Q_2\, y_2^2\, y_3^2\, y_4^3\, y_5\, y_9 + \\
& 3Q_2\, y_1\, y_2\, y_3\, y_4^4\, y_5\, y_9 - 3Q_2\, y_2^2\, y_4^5\, y_5\, y_9 - \\
& 3Q_2\, y_1^2\, y_3^2\, y_4\, y_5\, y_9 + 6Q_2\, y_1\, y_2\, y_3\, y_4^2\, y_5\, y_9 - \\
& 3Q_2\, y_2^2\, y_4^3\, y_5\, y_9 + 0.25Q_2\, y_4\, y_5\, y_9 + 0.5\, y_4\,,
\end{aligned} \tag{3.1.3}$$

$$\begin{aligned} y_4' = & -3Q_2\, y_1^6\, y_3\, y_5\, y_9 + 3Q_2\, y_1^5\, y_2\, y_4\, y_5\, y_9 - \\ & 6Q_2\, y_1^4\, y_2^2\, y_3\, y_5\, y_9 + 6Q_2\, y_1^3\, y_2^3\, y_4\, y_5\, y_9 - \\ & 3Q_2\, y_1^2\, y_2^4\, y_3\, y_5\, y_9 + 3Q_2\, y_1\, y_2^5\, y_4\, y_5\, y_9 + \\ & 3Q_2\, y_1^2\, y_3^5\, y_5\, y_9 - 3Q_2\, y_1\, y_2\, y_3^4\, y_4\, y_5\, y_9 + \\ & 6Q_2\, y_1^2\, y_3^3\, y_4^2\, y_5\, y_9 - 6Q_2\, y_1\, y_2\, y_3^2\, y_4^3\, y_5\, y_9 + \\ & 3Q_2\, y_1^2\, y_3\, y_4^4\, y_5\, y_9 - 3Q_2\, y_1\, y_2\, y_4^5\, y_5\, y_9 + \\ & 3Q_2\, y_1^2\, y_3^3\, y_5\, y_9 - 6Q_2\, y_1\, y_2\, y_3^2\, y_4\, y_5\, y_9 + \\ & 3Q_2\, y_2^2\, y_3\, y_4^2\, y_5\, y_9 - 0.25Q_2\, y_3\, y_5\, y_9 - 0.5\, y_3\,, \end{aligned} \qquad (3.1.4)$$

$$y_5' = y_6\,, \qquad (3.1.5)$$

$$\begin{aligned} y_6' = & -y_5 + y_9 - 6Q_2\, y_1^2\, y_3^2\, y_5^2\, y_9 + \\ & +12\,Q_2\, y_1\, y_2\, y_3\, y_4\, y_5^2\, y_9 - 6Q_2\, y_2^2\, y_4^2\, y_5^2\, y_9 + \\ & +0.5\,Q_2\, y_5^2\, y_9 - 6Q_2\, y_1^2\, y_3^2\, y_6^2\, y_9 + \\ & +12\,Q_2\, y_1\, y_2\, y_3\, y_4\, y_6^2\, y_9 - \\ & -6\,Q_2\, y_2^2\, y_4^2\, y_6^2\, y_9 + 0.5\,Q_2\, y_6^2\, y_9\,, \end{aligned} \qquad (3.1.6)$$

$$y_7' = 12Q_2\, y_1^2\, y_3^2\, y_6 - 24Q_2\, y_1\, y_2\, y_3\, y_4\, y_6 + 12Q_2\, y_2^2\, y_4^2\, y_6 - Q_2\, y_6\,, \qquad (3.1.7)$$

$$y_8' = \mu^{-1/2}\, y_{10}\, r_2\,, \qquad (3.1.8)$$

where $Q_2 = q_2/\mu$, (3.2.1)

$y_9 = 1/y_7$, (3.2.2)

$y_{10} = 1/y_7^{1/2}$, (3.2.3)

$r_2 = r^2$. (3.2.4)

Substituting with new variables to reduce the order of Eqs.(3.1). So, we let

$y_{ii} = y_i\, y_i$, $i = 1(1)4$; $y_{i9} = y_i\, y_9$, $i = 5, 6$;
$e_i = y_i\, y_{59}$, $i = 1(1)5$; $y_{ij} = y_i\, y_j$, $i = 1,2$, $j = 3,4$;
$r_3 = y_{10}\, r_2$; $e_6 = y_6\, y_{69}$; $u = y_{13}\, y_{59}$;
$w = y_{24}\, y_{59}$; $z_{ii} = y_{ii}\, y_{ii}$, $i = 1(1)4$; $z_{ii} = y_{ii}\, y_{ii}$, $i = 1(1)4$;
$z_{ij} = y_{ii}\, y_{jj}$, $i = 1,2$, $j = 2,4$; $b_{1i} = y_{13}\, y_i$, $i = 1(1)5$;
$b_{2i} = y_{24}\, y_i$, $i = 1(1)5$; $d_{11} = y_{13}\, y_{13}$;
$d_{12} = y_{24}\, y_{24}$; $d_{13} = y_{13}\, y_{24}$;
$f = 3\, z_{11} + 6\, z_{12} + 3\, z_{22} - 3\, z_{33} - 6\, z_{34} - 3\, z_{44}$;
$x_i = f\, y_i$, $i = 1(1)4$; $d_i = d_{1i}\, y_6$, $i = 1(1)3$;
$x_{1i} = u\, b_{1i}$, $i = 1(1)5$; $x_{2i} = w\, b_{2i}$, $i = 1(1)5$;
$x_{3i} = u\, b_{2i}$, $i = 1(1)5$; $c_{1i} = u\, x_i$, $i = 1(1)4$;
$c_{2i} = w\, x_i$, $i = 1(1)4$; $d_4 = d_{12}\, e_5$;
$d_5 = -6\, d_1 + 12\, d_3 - 6\, d_2$; and $d_6 = d_5\, y_{69}$.

Using the previous substitutions into Eqs.(3.12), we get the following first order differential set in eight unknowns

$$y_1' = Q_2\,c_{14} - Q_2\,c_{24} - 3Q_2\,x_{12} + 6Q_2\,x_{32} - 3Q_2\,x_{22} + 0.25Q_2\,e_2 + 0.5y_2\,, \qquad (3.3.1)$$

$$y_2' = Q_2\,c_{13} - Q_2\,c_{23} + 3Q_2\,x_{11} - 6Q_2\,x_{31} + 3Q_2\,x_{21} - 0.25Q_2\,e_1 - 0.5y_1\,, \qquad (3.3.2)$$

$$y_3' = -Q_2\,c_{12} + Q_2\,c_{22} - 3Q_2\,x_{14} + 6Q_2\,x_{34} - 3Q_2\,x_{24} + 0.25Q_2\,e_4 + 0.5y_4\,, \qquad (3.3.3)$$

$$y_4' = -Q_2\,c_{11} + Q_2\,c_{21} + 3Q_2\,x_{13} - 6Q_2\,x_{33} + 3Q_2\,x_{23} - 0.25Q_2\,e_3 - 0.5y_3\,, \qquad (3.3.4)$$

$$y_5' = y_6\,, \qquad (3.3.5)$$

$$y_6' = -y_5 + y_9 - 6Q_2\,x_{15} + 12Q_2\,x_{35} - 6Q_2\,d_4 + 0.5Q_2\,e_5 + Q_2\,d_6 + 0.5e_6\,, \qquad (3.3.6)$$

$$y_7' = -2Q_2\,d_5 - Q_2\,y_6\,, \qquad (3.3.7)$$

$$y_8' = \mu^{-1/2}\,r_3\,. \qquad (3.3.8)$$

Let us define the eight Taylor expansions as follows

$$h_i = \sum_{n=1}^{\infty} H_i^{(n)}\,\tilde{\phi}^{\,n-1}\;; \qquad i = 1, 2, \ldots, 8 \qquad (3.4)$$

and

$$h_i' = \sum_{n=1}^{\infty} n\,H_i^{(n+1)}\,\tilde{\phi}^{\,n-1}\;; \qquad (3.5)$$

where we have used small letters (*h*) for the unknown variables and capital letters (*H*) for the coefficients in their Taylor series expansion.

Now, let us define the product of two infinite power series. If a and b are two infinite power series such that

$$a = \sum_{i=1}^{\infty} A^{(i)}\,S^{\,i-1}\,,$$

$$b = \sum_{i=1}^{\infty} B^{(i)}\,S^{\,i-1}\,.$$

Then, it is easy to show that

$$c = a\,b = \sum_{n=1}^{\infty} C^{(n)}\,S^{\,n-1}\,,$$

where

$$C^{(n)} = \sum_{i=1}^{n} A^{(i)}\,B^{(n-i+1)}\,.$$

Substituting Eqs.(3.4 and 3.5) into Eqs.(3.3), and using the rule of the product of two power series, and equating coefficients of equal powers of $\tilde{\phi}$ in both sides of each of the resulting equations, then we get the coefficients of the following recurrence formulae

$$nY_1^{n+1} = Q_2\,C_{14} - Q_2\,C_{24} - 3Q_2\,X_{12} + 6Q_2\,X_{32} - 3Q_2\,X_{22} + 0.25Q_2\,E_2 + 0.5Y_2\,, \qquad (3.6.1)$$

$$nY_2^{n+1} = Q_2\,C_{13} - Q_2\,C_{23} + 3Q_2\,X_{11} - 6Q_2\,X_{31} + 3Q_2\,X_{21} - 0.25Q_2\,E_1 - 0.5Y_1\,, \qquad (3.6.2)$$

$$nY_3^{n+1} = -Q_2\,C_{12} + Q_2\,C_{22} - 3Q_2\,X_{14} + 6Q_2\,X_{34} - 3Q_2\,X_{24} + 0.25Q_2\,E_4 + 0.5Y_4\,, \qquad (3.6.3)$$

$$nY_4^{n+1} = -Q_2\,C_{11} + Q_2\,C_{21} + 3Q_2\,X_{13} - 6Q_2\,X_{33} + 3Q_2\,X_{23} - 0.25Q_2\,E_3 - 0.5Y_3\,, \qquad (3.6.4)$$

$$nY_5^{n+1} = Y_6\,, \qquad (3.6.5)$$

$$nY_6^{n+1} = -Y_5 + Y_9 - 6Q_2\,X_{15} + 12Q_2\,X_{35} - 6Q_2\,D_4 + 0.5Q_2\,E_5 + Q_2\,D_6 + 0.5E_6\,, \qquad (3.6.6)$$

$$nY_7^{n+1} = -2Q_2\,D_5 - Q_2\,Y_6\,, \qquad (3.6.7)$$

$$nY_8^{n+1} = \mu^{-1/2}\,R_3\,, \qquad (3.6.8)$$

then we can compute the coefficients (capital letters) to get small letters which are the unknown variables (y's).

4. COMPUTATIONAL DEVELOPMENTS:

In this section, the computational developments of the formulations of section 3 will be considered.

4.1 Computation Of The Initial Values:

Knowing the position and velocity vectors $\vec{x}_0$ and $\dot{\vec{x}}_0$ at the instant time (t = 0), we have the initial values of the y's as follows

1) $r_0 = \sqrt{x_{01}^2 + x_{02}^2 + x_{03}^2}$,

2) $y_5 = 1/r_0$,

3) $\dot{r}_0 = y_5 (x_{01}\,\dot{x}_{01} + x_{02}\,\dot{x}_{02} + x_{03}\,\dot{x}_{03})$,

4) $V_0 = 1.5\mu\, R^2\, J_2\, y_5^5\, x_{03} - 0.5\mu\, R^2\, J_2\, y_5^3$,

5) $y_7 = (\dot{x}_{01} + \dot{x}_{02} + \dot{x}_{03} - \dot{r}_0^2 + 2V_0)/(\mu\, y_5^2)$,

6) $y_6 = -\dot{r}_0 / \sqrt{\mu\, y_7}$,

7) $C_{1i} = -x_{0i}\, y_5$, $i = 1(1)3$,

8) $p = (\dot{x}_{01} + \dot{x}_{02} + \dot{x}_{03} - \dot{r}_0^2)/(\mu\, y_5^2)$,

9) $C_{2i} = (\dot{x}_{01} / y_5 - \dot{r}_0\, x_{0i}) / \sqrt{\mu\, p}$,

10) $C_{31} = C_{12}\ C_{23} - C_{13}\ C_{22}$,

11) $C_{32} = C_{13}\ C_{21} - C_{11}\ C_{23}$,

12) $C_{33} = C_{11}\ C_{22} - C_{12}\ C_{21}$,

13) $y_4 = 0.5\sqrt{1 + C_{11} + C_{22} + C_{33}}$,

14) $y_1 = (C_{23} - C_{32})/(4\,y_4)$,

15) $y_2 = (C_{31} - C_{13})/(4\,y_4)$,

16) $y_3 = (C_{12} - C_{21})/(4\,y_4)$,

17) $y_8 = t_0$.

Computation Of The Step Size

The related equation between the step size Δt of the time t and the step size $\Delta\tilde{\phi}$ of perturbed true anomaly is

$$\Delta\tilde{\phi} = \Delta t\ y_5^2 \sqrt{\mu\, y_7}\ .$$

Computation Of Accuracy Check

The accuracy of the computed values of the y's at any time could be checked using the relation

$$y_1^2 + y_2^2 + y_3^2 + y_4^2 = 1.$$

RESULTS AND DISCUSSION

As we mentioned in the abstract that we'll take the numerical example of the Indian satellite RS-1 at about 300 Km height (Sharma and Mani, 1985) which remained in its orbit for 371 days, its initial position and velocity components are

$\vec{x}$ = (1626.742, 6268.094, -1776.018) Km,

$$\dot{\vec{X}}_0 = (-5.920522,\ 0.239214,\ -5.15883)\ \text{Km/sec}$$

at epoch 20 July 1980, where its one orbital revolution is elapsed 1.588352085 hrs. Since the adopted physical constant are

$$R = 6378.135\ \text{Km}, \qquad \mu = 398600.8\ \text{Km}^3/\text{sec}^2\ ,$$

and the Earth's zonal harmonic coefficient J_2 equal 1.0826157×10^{-3} .

Using the above values to compute the position and velocity components, i.e., the six elements, and the accuracy check at any time. The results tabulated in the following table which shows the variation in the elements (a, e, i, Ω, ω) and the check relation even 10 days for 250 day. Because of [7] have a perfect prediction up to 250 day and after that day the predication is not good. So, we did our work for the same interval of days.

Computed osculating orbital elements.

Rev. No.	**Mean Solar Day**	**a (Km)**	**e**	**i**	**Ω**	**ω**	**Check Relation**
1	0	6993.17639	0.04432430	44° 41′ 12″.47	239° 21′ 13″.36	174° 49′ 36″.79	1.00000000
152	10.026	6993.1758	0.04432418	44° 41′ 12″.46	239° 21′ 13″.36	174° 49′ 37″.07	1.00000000
303	20.052	6993.17504	0.04432406	44° 41′ 12″.43	239° 21′ 13″.34	174° 49′ 37″.18	1.00000000
454	30.046	6993.17367	0.04432392	44° 41′ 12″.34	239° 21′ 13″.29	174° 49′ 36″.67	0.99999998
605	40.039	6993.17099	0.04432378	44° 41′ 12″.11	239° 21′ 13″.16	174° 49′ 34″.74	0.99999991
756	50.033	6993.16611	0.04432365	44° 41′ 11″.62	239° 21′ 12″.89	174° 49′ 30″.25	0.99999977
907	60.026	6993.15797	0.04432355	44° 41′ 10″.70	239° 21′ 12″.37	174° 49′ 21″.69	0.99999952
1058	70.019	6993.14549	0.04432357	44° 41′ 09″.04	239° 21′ 11″.43	174° 49′ 07″.08	0.99999912
1209	80.013	6993.12752	0.04432383	44° 41′ 06″.14	239° 21′ 09″.78	174° 48′ 44″.03	0.99999853
1360	90.006	6993.1023	0.04432445	44° 41′ 01″.06	239° 21′ 06″.89	174° 48′ 09″.55	0.99999769
1511	100.000	6993.06583	0.04432542	44° 40′ 52″.02	239° 21′ 01″.72	174 47′ 19″.86	0.99999646
1662	109.993	6993.00744	0.04432618	44° 40′ 35″.57	239° 20′ 52″.30	174° 46′ 09″.60	0.99999447
1813	119.986	6992.89894	0.04432461	44° 40′ 05″.06	239° 20′ 34″.83	174° 44′ 30″.20	0.99999077
1964	129.980	6992.66959	0.04431467	44° 39′ 07″.62	239° 20′ 01″.96	174° 42′ 05″.65	0.99998297
2115	139.973	6992.14703	0.04428088	44° 37′ 18″.40	239° 18′ 59″.58	174° 38′ 22″.27	0.99996526
2266	149.966	6990.9155	0.04418504	44° 33′ 49″.44	239° 17′ 00″.44	174° 32′ 02″.48	0.99992362
2417	159.960	6987.96143	0.04393307	44° 27′ 08″.19	239° 13′ 12″.00	174° 19′ 53″.93	0.99982386
2568	169.953	6980.74989	0.04328943	44° 14′ 16″.41	239° 05′ 52″.69	173° 53′ 21″.22	0.99958026
2719	179.947	6962.73767	0.0416513	43° 49′ 32″.59	238° 51′ 45″.33	172° 46′ 49″.09	0.99897014
2870	189.940	6916.61487	0.03747873	43° 02′ 08″.64	238° 24′ 22″.47	169° 28′ 19″.74	0.99739475
3021	199.934	6796.67480	0.02749732	41° 31′ 55″.06	237° 30′ 34″.23	155 36′ 01.13	0.99320452
3172	209.927	6489.92076	0.02569575	38° 42 12″.99	235° 40′ 34″.60	76° 33′ 58″.60	0.98182809
3323	219.920	5774.25984	0.10775407	33° 29′ 45″.21	231° 27′ 54″.52	40° 51′ 13″.98	0.95094279
3474	229.914	4454.48609	0.31355693	24° 35′ 43″.55	218° 06′ 11″.52	51° 22′ 49″.49	0.87098695
3625	239.907	2865.02646	0.64245432	21° 31′ 41″.20	160° 20′ 46″.72	123 17′ 06″.92	0.70069525
3776	249.900	2293.09114	0.77037046	63° 30′ 31″.70	149′ 29′ 20″.21	204° 12′ 03″.37	0.60453324

CONCLUSION

From the table we can conclude that, from 0 up to 210 mean solar days, there are obviously decay in the two elements (a, e), but the other elements (i, Ω, ω) show lightly change. This expected because the only force affecting on the motion of artificial satellite is Earth's gravitational field. This force slightly affect on the elements (i, Ω, ω) where these elements are strongly affected by the other forces like drag, solar radiation pressure, etc.

Also, the table shows that the accuracy check is always nearly to one, i.e., the predictions of the components of position and velocity (the elements) of the artificial satellite is very good.

After 210 up to 250 mean solar days the accuracy check is not good. Depending on this result the satellite will go-down after 210 day. This result is nearly to that coming from [7] and [6]

To get more accurate prediction of the motion of the artificial satellite we will be taken into account the whole other forces affecting on the motion.

REFERENCES

[1]Sharaf MA, Arafah MR, Awad ME. Prediction of satellites in earth's gravitational field with axial symmetry using Burdet's regularized theory. Earth Moon Planets 1987a; 38: 21-36.

[2] Sharaf MA, Awad ME, Najmuldeen SA. The motion of artificial satellites in the set of Eulerian redundant parameters1991. Earth Moon Planets 1991; 55: 21-44

[3]Sharaf MA, Awad ME, Najmuldeen SA. Motion of artificial satellites in the set of Eulerian redundant parameters (III). Earth Moon Planets 1992; 56: 141.

[4] Sharma RK, Raj MX. Long-term orbit computations with KS uniformly regular canonical elements with oblatene. Earth Moon Planets 1988; 42: 163-78.

[5]Awad ME. Encke's special perturbation technique associated with the KS regularized variables. Earth Moon Planets 1988; 43(1): 7- 20.

[6]Z.M.Hayman, J2-Gravity Perturbed Motion of Artifical Satellite in Terms of Euler Parameters 2012 The Open Astronomy Journal Vol.5 p 12-18

[7] Sharma RK, Mani L. Study of RS-1 orbitl decay with KS differential equations. Indian J Pure Appl Math 1985; 16(7): 833-42.