Satellite Communications (Data & Formula Sheet)
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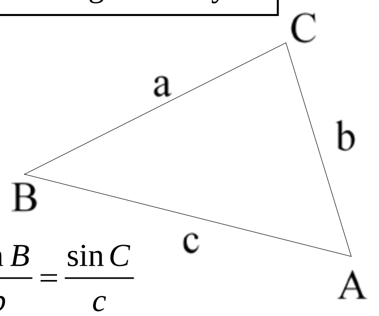
Average radius of the earth=6,378.137 km
Kepler's constant =3.986004418 × 10^5 km^3/s^2. You may use = 3.986 * 10^5 km^3/s^2
Dhahran 26.3°N and50.1°E
Duration of Earth's solar day ≈ 24 Hours.
Speed of light = 2.998 * 10^5 km/s

Plane trigonometry



$$\frac{\sin A}{a}=\frac{\sin B}{b}=\frac{\sin C}{c}$$

$$c^2=a^2+b^2-2ab\cos C$$

$$\tan\frac{C}{2}=\sqrt{\frac{(d-a)(d-b)}{d(d-c)}},\; d=\frac{a+b+c}{2}$$

$F = ma$

$F_{IN} = m \times (\mu / r^2) = m \times (GM_E / r^2)$

$$\bar{F}=-\frac{GM_E m\bar{\mathbf{r}}}{r^3}$$

$$\bar{F}=m\frac{d^2\bar{\mathbf{r}}}{dt^2}$$

$\Delta f=V_T f_T/c=V_T/\lambda$,

$$r_0=\frac{p}{1+e*\cos(\phi_0)}$$

$T^2 = (4\pi^2 a^3)/\mu$ $\quad a=\frac{p}{1-e^2}$ $\quad b=a\left(1-e^2\right)^{1/2}$ $\quad p=\frac{h^2}{\mu}$ $\quad e=\frac{a-b}{a+b}$

$\cos(\gamma) = \cos(L_e)\cos(L_s)\cos(l_s-l_e) + \sin(L_e)\sin(L_s)$

$$d=r_S\sqrt{1+\left(\frac{r_E}{r_S}\right)^2-2\left(\frac{r_E}{r_S}\right)\cos(\gamma)}$$

spherical trigonometry

$$El=\tan^{-1}\left[\frac{\left(\cos\gamma-\frac{r_e}{r_s}\right)}{\sin\gamma}\right]$$

$$\frac{\sin A}{a}=\frac{\sin B}{b}=\frac{\sin C}{c}$$

$$\cos a=\cos b\cos c+\sin b\sin c\cos A$$

$$\cos A=-\cos B\cos C+\sin B\sin C\cos a$$

$$\alpha=\tan^{-1}\left[\frac{\tan\left|(l_s-l_e)\right|}{\sin(L_e)}\right]$$

G= $\eta_A\{4\pi A/\lambda^2\}$, G= $\eta_A\{\pi D/\lambda\}^2$, $\Theta_{3dB}\approx 75\,\lambda/D$ degrees , G $\approx 33000/(\Theta_{3dB})^2$

Given the time of perigee t_p, the eccentricity e and the length of the semimajor axis a:

- η Average Angular Velocity, $\eta=2\pi/T=\mu^{1/2}/a^{3/2}$ (eqn. 2.25)
- **M** Mean Anomaly, M= $\eta\,(t-t_p)$ (eqn. 2.30)
- **E** Eccentric Anomaly, M= E-e sin E, (solve eqn. 2.30)
- r_o Radius from orbit center, $r_o=a-ae\cos E$ (eqn. 2.27)
- φ_o True Anomaly, $r_o=(a(1-e^2))/(1+e\cos\varphi_o)$ (solve eq. 2.22)
- x_0 and y_0 , $x_0=r_0\cos\varphi_o$, $y_0=r_0\sin\varphi_o$ (using eqn. 2.23 and 2.24)