

Nota: si no se utilizan las unidades indicadas hay que tomar las siguientes fórmulas:

$$u = \frac{GM}{R^2} (1 - 3KR^2(\dots)) / (\dots)$$

$$\varepsilon = \frac{6KR^2 \sqrt{GM}}{\mu p^2}$$

$$m^2 a^3 = \mu GM$$

- o bien:
- 1) Sustitución de  $R$  por  $aR^2$
  - 2) sustitución de  $\mu$  por  $\mu GM$  en

1)

C.. MV 670723

C.. MOVIMIENTO SATELITES ARTIFICIALES 7

C.. ~~DATOS~~ PARA BARCELONA

C.. DATOS SATELITE

$$C\phi NS = .000054145 \quad (0' .00055) * 40,589641$$

3 IF (SENSE SWITCH 1) 5, 10

5 READ, T $\phi$ , Q, EX, ZM, SIG, DMGA, AN $\phi$ D

$$A = Q/(1. - EX)$$

$$P = Q*(1. + EX)$$

$$S1 = \sin(ZM)$$

$$S2 = S1 * S1$$

$$C1 = \cos(ZM)$$

$$UM = 1. - 3. * C\phi NS * (1. - 1.5 * S2) / (A * A * (1. - EX * EX) ** 1.5)$$

$$ENE = 1723.4580 * \sqrt{UM/A} / A$$

$$EPS = 6. * C\phi NS / (P * P * UM)$$

$$AL1 = 1. + 2. * EPS * C1 * C1$$

$$AK = EPS * S2 / AL1$$

$$AL1 = \sqrt{AL1}$$

$$AL2 = \sqrt{1. + EPS * (1. - S2 - S2)}$$

$$FF1 = .5 * EPS * C1 * (1. + 1.25 * EPS + (1. + 1.5 * S2))$$

$$FCH1 = 1. / (1. + AK * (.140625 + AK * .09765625))$$

$$PF1 = 6.2831853 * (1. + .5 * EPS * (1. - C1)) * AL2 / AL1$$

AVANT

$$\frac{GK2}{C.. DATOS SOL} = \frac{3.1415927 * (1. + AK * (.25 + AK * (.140625 + AK * .09765625)))}{50}$$

10 READ, TS GO

$$GK4 = GK2 + GK2$$

$$TS GO = TS GO + .03710279$$

$$L1 = 1$$

$$L2 = 2$$

READ, T, H $\phi$  RA, DT

$$DTS = 1.0027391 * DT$$

$$T = T + HORA / 24. - DT$$

$$TS = TS GO + 2 HORA * 1.0027391 - DTS$$

$$15 T = T + DT$$

$$TS = TS + DTS$$

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### C.. INVESTIGACION DIA & NOCHE

$$W = 6.2195015 + .017201969 * T$$

USE 6000

$$W = W + .033445119 * \sin(W) + 3.4955499 \times 10^{-4} * \sin(W +$$

$$W = W + 4.9286353 + .82179357 \times 10^{-6} * T$$

USE 6000

$$X = \cos(W)$$

$$Y = \sin(W)$$

$$\text{ASC} = \text{ATAN}(.91733029 * Y / X)$$

IF(X) 20, 25, 25

$$20 \quad \text{ASC} = \text{ASC} + 3.1415927$$

~~PRINT TS-ASCE~~

$$25 \quad \text{SEND} = .39812704 * Y$$

$$\text{COSD} = \sqrt{1 - \text{SEND} * \text{SEND}}$$

$$W = .66152747 * Y + .74992092 * X * \cos(135) \text{ TS-AS}$$

$$1F(W + .20771168) 35, 35, 30$$

30 PRINT T, L1

GO TO 15

### C.. ECUACIONES DE GARFINKEL

$$35 \quad \text{PZ202} \quad W = S1G + ENE * (T - T\phi)$$

$$W = W + E2 * \sin(W) + E54 * \sin(W + W)$$

USE 6000

V = W

$$R = P / (1 + EX * \cos(V))$$

$$U = AL1 * (V + \phi MCA)$$

$$U = U + GK2$$

$$M = U / GK4$$

$$S = M$$

$$J = U - S * GK4$$

$$1F(J) 40, 45, 45$$

$$40 \quad J = J + GK4$$

$$S = S - 1$$

$$45 \quad J = J - GK2$$

$$CHI = FC\chi * U$$

$$PSI = CHI + .125 * AK * \sin(CHI + CHI)$$

$$SPSI = CPS(CHI)$$

$$SPSI = (1. + .25 * AK * SPSI * SPSI) * \sin(CHI)$$

$$SZ = SA * SPSI$$

$$Z = ATAN(SZ / \sqrt{1. - SZ * SZ})$$

$$FI = PSI$$

$$G = 0.$$

$$W = \sqrt{1. - SPSI * SPSI}$$

IF (ABS(PSI) = 1.5707963) 60, 65, 70

50 G = 3.1415927

$$W = -W$$

IF (SPSI) 55, 65, 60

$$55^{\circ} G = -G$$

$$60 FI = ATAN(C1 * SPSI / W) + G$$

$$65 FI = ANDD + FI - FFI * PSI + S * PFI$$

$$W = FI$$

USE 6000

$$FI = W$$

## C. COMPROBACION VISIBILIDAD

~~H = FI - ASC~~

$$X = R * \cos(Z)$$

$$Y = R * \sin(Z)$$

$$CZS = Y * SEND + X * CDS, * \cos(FI - ASC)$$

$$W = \sqrt{R * R - 40.589641}$$

$$IF (CZS + W) 70, 75, 75$$

70 PRINT, T, L2

GO TO 15

# C.. CALCULO ASCENCION RECTA Y DECLINACION TOPOCENTRICA

$$TS - W = TS - F_1$$

USE 6000

$$AR = W$$

$$X = R * \cos(z)$$

$$Y = X * \sin(z)$$

~~$$z_1 = X * \cos(AR) - S$$~~

~~$$z_1 = R * \sin(z) - S$$~~

$$R_1 = X * X + Y * Y$$

$$\theta = \text{ATAN}(z_1 / \sqrt{R_1}) * 57.295780$$

$$AR = \text{ATAN}(Y/X)$$

$$IF(x) 80, 85, 85$$

$$80 \quad AR = AR + 3.1415927$$

$$85 \quad W = TS - AR$$

USE 6000

$$AR = W * 57.295780$$

$$R_1 = \sqrt{R_1 + z_1 * z_1}$$

## C.. CALCULO ACIMUT Y ALTURA

$$x_1 = X * .66152747 - z_1 * .74992092$$

$$z_1 = X * .74992092 + z_1 * .66152747$$

$$H = \text{ATAN}(z_1 / \sqrt{x_1 * x_1 + Y * Y}) * .57295780$$

~~$$AC = \text{ATAN}(Y/x_1)$$~~

$$IF(x_1) 90, 95, 95$$

$$90 \quad AC = AC + 3.1415927$$

$$95 \quad W = TS - AC$$

USE 6000

~~$$AC = W * 57.295780$$~~

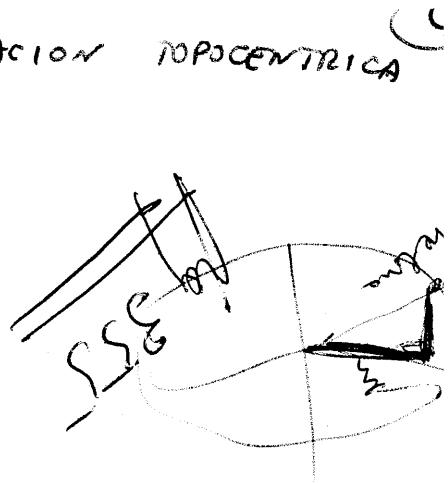
$$F_1 = F_1 * 57.295780$$

$$Z = Z * 57.295780$$

PRINT, T, R, F1, Z, R1, AR, ~~D~~, AC, H

GO TO 15

6000



Unidades : { Mm  
 { Días  
 Radianes

$Q$  : q, Radio vector perigeo (Mm)

$\text{EX}$  : e, excentricidad

$\text{ZM}$  :  $i$ , inclinación órbita (rad.)

$\text{SIG}$  :  $\delta$ , anomalía en la época (rad)

$\text{OMA}$  :  $\omega$ , argumento de declinación perigeo (rad)

$\text{ANOD}$  :  $\Omega$ , Argumento ascensión recta Nodo ascendente (rad)

$T\phi$  :  $t$ , Epoca constante (en días y fracciones a partir 1968,0)

$\text{TS60}$  :  $t_{\text{MS}}$  : Tiempo sideral en Greenwich  $\approx 0^{\circ} \text{T.U.}$

$T$  : Días enteros a partir de 1968,0

$\text{HORA}$  :  $t$  tiempo universal T.U. en horas y fracciones

## RESULTADOS

$T$  : hora

$R$  : distancia geocéntrica satélite

$F1$  : Ascensión recta "

$Z$  : Declinación "

$R1$  : Distancia topocéntrica "

$AR$  : Ascensión recta "

$D$  : Declinación topocéntrica "

$AC$  : Altitud

$H$  : alturas angulares sobre el horizonte

# CONSTANTES NUMÉRICAS

6

De Barcelona :

$\lambda$ :

$$\lambda, \text{ Longitud} : 8^{\circ} 38' 5'' \leftarrow = -0.03710279$$

$$\varphi, \text{ Latitud} : 41^{\circ} 24' 10'' N = .72261478$$

$$\cos \varphi = .74996092$$

$$\sin \varphi = .66152747$$

$$p = \frac{\text{Radio ge}}{\text{Distancia entre Tierra}} =$$

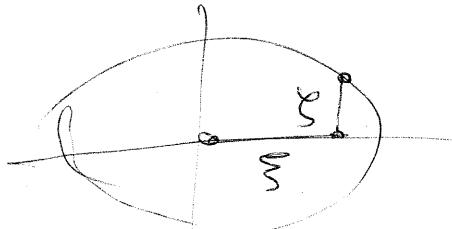
$$\text{Constante de Gauss} : 1723.4580 \text{ Mm}^{3/2} \text{ dia}^{-1}$$

$$\omega_E = .91733029$$

$$\sin \varepsilon = .39812704$$

$$\sin 12^\circ = .20791168$$

$$\left. \begin{array}{l} \xi = 4.792\ 6095 \text{ Mm} \\ \eta = 4.194\ 7984 \text{ Mm} \\ g = .99853528 \quad a = 63690454 \end{array} \right\} \text{BARCELONA}$$



~~(23650134)~~

63690454

## CONSTANTES SATELITE

$$C\phi NS = .00055$$

$$Q = \frac{q}{1-e}$$

$$EX = e$$

$$ZM = i$$

$$SIG = \sigma$$

$$OMGA = \omega$$

$$ANOD = \Omega$$

$$T\phi = t_0$$

$$A = \frac{q}{1-e}$$

$$P = \frac{q(1+e)}{1-e}$$

$$S1 = \sin(\Omega) \sin i$$

$$S2 = \sin^2 i$$

$$C1 = \cos i$$

~~DEFINICIONES~~

$$F = \frac{1+e}{1-e}$$

~~DEFINICIONES~~

~~DEFINICIONES~~

## ANGULOS

$$UM = \mu = \dots$$

$$EPS = \varepsilon = \dots$$

$$AL1 = \lambda_1 = \dots$$

$$AL2 = \lambda_2 = \dots$$

$$FF1 = \dots$$

$$FCHI = \dots$$

$$PF1 = \dots$$

$$ENE = n$$

$$AK : R$$

$$L1 : aux.$$

$$L2 : aux.$$

## UMIDADES

$$Mm$$

Dias medios

excepcionalmente:

horas

$$\begin{aligned} T\phi &= t_0 \\ TSGO &= t_{0mo} \end{aligned}$$

$$\begin{aligned} T &= t \\ DT &= \Delta t \\ TS &= \theta \end{aligned}$$

$$\begin{aligned} \text{HORA} &= t \\ T_1 &= T - T_0 \end{aligned}$$

~~SISTEMA DE COORDENADAS~~

$$\begin{aligned} W &= M && \text{GEOCENTRICO} \\ \Delta V &= V && (\text{no se usa}) \\ x &= \cos(V) \\ y &= \sin(V) \\ \text{ASC} &= A \end{aligned}$$

~~SISTEMA DE COORDENADAS~~

$$\text{sen} \beta = \sin D$$

$$\cos \beta = \cos D$$

$$z_1 = \cos Z$$

$$H = H_0$$

OBSERVADOR

$$R = \begin{array}{l} \text{GEOCENTRICO} \\ \text{distancia geocentrica satelite} \end{array}$$

M = n° vuelta

$$CH1 = X \quad \text{angulos auxiliares}$$

$$PS1 = \psi = \text{angulos auxiliares}$$

$$SPSI = \sin \psi$$

$$SZ = \sin D_s$$

$$F1 = D_2$$

$$F1 = AS$$

$$G = \text{aux. min}$$

Hay tres origenes:

$$1968,0$$

o/o T.U. del dia

T $\phi$  ejes de constantes satelite a partir de 1968,0

## PUNTO SUBSATELITE

$$H\alpha = H''_0$$

$$C2S = \cos Z''_S$$

$$(V\alpha) = \cos Z''_0 \quad (\text{ojo})$$

## TOPOCENTRICOS (OBSERVADOR)

$$AR = A'$$

$$X$$

$$Y$$

$$Z$$

$$Z_1$$

coordenadas

$$X_1$$

$$Z_1$$

$$R_1$$

$$H\alpha$$

$$A'$$

$$D'_s$$

distancia topocentrica