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# Satellite Orbital Characteristics Formulas

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# List of 16 Satellite Orbital Characteristics Formulas

## Satellite Orbital Characteristics

### 1) Anomalistic Period

$$\text{fx } T_{\text{AP}} = \frac{2 \cdot \pi}{n}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$\text{ex } 139.6263\text{s} = \frac{2 \cdot \pi}{0.045\text{rad/s}}$$

### 2) Julian Century

$$\text{fx } \text{JC} = \frac{\text{JD} - \text{JD}_{\text{ref}}}{t_{\text{ref}}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$\text{ex } 300\text{d} = \frac{427\text{d} - 7\text{d}}{1.4}$$

### 3) Julian Day

$$\text{fx } \text{JD} = (t_{\text{ref}} \cdot \text{JC}) + \text{JD}_{\text{ref}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$\text{ex } 427\text{d} = (1.4 \cdot 300\text{d}) + 7\text{d}$$



#### 4) Kepler's First Law

[Open Calculator !\[\]\(4729e517bc6a7cd81c8025b9646574fb\_img.jpg\)](#)

$$fx \quad e = \frac{\sqrt{(a_{\text{semi}}^2 - b_{\text{semi}}^2)}}{a_{\text{semi}}}$$

$$ex \quad 0.126863 = \frac{\sqrt{((581.7\text{km})^2 - (577\text{km})^2)}}{581.7\text{km}}$$

#### 5) Kepler's Third Law

[Open Calculator !\[\]\(e474458956c9a37fbf9586ddb60a7fa1\_img.jpg\)](#)

$$fx \quad a_{\text{semi}} = \left( \frac{[\text{GM.Earth}]}{n^2} \right)^{\frac{1}{3}}$$

$$ex \quad 581706.9\text{km} = \left( \frac{[\text{GM.Earth}]}{(0.045\text{rad/s})^2} \right)^{\frac{1}{3}}$$

#### 6) Local Sidereal Time

[Open Calculator !\[\]\(4fe57c3593bf1b21d272ae7ac8dfaf77\_img.jpg\)](#)

$$fx \quad \text{LST} = \text{GST} + E_{\text{long}}$$

$$ex \quad 111^\circ = 96^\circ + 15^\circ$$


#### 7) Mean Anomaly

[Open Calculator !\[\]\(2bae76de5ebbd5c4d7d47162f1673734\_img.jpg\)](#)

$$fx \quad M = E - e \cdot \sin(E)$$

$$ex \quad 31.95869^\circ = 36^\circ - 0.12 \cdot \sin(36^\circ)$$



8) Mean Motion of Satellite [Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5\_img.jpg\)](#)

$$fx \quad n = \sqrt{\frac{[GM.Earth]}{a_{semi}^3}}$$

$$ex \quad 0.045001 \text{rad/s} = \sqrt{\frac{[GM.Earth]}{(581.7 \text{km})^3}}$$

9) Nominal Mean Motion [Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d\_img.jpg\)](#)

$$fx \quad n_o = \sqrt{\frac{[GM.Earth]}{a_{semi}^3}}$$

$$ex \quad 0.045001 \text{rad/s} = \sqrt{\frac{[GM.Earth]}{(581.7 \text{km})^3}}$$

10) Orbital Period of Satellite in Minutes [Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32\_img.jpg\)](#)

$$fx \quad P_{min} = 2 \cdot \frac{\pi}{n}$$

$$ex \quad 2.327106 \text{min} = 2 \cdot \frac{\pi}{0.045 \text{rad/s}}$$



## 11) Position Vector

$$\text{fx } r_{\text{pos}} = \frac{a_{\text{major}} \cdot (1 - e^2)}{1 + e \cdot \cos(v)}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$\text{ex } 9.693632\text{m} = \frac{10.75\text{m} \cdot (1 - (0.12)^2)}{1 + 0.12 \cdot \cos(0.684\text{s})}$$

## 12) Range Vector

$$\text{fx } V_{\text{range}} = V_{\text{sr}} - [\text{Earth-R}]$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$\text{ex } 1084.991\text{km} = 7456\text{km} - [\text{Earth-R}]$$

## 13) Reference Time in Julian Centuries

$$\text{fx } t_{\text{ref}} = \frac{\text{JD} - \text{JD}_{\text{ref}}}{\text{JC}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$\text{ex } 1.4 = \frac{427\text{d} - 7\text{d}}{300\text{d}}$$

## 14) True Anomaly

$$\text{fx } v = M + (2 \cdot e \cdot \sin(M))$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$\text{ex } 0.684804\text{s} = 31.958^\circ + (2 \cdot 0.12 \cdot \sin(31.958^\circ))$$



15) Universal Time 

fx

Open Calculator 

$$UT_{\text{day}} = \left( \frac{1}{24} \right) \cdot \left( t_{\text{hrs}} + \left( \frac{t_{\text{min}}}{60} \right) + \left( \frac{t_{\text{sec}}}{3600} \right) \right)$$

ex

$$0.291676\text{d} = \left( \frac{1}{24} \right) \cdot \left( 168\text{h} + \left( \frac{20\text{min}}{60} \right) + \left( \frac{0.5\text{s}}{3600} \right) \right)$$

16) Universal Time Degree 

fx

$$UT^{\circ} = (UT_{\text{day}} \cdot 360)$$

Open Calculator 

ex

$$6002.306^{\circ} = (0.291\text{d} \cdot 360)$$



## Variables Used

- $a_{\text{major}}$  Major Axis (Meter)
- $a_{\text{semi}}$  Semi Major Axis (Kilometer)
- $b_{\text{semi}}$  Semi Minor Axis (Kilometer)
- $e$  Eccentricity
- $E$  Eccentric Anomaly (Degree)
- $E_{\text{long}}$  East Longitude (Degree)
- $\text{GST}$  Greenwich Sidereal Time (Degree)
- $\text{JC}$  Julian Century (Day)
- $\text{JD}$  Julian Day (Day)
- $\text{JD}_{\text{ref}}$  Julian Day Reference (Day)
- $\text{LST}$  Local Sidereal Time (Degree)
- $M$  Mean Anomaly (Degree)
- $n$  Mean Motion (Radian per Second)
- $n_0$  Nominal Mean Motion (Radian per Second)
- $P_{\text{min}}$  Orbital Period in Minutes (Minute)
- $r_{\text{pos}}$  Position Vector (Meter)
- $T_{\text{AP}}$  Anomalistic Period (Second)
- $t_{\text{hrs}}$  Time in Hour (Hour)
- $t_{\text{min}}$  Time in Minutes (Minute)
- $t_{\text{ref}}$  Reference Time
- $t_{\text{sec}}$  Time in Seconds (Second)
- $\text{UT}_{\text{day}}$  Universal Time (Day)







- **UT°** Universal Time Degree (Degree)
- **v** True Anomaly (Second)
- **V<sub>range</sub>** Range Vector (Kilometer)
- **V<sub>sr</sub>** Satellite Radius Vector (Kilometer)





## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Constant:** **[Earth-R]**, 6371.0088 Kilometer  
*Earth mean radius*
- **Constant:** **[GM.Earth]**,  $3.986004418 \times 10^{14} \text{ m}^3 \text{ s}^{-2}$   
*Earth's Geocentric Gravitational Constant*
- **Function:** **cos**,  $\cos(\text{Angle})$   
*Trigonometric cosine function*
- **Function:** **sin**,  $\sin(\text{Angle})$   
*Trigonometric sine function*
- **Function:** **sqrt**,  $\sqrt{\text{Number}}$   
*Square root function*
- **Measurement:** **Length** in Kilometer (km), Meter (m)  
*Length Unit Conversion* 
- **Measurement:** **Time** in Second (s), Day (d), Minute (min), Hour (h)  
*Time Unit Conversion* 
- **Measurement:** **Angle** in Degree ( $^{\circ}$ )  
*Angle Unit Conversion* 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s)  
*Angular Velocity Unit Conversion* 



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- [Radio Wave Propagation Formulas](#) 
- [Satellite Orbital Characteristics Formulas](#) 

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