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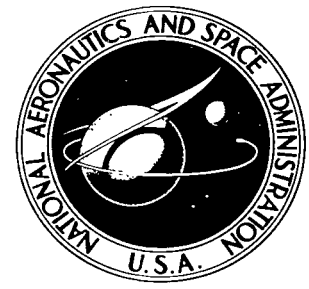

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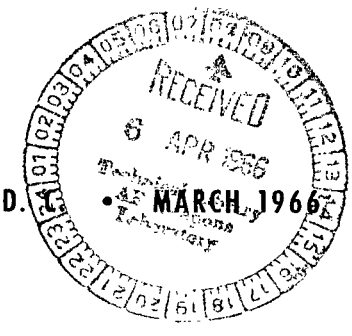
THE DEVELOPMENT OF HANSEN'S COORDINATES IN THE LUNAR PROBLEM BY THE METHOD OF ITERATION

by Milton L. Charnow

Goddard Space Flight Center
Greenbelt, Md.



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ABSTRACT

A modification of Hansen's solution of the lunar problem by Musen has been programmed and verified by duplicating some of Hansen's series. Methods were developed for manipulating trigonometric series with numerical coefficients and literal arguments. The program described will be used to calculate perturbations and ephemerides of both natural and artificial satellites.

CONTENTS

THE DEVELOPMENT OF HANSEN'S COORDINATES IN THE LUNAR PROBLEM BY THE METHOD OF ITERATION

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INTRODUCTION

This modification of Hansen's solution of the lunar problem (References 1 and 2) was suggested by Musen (Reference 3) and programmed by the author. This theory can be used for planetary satellites with high inclinations. The modification is adjusted to the use of the process of iteration, thus contributing to the uniformity of the programming and facilitating treatment of the problem by modern digital computing machines. Hansen's original lunar theory requires the use of the derivatives of the disturbing function with respect to the eccentricity and the parameters determining the orbit plane's position. This means that a *literal* development of the disturbing function must be obtained before the *numerical* values of the elements can be substituted. The present modification permits a numerical development of the disturbing function.

In order to reproduce some of Hansen's series, it was necessary to devise methods for the machine to perform both numerical and algebraic manipulations. The trigonometric series employed in the lunar problem are slowly convergent. The original program allowed 50 terms to a series. Of the two completed versions, the program written for the IBM-7094 Mod II allows for 200 terms to a series and the Univac 1107 version allows 3,333 terms to a series.

The IBM 7094 program utilizes the double core storage of 65,000 words. The Univac 1107 program uses 500,000 words of drum storage and allows 10,000 words of storage for each series. Almost the entire 65,000 word core storage of the Univac 1107 is used as accumulators to bring in the series to be operated on and to accumulate the results. Core storage of 20,000 words is used as an accumulator to store the resultant series.

A complete package of routines to multiply, add, subtract, scalar multiply, differentiate, integrate, and evaluate trigonometric series and to extract the numerical coefficient of any argument was written. By the uses of these tools, series manipulations are programmed almost as easily as numerical calculations.

PROGRAM DEVELOPMENT

The Hansen lunar theory utilizes trigonometric terms of five arguments multiplied by a numerical coefficient. The arguments are g, g', ω, ω' and γ, of which g and g' represent the mean

anomalies of the satellite and the sun (the perturbed and perturbing bodies) while ω and ω' represent the mean arguments of perigee of the perturbed and perturbing bodies and γ represents a fictitious mean anomaly of the auxiliary satellite. For example, the largest term in the $n_0 \delta z$ series is the evection term; its value is $4466''.9 \sin(1g - 2g' + 2\omega - 2\omega')$.

A number scheme was developed to represent a cosine or sine. This scheme is normalized to the number 00505050+08. The evection term in this notation is 44669000+04 - 01485248+08 + 50505050+08. Of these three words, the first is an ordinary number. The second and third are logic words which permit a representation of a trigonometric term with as many as eight arguments in literal form whose multipliers can assume any value from +49 to -49. The first argument is positive and can assume values from 0 to 99.

The parts composing the multiplication routine are multiplier, collapser, and arranger. After each term of a series is multiplied, it is compared with every term previously generated so that the resultant series has no duplicates. The resultant series is then arranged in descending order of the numerical coefficients.

In addition to the routines described, Appendix B shows an example of a sample series printout programmed by T. P. Gorman.

COLLECTION OF FORMULAS AND DISCUSSION

A Bessel-function routine is employed to generate the numerical coefficients of the input series $(\rho/a')\cos\phi$ through a'/ρ'. The input series have literal arguments. The major iterative loop begins with the calculation of the s_1 series. The disturbing function is generated from the s and the p series. When the series representing the $d\psi/dt$, $d\lambda_2/dt$ and $d\lambda_3/dt$ functions have been formed, the values of $n_0 y$, $n_0 \alpha$ and $n_0 \eta$ are determined by imposing the condition that the series representing those functions contain no constant terms.

The values, $n_0 y$, $n_0 \alpha$ and $n_0 \eta$ relate to the motion of the lunar perigee, lunar node, and solar perigee. The series

$$\left[\frac{h_0}{h}\right], \quad [T], \quad [\Psi], \quad [\lambda_i] \qquad (i = 1, 2, 3, 4)$$

are obtained by the formal integration process. The $n_0 \delta z$ series is computed from the $dn_0 \delta z/dt$ series after c_1 and c_2 are calculated so that $n_0 \delta z$ contains no constant or $\sin g$ terms.

The $n_0 \delta z$ series has been computed; now the

$$\frac{h_0}{h}, \quad \Xi, \quad \frac{h}{h_0}, \quad T, \quad \Psi, \quad \bar{W} \quad \text{and} \quad \nu$$

are constructed for final output or for use in the next iteration. They are complete when the values of $n_0 y$, $n_0 \alpha$, and $n_0 \eta$ have converged. This modified version of the lunar theory converged in

ten iterations. One iteration is completed in approximately one hour on the Univac 1107 program.

The following input values were used:

$n_0 = 0.228027130$ radians/day

$I_0 = 0.089826279$ radians

$e_0 = 0.054908070$

$n' = 0.01720197$ radians/day

$e' = 0.01679226$

$\frac{m' a^2}{a^3} = 0.00569091504$

$\frac{m' a^3}{a'^4} = 0.000014054$

$\frac{m' a^4}{a'^5} = 0.000000036$

Input information:

$$g_0, \omega_0, \omega_0', I_0, a_0, e_0, n_0 ,$$

$$g_0', a', e', n', i', \Omega' .$$

Basic arguments:

$$g = g_0 + n_0 t , \qquad g' = g_0' + n_0' t ,$$

$$\omega = \omega_0 + n_0 (y + \alpha - \eta) t ,$$

$$\omega' = \omega_0' + n_0 (\alpha + \eta + y') t ,$$

$$\theta = \left(\pi_0' + n_0 y' t - \sigma'\right) - \omega' .$$

The following standard formulas of the elliptic motion are used; however, if preferred, Cayley's Tables can be used instead.

$$\frac{\rho}{a_0} \cos\phi = -\frac{3}{2} e_0 + 2 \sum_{p=1}^{+\infty} \frac{J_p'(pe_0)}{p} \cos p\gamma ,$$

$$\frac{\rho}{a_0} \sin\phi = \frac{2\sqrt{1-e_0^2}}{e_0} \sum_{p=1}^{+\infty} \frac{J_p(pe_0)}{p} \sin p\gamma ,$$

$$\frac{\rho}{a_0} = 1 + \frac{1}{2} e_0^2 - 2e_0 \sum_{p=1}^{+\infty} \frac{J_p'(pe_0)}{p} \cos p\gamma ,$$

$$\frac{\rho^2}{a_0^2} = 1 + \frac{3}{2} e_p^2 - 4 \sum_{p=1}^{+\infty} \frac{J_p(pe_0)}{p^2} \cos p\gamma ,$$

$$\frac{a_0}{\rho} = 1 + 2 \sum_{p=1}^{+\infty} J_p(pe_0) \cos p\gamma ,$$

and

$$\frac{a'}{r'} = 1 + 2 \sum_{p=1}^{+\infty} J_p(pe') \cos pg' .$$

Beginning of Iteration

$$s_1 = (1+\nu) \cdot \frac{\rho}{a_0} \cdot \frac{a'}{r'} \cos(\phi + \bar{f}' + \omega + \omega') ,$$

$$s_2 = (1+\nu) \cdot \frac{\rho}{a_0} \cdot \frac{a'}{r'} \sin(\phi + \bar{f}' + \omega + \omega') ,$$

$$s_3 = (1+\nu) \cdot \frac{\rho}{a_0} \cdot \frac{a'}{r'} \cdot \cos(\phi - \bar{f}' + \omega - \omega') ,$$

$$s_4 = (1+\nu) \cdot \frac{\rho}{a_0} \cdot \frac{a'}{r'} \cdot \sin(\phi - \bar{f}' + \omega - \omega') ,$$

$$s = + (\lambda_1^2 - \lambda_2^2) s_1 - 2\lambda_1\lambda_2 s_2 + (\lambda_4^2 - \lambda_3^2) s_3 - 2\lambda_3\lambda_4 s_4 ;$$

$$p = (1+\nu) \frac{\rho}{a_0} \cdot \frac{a'}{r'} ;$$

$$\frac{1}{2} \frac{\partial s}{\partial \lambda_1} = + \lambda_1 s_1 - \lambda_2 s_2 = \sigma_1 ,$$

$$\frac{1}{2} \frac{\partial s}{\partial \lambda_2} = - \lambda_2 s_1 - \lambda_1 s_2 = \sigma_2 ,$$

$$\frac{1}{2}\frac{\partial s}{\partial \lambda_3} = -\lambda_3 s_3 - \lambda_4 s_4 = \sigma_3 ,$$

$$\frac{1}{2}\frac{\partial s}{\partial \lambda_4} = +\lambda_4 s_3 - \lambda_3 s_4 = \sigma_4 ;$$

$$M_1 = \frac{2a_0 n_0}{1-e_0^2}\left[\frac{1}{e_0}\left(1-e_0^2-\frac{\rho^2}{a_0^2}\right) - \frac{\nu}{1+\nu}\frac{1}{e_0}\left(1-e_0^2-\frac{\rho}{a_0}\right) + \left(\frac{h^2}{h_0^2}-1\right)\frac{1}{e_0}\frac{\rho}{a_0}\left(1-\frac{\rho}{a_0}\right)\right] ,$$

$$N_1 = \frac{2a_0 n_0}{1-e_0^2}\cdot\frac{\rho}{a_0}\cdot\frac{\sin\phi}{\sqrt{1-e_0^2}}\left[1-\frac{a_0}{\rho}\cdot\frac{\nu}{1+\nu}-\left(\frac{h^2}{h_0^2}-1\right)\left(\frac{a_0}{\rho}-1\right)\right] ,$$

$$M_2 = \frac{2a_0 n_0}{1-e_0^2}\left[\frac{1}{\sqrt{1-e_0^2}}\int\left(2\frac{\rho}{a_0}\cos\phi+3e_0\right)d\gamma - \frac{\nu}{1+\nu}\frac{\rho}{a_0}\sin\phi+\left(\frac{h^2}{h_0^2}-1\right)\frac{\rho^2}{a_0^2}\cdot\frac{\sin\phi}{1-e_0^2}\right] ,$$

$$N_2 = \frac{2a_0 n_0}{\left(1-e_0^2\right)^{3/2}}\left[-\left(\frac{\rho}{a_0}\cos\phi+2e_0\right)+\sqrt{1-e_0^2}\,\frac{\nu}{1+\nu}\frac{d}{d\gamma}\frac{\rho}{a_0}\sin\phi+\left(\frac{h^2}{h_0^2}-1\right)e_0\frac{\rho}{a_0}\frac{\sin\phi}{\sqrt{1-e_0^2}}\frac{d}{d\gamma}\frac{\rho}{a_0}\cos\phi\right] ,$$

$$M_3 = +\frac{n_0 a_0}{1-e_0^2}\frac{\rho^2}{a_0^2} ,$$

$$N_3 = -\frac{n_0 a_0}{1-e_0^2}\cdot\frac{\rho}{a_0}\cdot\frac{e_0\sin\phi}{\sqrt{1-e_0^2}} ;$$

$$\Omega_1 = \frac{m' a^2}{a'^3}\cdot\frac{a'}{r'}\cdot\left(\frac{3}{2}s^2-\frac{1}{2}p^2\right) ,$$

$$\Omega_2 = \frac{m' a^3}{a'^4}\cdot\frac{a'}{r'}\cdot\left(\frac{5}{2}s^3-\frac{3}{2}sp^2\right) ,$$

$$\Omega_3 = \frac{m' a^4}{a'^5}\cdot\frac{a'}{r'}\cdot\left(\frac{35}{8}s^4-\frac{15}{4}s^2p^2+\frac{3}{8}p^4\right) ,$$

. . . . . .

$$\Omega = \Omega_1 + \Omega_2 + \Omega_3 + \cdots ,$$

$$\frac{\partial\Omega}{\partial\gamma} = \frac{\partial\Omega_1}{\partial\gamma} + \frac{\partial\Omega_2}{\partial\gamma} + \frac{\partial\Omega_3}{\partial\gamma} + \cdots ,$$

$$\rho\frac{\partial\Omega}{\partial\rho} = 2\Omega_1 + 3\Omega_2 + 4\Omega_3 + \cdots ,$$

$$\frac{1}{1+\nu}\cdot\frac{a}{\rho}\cdot\frac{\bar{r}'}{a'}\cdot\frac{\partial\Omega}{\partial S}=+\frac{m'a^2}{a'^3}\cdot\frac{a'}{r'}\cdot 3s+\frac{m'a^3}{a'^4}\cdot\frac{a'}{r'}\cdot\left(\frac{15}{2}s^2-\frac{3}{2}p^2\right)+\frac{m'a^4}{a'^5}\cdot\frac{a'}{r'}\cdot\left(\frac{35}{2}s^3-\frac{15}{2}sp^2\right)+\cdots,$$

$$T_i \equiv M_i\frac{\partial\Omega}{\partial\gamma}+N_i\cdot\rho\frac{\partial\Omega}{\partial\rho}\qquad(i=1,2,3);$$

$$F_i=\sum_n\frac{1}{n!}\frac{\overline{\partial^n T_i}}{\partial\gamma^n}(n_0\delta z)^n\qquad(n=0.\ 1,\ 2,\ 3,\cdots),$$

$$\frac{d\boldsymbol{\Gamma}}{dt}=+n_0 y\Psi+F_1,$$

$$\frac{d\Psi}{dt}=-n_0 y\left(\boldsymbol{\Gamma}+2\frac{h}{h_0}\cdot\frac{e_0}{1-e_0^2}\right)+F_2,$$

$$\frac{d}{dt}\frac{h_0}{h}=F_3;$$

$$G_1=\frac{1}{2}\frac{h}{h_0}\cdot\frac{a_0 n_0}{\sqrt{1-e_0^2}}\cdot\left(\frac{a}{\rho}\cdot\frac{\bar{r}'}{a'}\cdot\frac{1}{1+\nu}\frac{\partial\Omega}{\partial S}\right)\cdot\left[+\left(\lambda_3^2+\lambda_4^2\right)\sigma_2-\left(\lambda_1\lambda_4+\lambda_2\lambda_3\right)\sigma_3-\left(\lambda_2\lambda_4-\lambda_1\lambda_3\right)\sigma_4\right],$$

$$G_2=\frac{1}{2}\frac{h}{h_0}\cdot\frac{a_0 n_0}{\sqrt{1-e_0^2}}\cdot\left(\frac{a}{\rho}\cdot\frac{\bar{r}'}{a'}\cdot\frac{1}{1+\nu}\frac{\partial\Omega}{\partial S}\right)\left[-\left(\lambda_4^2+\lambda_3^2\right)\sigma_1-\left(\lambda_2\lambda_4-\lambda_1\lambda_3\right)\sigma_3+\left(\lambda_1\lambda_4+\lambda_2\lambda_3\right)\sigma_4\right],$$

$$G_3=\frac{1}{2}\frac{h}{h_0}\cdot\frac{a_0 n_0}{\sqrt{1-e_0^2}}\cdot\left(\frac{a}{\rho}\cdot\frac{\bar{r}'}{a'}\cdot\frac{1}{1+\nu}\frac{\partial\Omega}{\partial S}\right)\left[-\left(\lambda_1^2+\lambda_2^2\right)\sigma_4+\left(\lambda_1\lambda_4+\lambda_2\lambda_3\right)\sigma_1+\left(\lambda_2\lambda_4-\lambda_1\lambda_3\right)\sigma_2\right],$$

$$G_4=\frac{1}{2}\frac{h}{h_0}\cdot\frac{a_0 n_0}{\sqrt{1-e_0^2}}\cdot\left(\frac{a}{\rho}\cdot\frac{\bar{r}'}{a'}\cdot\frac{1}{1+\nu}\frac{\partial\Omega}{\partial S}\right)\cdot\left[+\left(\lambda_1^2+\lambda_2^2\right)\sigma_3+\left(\lambda_2\lambda_4-\lambda_1\lambda_3\right)\sigma_1-\left(\lambda_1\lambda_4+\lambda_2\lambda_3\right)\sigma_2\right];$$

$$H_i=\sum_n\frac{1}{n!}(n_0\delta z)^n\frac{\overline{\partial^n G_i}}{\partial\gamma^n}\qquad(i=0,1,2,3,4),$$

$$\frac{d\lambda_1}{dt}=+n_0\alpha\lambda_2+H_1-\frac{1}{2}\left(+\lambda_4\sin\theta+\lambda_3\cos\theta\right)\cdot\sin i'\frac{d\Omega'}{dt},$$

$$\frac{d\lambda_2}{dt} = -n_0\,\alpha\lambda_1 + H_2 + \frac{1}{2}\left(+\lambda_4\cos\theta - \lambda_3\sin\theta\right)\cdot\sin i'\,\frac{d\Omega'}{dt}\ ,$$

$$\frac{d\lambda_3}{dt} = +n_0\,\eta\lambda_4 + H_3 + \frac{1}{2}\left(+\lambda_1\cos\theta + \lambda_2\sin\theta\right)\cdot\sin i'\,\frac{d\Omega'}{dt}\ ,$$

$$\frac{d\lambda_4}{dt} = -n_0\,\eta\lambda_3 + H_4 + \frac{1}{2}\left(+\lambda_1\sin\theta - \lambda_2\cos\theta\right)\cdot\sin i'\,\frac{d\Omega'}{dt}\ .$$

Where

$$\left[\frac{h_0}{h}\right],\ [\Upsilon],\ [\Psi],\ [\lambda_i] \qquad (i = 1, 2, 3, 4)$$

is the series obtained by the formal integration process,

$$\Psi = [\Psi]\ ,$$

$$[\Xi] = -3\left[\frac{h_0}{h}\right] - \frac{3}{2}\,e_0\,[\Upsilon] + 2\left(\Delta^2 - \Delta^3 + \cdots\right)\ ,$$

$$\left(\frac{\bar r}{a_0}\cos\bar f\right) - \left(\frac{\bar\rho}{a_0}\cos\bar\phi\right) = \sum_n \frac{\left(n_0\,\delta z\right)^n}{n!}\,\frac{d^n}{dg^n}\,\frac{\bar\rho}{a_0}\cos\bar\phi\ ,$$

$$\left(\frac{\bar r}{a_0}\sin\bar f\right) - \left(\frac{\bar\rho}{a_0}\sin\bar\phi\right) = \sum_n \frac{\left(n_0\,\delta z\right)^n}{n!}\,\frac{d^n}{dg^n}\,\frac{\bar\rho}{a_0}\sin\phi\ ,$$

$$\left(\frac{\bar r}{a_0}\right)^2 - \left(\frac{\bar\rho}{a_0}\right)^2 = \sum_n \frac{\left(n_0\,\delta z\right)^n}{n!}\,\frac{d^n}{dg^n}\,\frac{\bar\rho^2}{a_0^2}\ ;$$

$$\left[\bar W_0\right] = [\Xi] + [\Upsilon]\left(\frac{\bar\rho}{a_0}\cos\bar\phi + \frac{3}{2}\,e_0\right) + [\Psi]\,\frac{\bar\rho}{a_0}\sin\bar\phi\ ;$$

$$B = n_0\,[\Upsilon]\left(\frac{\bar r}{a_0}\cos\bar f - \frac{\bar\rho}{a_0}\cos\bar\phi\right) + n_0\,[\Psi]\left(\frac{\bar r}{a_0}\sin\bar f - \frac{\bar\rho}{a_0}\sin\bar\phi\right) - \frac{n_0\,y}{\sqrt{1-e_0^2}}\left(\frac{\bar r^2}{a_0^2} - \frac{\bar\rho^2}{a_0^2}\right) + \frac{n_0\,\nu^2(1+\bar W)}{1-\nu^2} + n_0\,c_2\left(\frac{\bar r}{\bar a}\cos\bar f - \frac{\bar\rho}{\bar a}\cos\bar\theta\right)\ ,$$

$$n_0\left[\bar W_0\right] - \frac{n_0\,y}{\sqrt{1-e_0^2}}\cdot\frac{\bar\rho^2}{a_0^2} + B = A_1 + A_2\cos g + \cdots\ ,$$

$$\frac{\bar\rho}{a_0}\cos\bar\phi + \frac{3}{2}\,e_0 = \beta\cos g + \cdots\ ;$$

$$c_1 = \frac{A_1}{3n_0} + \frac{A_2 e_0}{2\beta n_0} ,$$

$$c_2 = -\frac{A_2}{\beta n_0} ;$$

$$\frac{dn_0 \delta z}{dt} = n_0 \left(-3c_1 - \frac{3}{2} e_0 c_2\right) + n_0 c_2 \left(\frac{\bar{\rho}}{a_0} \cos\bar{\phi} + \frac{3}{2} e_0\right) - \frac{n_0 y}{\sqrt{1-e_0^2}} \frac{\bar{\rho}^2}{a_0^2} + n_0 \left[\bar{W}_0\right] + B ,$$

$$n_0 \delta_2 = \int \frac{dn_0 \delta_2}{dt} ,$$

$$\frac{h_0}{h} = 1 + c_1 + \left[\frac{h_0}{h}\right] = 1 + \Delta ,$$

$$\tau = c_2 + [\tau] ,$$

$$\Xi = -3\Delta - \frac{3}{2} e_0 \tau + 2\left(\Delta^2 - \Delta^3 + \cdots\right) ;$$

$$\frac{h}{h_0} = 1 - \Delta + \Delta^2 - \Delta^3 + \Delta^4 - \Delta^5 + \cdots ,$$

$$\bar{W} = \Xi + \tau\left(\frac{\bar{r}}{a_0} \cos\bar{f} + \frac{3}{2} e_0\right) + \Psi \frac{\bar{r}}{a_0} \sin\bar{f} ,$$

$$\nu = \frac{1}{2}(\Delta - \bar{W}) - \frac{1}{2}(\Delta + \bar{W})\nu ;$$

$$(11) = \text{const. in } \left\{\left(\left[\lambda_1\right] + \left[\lambda_4\right]\right)^2 + \left(\left[\lambda_2\right] - \left[\lambda_3\right]\right)^2\right\} ,$$

$$(12) = \text{const. in } \left\{\left(\left[\lambda_1\right] - \left[\lambda_4\right]\right)^2 + \left(\left[\lambda_2\right] + \left[\lambda_3\right]\right)^2\right\} ,$$

$$A^2 + 2A\left(\cos\frac{1}{2} I_0 + \sin\frac{1}{2} I_0\right) + (11) = 0 ,$$

$$B^2 - 2B\left(\cos\frac{1}{2} I_0 - \sin\frac{1}{2} I_0\right) + (12) = 0 ;$$

$$\lambda_1 = \sin\frac{1}{2} I_0 + \frac{1}{2}(A+B) + \left[\lambda_1\right] ,$$

$$\lambda_2 = \left[\lambda_2\right] ,$$

$$\lambda_3 = \left[\lambda_3\right] ,$$

$$\lambda_4 = \cos\frac{1}{2} I_0 + \frac{1}{2}(A-B) + \left[\lambda_4\right] ;$$

End of Iteration

$$A_1(\alpha) = \begin{bmatrix} +1 & 0 & 0 \\ 0 & +\cos\alpha & -\sin\alpha \\ 0 & +\sin\alpha & +\cos\alpha \end{bmatrix},$$

$$A_3(\alpha) = \begin{bmatrix} +\cos\alpha & -\sin\alpha & 0 \\ +\sin\alpha & +\cos\alpha & 0 \\ 0 & 0 & +1 \end{bmatrix}$$

$$r = A_3(-\omega') \cdot \Lambda \cdot A_3(\omega)(1+\nu) \begin{bmatrix} \bar{r}\cos\bar{f} \\ \bar{r}\sin\bar{f} \\ 0 \end{bmatrix},$$

$$v = \frac{a_0 n_0}{\sqrt{1-e_0^2}} A_3(-\omega') \cdot \Lambda \cdot A_3(\omega) \cdot \begin{bmatrix} -\frac{h}{h_0}\sin\bar{f} & -\frac{1}{2}(1-e_0^2)\Psi \\ +\frac{h}{h_0}(\cos\bar{f}+e_0) & +\frac{1}{2}(1-e_0^2)r \\ 0 & \end{bmatrix};$$

$$\lambda_{11} = +\lambda_1^2 + \lambda_2^2 - \lambda_3^2 + \lambda_4^2,$$

$$\lambda_{12} = -2(\lambda_3\lambda_4 + \lambda_1\lambda_2),$$

$$\lambda_{13} = +2(\lambda_1\lambda_3 - \lambda_2\lambda_4),$$

$$\lambda_{21} = +2(\lambda_3\lambda_4 - \lambda_1\lambda_2),$$

$$\lambda_{22} = -\lambda_1^2 + \lambda_2^2 - \lambda_3^2 + \lambda_4^2,$$

$$\lambda_{23} = -2(\lambda_1\lambda_4 + \lambda_2\lambda_3),$$

$$\lambda_{31} = +2(\lambda_1\lambda_3 + \lambda_2\lambda_4),$$

$$\lambda_{32} = +2(\lambda_1\lambda_4 - \lambda_2\lambda_3),$$

$$\lambda_{33} = -\lambda_1^2 - \lambda_2^2 + \lambda_3^2 + \lambda_4^2.$$

Notations

a_0 the mean semi-major axis of the satellite's orbit

a, e, n the osculating elements of the satellite

e_0 the mean eccentricity of the satellite's orbit

f the osculating true anomaly

$\vec{f}'$ the true anomaly of the disturbing body

$g = g_0 + n_0 t$ the undisturbed mean anomaly of the satellite

g_0 satellite's mean anomaly at the epoch

$$h = \frac{an}{\sqrt{1 - e^2}}$$

$$h_0 = \frac{a_0 n_0}{\sqrt{1 - e_0^2}}$$

I_0 the mean value of the mutual inclination of two orbit planes

$-2K$ the periodic part in $\psi - \psi'$

$l = g_0 + n_0 t + n_0 \delta z$ the perturbed mean anomaly of the satellite

m' the mass of the disturbing body

$-2N$ the periodic part in $\psi + \psi'$

n_0 the mean anomalistic mean motion of the satellite (a_0 is defined as $n_0^{-2/3}$; the gravitational constant is put equal to 1)

$n_0 \delta z$ the perturbations in the satellite's mean anomaly

$-2n_0 \alpha t$ the secular part in $\psi + \psi'$

$+2n_0 \eta t$ the secular part in $\psi - \psi'$

$\mathbf{r}$ the position vector of the satellite, $r = |\mathbf{r}|$

$\mathbf{r}'$ the position vector of the disturbing body, $|\mathbf{r}'| = r' = \vec{r}$

$\vec{r}, \vec{f}$ the radius vector and the true anomaly depending upon l, where $\vec{r} \cos \vec{f} = a_0 (\cos E - e_0)$, $\vec{r} \sin \vec{f} = a_0 \sqrt{1 - e_0^2} \sin E$, and $E - e_0 \sin E = l$

$S = \cos (r, r')$

v the true orbital longitude of the satellite, reckoned from the departure point in the satellite's orbit plane

v' the true orbital longitude of the disturbing body, reckoned from the departure point in the body's orbit plane

γ the auxiliary mean anomaly; γ is replaced by l at the later stage of computation

Δ the distance between the satellite and the disturbing body

$\lambda_1, \lambda_2, \lambda_3, \lambda_4$ the parameters defining the periodic perturbations of the orbit plane, where $\lambda_1 = \sin 1/2 \cos N$, $\lambda_2 = \sin 1/2 \sin N$, $\lambda_3 = \cos 1/2 \sin K$, and $\lambda_4 = \cos 1/2 \cos K$

ν the perturbations in the radius vector r, where $r = (1+\nu)\vec{r}$

$\pi_0 + n_0 yt$ the mean orbital longitude of the pericenter of the satellite

$\pi_0' + n_0 y' t$ the mean orbital longitude of the pericenter of the disturbing body

ρ, ϕ the radius vector and the true anomaly depending upon the auxiliary mean anomaly γ, where $\rho \cos \phi = a_0 (\cos \epsilon - e_0)$, $\rho \sin \phi = a_0 \sqrt{1 - e_0^2} \sin \epsilon$, and $\epsilon - e_0 \sin \epsilon = \gamma$

$\vec{\rho}, \vec{\phi}$ the radius vector and the true anomaly depending upon g, where $\vec{\rho} \cos \vec{\phi} = a_0 (\cos \vec{\epsilon} - e_0)$, $\vec{\rho} \sin \vec{\phi} = a_0 \sqrt{1 - e_0^2} \sin \vec{\epsilon}$, and $\vec{\epsilon} - e_0 \sin \vec{\epsilon} = g$

σ' the true orbital longitude of the node of the disturbing body's orbit plane; the fixed ecliptic and equinox serve as a reference

χ the true orbital longitude of the osculating pericenter of the satellite

ψ the true orbital longitude of the common node, as reckoned from the departure point in the orbit plane of the satellite

ψ' the true orbital longitude of the common node, as reckoned from the departure point in the orbit plane of the disturbing body

ψ_0, ψ_0' the constant parts in ψ and ψ'

Ω the disturbing function

$\frac{\partial \Omega}{\partial r}$ the radial component of the disturbing force

$\frac{\partial \Omega}{\partial Z}$ the component of the disturbing force normal to the orbit plane

COMPARISON OF RESULTS

Comparison of the results from the method of iteration and from Hansen is shown in Tables 1, 2 and 3 which follow.

Table 1

Comparison of $n_0 \delta z$ from the Method of Iteration and from Hansen.

sin (ig, i′ g′,	jω,	j′ ω′)	Method of Iteration (MI)	Hansen Method (H)	Difference H - MI
1, -2,	2,	-2	1.2408	1.2408	0.0000
2, -2,	2,	-2	0.5958	0.5958	0.0000
-1, 0,	0,	0	0.1814	0.1826	0.0012
1, -3,	2,	-2	0.0549	0.0550	0.0001
2, -3,	2,	-2	0.0431	0.0431	0.0000
1, -1,	1,	-1	-0.0337	-0.0337	0.0000
1, -1,	0,	0	0.0309	0.0310	0.0001
1, 0,	2,	0	-0.0234	-0.0236	0.0002
0, 2,	0,	2	-0.0025	-0.0225	0.0000
-1, -1,	0,	0	0.0205	0.0204	-0.0001
3, -2,	2,	-2	0.0167	0.0167	0.0000
0, -2,	2,	-2	-0.0115	-0.0116	0.0001
3, -4,	4,	-4	0.0099	0.0099	0.0000
2, -4,	4,	-4	0.0083	0.0083	0.0000
1, -1,	2,	-2	-0.0079	-0.0077	0.0002
2, -1,	2,	-2	-0.0064	-0.0064	0.0000
1, 0,	1,	-1	0.0057	0.0049	-0.0008
0, -1,	1,	-1	0.0016	0.0032	0.0016
-1, 2,	0,	2	0.0047	0.0031	-0.0016
4, -4,	4,	-4	0.0030	0.0030	0.0000
2, -4,	4,	-4	0.0021	0.0021	0.0000
0, -2,	0,	0	0.0019	0.0020	0.0001
1, -4,	2,	-2	0.0020	0.0019	-0.0001
3, -3,	2,	-2	0.0014	0.0014	0.0000
1, 2,	0,	2	-0.0013	-0.0013	0.0000
2, 0,	0,	0	-0.0013	-0.0012	0.0001
3, -5,	4,	-4	-0.0011	-0.0011	0.0000
0, -1,	2,	-2	-0.0009	-0.0010	-0.0001
0, 3,	0,	2	-0.0009	-0.0010	-0.0001
2, -3,	3,	-3	-0.0009	-0.0009	0.0000
2, -5,	4,	-4	0.0007	0.0007	0.0000
1, 0,	2,	-2	-0.0006	-0.0007	-0.0001
0, -3,	2,	-2	-0.0007	-0.0006	0.0001
1, -2,	0,	0	0.0005	0.0006	0.0001
4, -2,	2,	-2	0.0006	0.0006	0.0000

Table 2

Comparison of ν Series from the Method of Iteration and from Hansen.

cos (ig, i′ g′, jω, j′ ω′)	Method of Iteration (MI)	Hansen Method (H)	Difference H - MI
0, 0, 0, 0	-0.006446	-0.006479	-0.000033
1, -2, 2, -2	-0.010028	-0.010041	-0.000013
2, -2, 2, -2	-0.007373	-0.007331	0.000042
2, -3, 2, -2	-0.000519	-0.000517	0.000002
1, 0, 0, 0,	0.000451	0.000453	0.000002
1, -3, 2, -2	-0.000427	-0.000429	-0.000002
2, -2, 2, -2	-0.000337	-0.000334	0.000003
0, -2, 2, -2	-0.000246	-0.000250	-0.000004
1, -1, 0, 0	-0.000245	-0.000246	-0.000001
1, 0, 2, 0	0.000204	0.000205	0.000001
1, 1, 0, 0	0.000189	0.000187	-0.000002
0, -1, 0, 0	0.000120	0.000120	0.000000
3, -4, 4, -4	-0.000094	-0.000087	0.000007
2, -1, 2, -2	0.000078	0.000078	0.000000
1, -1, 2, -2	0.000069	0.000068	-0.000001
2, -4, 4, -4	-0.000057	-0.000056	-0.000001
2, -0, 0, 0	0.000029	0.000031	0.000002
0, 2, 0, 2	0.000029	0.000029	0.000000
4, -4, 4, -4	-0.000018	-0.000028	-0.000010
3, -3, 2, -2	-0.000026	-0.000026	0.000000
2, -4, 2, -2	-0.000025	-0.000025	0.000000
-1, 2, 0, 2	0.000020	0.000022	0.000002
4, -2, 2, -2	-0.000017	-0.000017	0.000000
1, -4, 2, -2	-0.000015	-0.000015	0.000000
2, 0, 2, 0	-0.000014	-0.000014	0.000000
1, 2, 0, 2	0.000012	0.000013	0.000001
0, -3, 2, -2	-0.000012	-0.000012	0.000000
3, -5, 4, -4	-0.000011	-0.000010	0.000001
1, 0, 2, -2	0.000005	0.000006	0.000001
-2, -1, 0, 0	0.000005	0.000006	0.000001

Table 3

Comparison of the Constants $n_0 y$, $n_0 \alpha$, and $n_0 \eta$ from the Method of Iteration and from Hansen.

	Method of Iteration (MI)	Hansen Method (H)	Difference H - MI
$n_0 y$	0°.11158 deg/day	0°.11157 deg/day	-0°.00001 deg/day
$n_0 \alpha$	0.05287	0.05288	0.00001
$n_0 \eta$	0.00001	0.00001	0.00000

APPLICATION TO LUNAR SATELLITE

This program was used to calculate the perturbations of an artificial lunar satellite. The numerical values of the inputs, the outputs representing $n_0 \delta z$, (Table 4) ν (Table 5) and the lambda parameters (Tables 6, 7, 8, 9), and the values of $n_0 y$, $n_0 \alpha$, and $n_0 \eta$ follow.

Inputs

$n = 3.6782734$ radians

$I = 0.13962634$ radians

$e = 0.20000000$

$n' = 0.22997151$

$e' = 0.0549$

$\frac{m' a^2}{a'^3} = 0.00386159$

$\frac{m' a^3}{a'^4} = 0.00013972$

$\frac{m' a^4}{a'^5} = 0.00000506$

Values of Constants

$n_0 y = 1.0266$ degrees/day

$n_0 \alpha = 0.6460$ degrees/day

$n_0 \eta = 0.0030$ degrees/day

Table 4

Numerical Values of the Outputs Representing $n_0 \delta z$.

sin (ig + i′ g′ + jω + j′ ω′)				Degrees
0,	1,	0,	0	-0.70
0,	2,	3,	-3	-0.22
0,	1,	-1,	1	0.12
0,	2,	-2,	2	0.11
0,	2,	0,	2	-0.06
0,	1,	1,	1	-0.02
0,	2,	0,	0	0.02
1,	-2,	2,	-2	3.42
1,	-3,	2,	-2	0.50
1,	0,	1,	-1	0.42
1,	-1,	1,	-1	-0.40
1,	0,	-1,	1	0.34
1,	0,	2,	0	-0.24
1,	-1,	0,	0	0.22
1,	1,	0,	0	-0.16
1,	-1,	2,	-2	-0.13
1,	-2,	1,	-3	0.07
1,	-2,	3,	-3	-0.07
1,	0,	1,	1	0.06
1,	-4,	2,	-2	0.06
1,	-2,	3,	-1	0.05
1,	-3,	3,	-3	-0.05
1,	2,	-2,	2	0.03
1,	-2,	1,	-1	0.02
1,	-2,	0,	-2	-0.02
1,	-4,	3,	-3	0.01

sin (ig + i′ g′ + jω + j′ ω′)				Degrees
2,	-2,	2,	-2	0.51
2,	-3,	2,	-2	0.11
2,	-4,	4,	-4	0.06
2,	-3,	3,	-3	-0.03
2,	-1,	2,	-2	-0.03
2,	-2,	1,	-3	0.02
2,	0,	1,	-1	0.02
2,	-5,	4,	-4	0.02
2,	0,	-1,	1	0.02
2,	-4,	2,	-2	0.02
2,	-1,	1,	-1	-0.02
2,	-2,	3,	-1	-0.02
2,	-2,	3,	-3	0.01
2,	-1,	0,	0	0.01
2,	0,	2,	0	-0.01
2,	0,	0,	0	-0.01
2,	-2,	4,	-2	-0.01
2,	1,	0,	0	-0.01
2,	-4,	3,	-3	-0.01
3,	-2,	2,	-2	0.05
3,	-4,	4,	-4	0.03
3,	-3,	2,	-2	0.01
3,	-5,	4,	-4	0.01
4,	-2,	2,	-2	0.01
4,	-4,	4,	-4	0.01

Table 5

Numerical Values of the Outputs Representing the ν Series.

cos (ig + i′ g′ + jω + j′ ω′)				
0,	0,	0,	0	-0.0036
0,	2,	-2,	2	-0.0026
0,	1,	-1,	1	0.0004
0,	1,	0,	0	0.0004
0,	3,	-2,	2	-0.0003
0,	2,	-3,	3	0.0003
0,	1,	-2,	2	-0.0003
0,	0,	1,	1	0.0002
0,	2,	0,	2	0.0001
1,	-2,	2,	-2	-0.0281
1,	-3,	2,	-2	-0.0039
1,	0,	1,	-1	-0.0037
1,	-1,	1,	-1	0.0035
1,	0,	-1,	+1	-0.0029
1,	0,	2,	0	0.0021
1,	-1,	0,	0	-0.0017
1,	1,	0,	0	0.0015
1,	0,	0,	0	-0.0010
1,	-1,	2,	-2	0.0009
1,	0,	1,	1	-0.0005
1,	-2,	3,	-3	0.0005
1,	-4,	2,	-2	-0.0004
1,	-2,	1,	-3	-0.0004
1,	-2,	3,	-1	0.0004
1,	-3,	3,	-3	0.0004

cos (ig + i′ g′ + jω + j′ ω′)				
1,	2,	-2,	2	-0.0003
1,	-2,	1,	-1	-0.0002
1,	0,	-1,	-1	-0.0002
1,	2,	0,	2	0.0001
1,	-2,	0,	-2	0.0001
2,	-2,	2,	-2	-0.0071
2,	-3,	2,	-2	-0.0013
2,	-4,	4,	-4	-0.0004
2,	0,	-1,	1	-0.0003
2,	0,	1,	-1	-0.0003
2,	-1,	1,	-1	0.0003
2,	-4,	2,	-2	-0.0003
2,	-2,	1,	-3	-0.0003
2,	0,	2,	0	0.0002
2,	-1,	0,	0	-0.0002
2,	1,	0,	0	0.0002
2,	0,	0,	0	0.0002
2,	-2,	3,	-1	0.0001
2,	-4,	4,	-4	-0.0001
3,	-2,	2,	-2	-0.0011
3,	-4,	4,	-4	-0.0004
3,	-3,	2,	-2	-0.0003
3,	-3,	3,	-3	-0.0002
4,	-2,	2,	-2	-0.0002

Table 6

Numerical Values of the Outputs Representing the Lambda 1 Series.

$\cos(ig + i'g' + j\omega + j'\omega')$				
0,	0,	0,	0	0.0698
0,	2,	0,	2	0.0017
0,	0,	2,	0	0.0015
0,	3,	0,	2	0.0002
0,	2,	-2,	2	0.0002
0,	1,	0,	2	-0.0001
1,	-2,	2,	-2	0.0001
1,	0,	2,	0	-0.0001

Table 7

Numerical Values of the Outputs Representing the Lambda 2 Series.

$\sin(ig + i'g' + j\omega + j'\omega')$				
0,	2,	0,	2	-0.0017
0,	0,	2,	0	-0.0015
0,	1,	0,	0	0.0006
0,	3,	0,	2	-0.0002
0,	1,	-1,	0	-0.0002
0,	2,	-2,	2	0.0002
0,	1,	0,	2	0.0001
0,	0,	1,	-1	-0.0001
0,	1,	1,	1	0.0001
1,	-2,	2,	-2	-0.0001
1,	0,	2,	0	0.0001
1,	0,	0,	0	-0.0001
2,	-2,	2,	-2	0.0001
2,	0,	2,	0	-0.0001

Table 8

Numerical Values of the Outputs Representing the Lambda 3 Series.

$\sin(ig + i'g' + j\omega + j'\omega')$				
0,	2,	0,	2	0.0001
0,	0,	2,	0	0.0001

Table 9

Numerical Values of the Outputs Representing the Lambda 4 Series.

$\cos(ig + i'g' + j\omega + j'\omega')$				
0,	0,	0,	0	0.9976
0,	2,	0,	2	-0.0001
0,	0,	0,	2	-0.0001

CONCLUSION

A comparison of the results, which indicates the accuracy required for the production of general theories, and ephemerides of satellites of the outer planets have been achieved. Lunar theory has been employed solely for verification. Future plans include the application of this program to the orbits of both natural and lunar satellites.

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Appendix A

Program

```
     HANSEN LUNAR THECRY AS MODIFIED BY DR MUSEN
  O 50176
  K COCCO
  K 00050
• B 00001                                SQUIRE RCOT FUNCTION        B C0001
  V 00005 +000CC000+00
  V 00007  10CCCC00 01
  V 00010  20CC0000-07
  G 00003 CC001 00003
  C 0C0C3 00005 00006
  H 00001 00004 CC005
  E 00002
• B 00006                                                            B C0006
  A 00008 C0007 C0007
  R 00009 C0007
  S 00011 0C0C7 00010
  C 00007 C0003 00012
  R 00009 00003
• B 00012                                                            B 00012
  D 00013 00003 CC009
  A C0014 0C009 0C013
  D 00015 00014 0C008
  D 00016 00015 00C09
  R C0009 CC015
  C 00011 C0016 00012
  H 00001 C0004 00C09
  E 00002
  K 00020
• B 0COC1                                SIN COSINE FUNCTION         B 00001
  V 00009  17CC0000-04
  V C0010  10CCCC00 01
  V 00011  67108864 08
  V C0012  15707963 01
  V 00013 -64596371 CC
  V 00014  79689679-01
  V 00015 -46737660-02
  V 00016  15148400-03
  V 00018 +COCOCCCO+0C
  V 00019 +62831853+01
  G 00003 CC001 00C03
```

```
  R 00020 00010                                                    00041
  C 00003 00018 00021                                              00042
  S 00020 00018 00020                                              00043
  S 00003 00018 00003                                              00044
• B 00021                                                  B 00021 00045
  D 00022 00003 00019                                              00046
  A 00022 00022 00011                                              00047
  S 00022 00022 00011                                              00048
  M 00022 00022 00019                                              00049
  S 00003 00003 00022                                              00050
  M 00003 00003 00020                                              00051
  S 00020 00018 00012                                              00052
  R 00023 00010                                                    00053
• B 00024                                                  B 00024 00054
  I 00025 +31415926+01                                             00055
  C 00003 00012 00026                                              00056
  S 00025 00018 00025                                              00057
  C 00020 00003 00026                                              00058
  D 00003 00003 00012                                              00059
  M 00027 00003 00003                                              00060
  M 00028 00016 00027                                              00061
  A 00028 00028 00015                                              00062
  M 00028 00028 00027                                              00063
  A 00028 00028 00014                                              00064
  M 00028 00028 00027                                              00065
  A 00028 00028 00013                                              00066
  M 00028 00028 00027                                              00067
  A 00028 00028 00012                                              00068
  M 00028 00028 00023                                              00069
  M 00003 00028 00003                                              00070
  H 00001 00004 00003                                              00071
  E 00002                                                          00072
* B 00026                                                  B 00026 00073
  S 00003 00003 00025                                              00074
  S 00023 00018 00023                                              00075
  E 00024                                                          00076
• B 00005                                                  B 00005 00077
  G 00003 00005 00007                                              00078
  S 00017 00012 00003                                              00079
  F 00017 00001 00017                                              00080
```

```
  H 00005 00008 00017                                                    00081
  E 00006                                                                00082
  K 00000                                                                00083
  K 00100                                                                00084
* B 00001                          FOURIER SERIES MOVE          B 00001  00085
  G 00005 00001 00003                                                    00086
  H 00001 00004 00005                                                    00087
  A 00006 00005 00005                                                    00088
  A 00006 00006 00005                                                    00089
  R 00005 00006                                                          00090
  A 00006 00006 00003                                                    00091
  C 00130 00005 00512                                                    00092
  D 00005 00130 00009                                                    00093
  U 00005 00005                                                          00094
  S 00005 00005 00008                                                    00095
  H 00001 00003 00005                                                    00096
  E 00001                                                                00097
* B 00512                                                   B 00512     00098
  A 00005 00596 00003                                                    00099
  C 00597 00005 00513              FROM CORE OR DRUM                     00100
  A 00005 00596 00004                                                    00101
  C 00597 00005 00514              TO CORE OR DRUM                       00102
* B 00007                                                   B 00007     00103
  A 00003 00003 00008                                                    00104
  A 00004 00004 00008                                                    00105
  G 00005 00001 00003                                                    00106
  H 00001 00004 00005                                                    00107
  C 00006 00003 00007                                                    00108
  E 00002                                                                00109
* B 00520                                                   B 00520     00110
  H 00001 00004 00091                                                    00111
  H 00002 00004 00092                                                    00112
  H 00003 00004 00094                                                    00113
  H 00004 00004 00095                                                    00114
  E 00002                                                                00115
* B 00513                                                   B 00513     00116
  A 00594 00004 00596              ABSOLUTE SERIES DESTINATION           00117
  Y 00002 00005 00594 00520        READ SERIES FROM DRUM                 00118
  E 00002                                                                00119
* B 00514                                                   B 00514     00120
```

```
   A 00594 00003 00596              ABSOLUTE SERIES LOCATION                          00121
   G 00593 00001 00003              NUMBER                                            00122
   A 00592 00593 00593                OF TERMS                                        00123
   A 00592 00592 00593                  TIMES 3 + 1 =                                 00124
   A 00592 00006 00592                    NUMBER OF CELLS                             00125
   Y 00003 00005 00592 00594        WRITE SERIES ON DRUM                              00126
   E 00002                                                                            00127
   V 00598 +10000000+05             NUMBER OF CELLS / DRUM SLOT                       00128
   V 00597 +50000000+02             NUMBER + 1 OF DRUM SLOTS                          00129
   V 00596 +10000000+03             VALUE OF THIS K                                   00130
   V 00008 +10000000+01                                                               00131
   V 00009 +30000000+01                                                               00132
   K 00010                                                                            00133
 • B 00001                          FOURIER ADDITION (11)                 B 00001     00134
   R 00080 00299                                                                      00135
   R 00072 00002                                                                      00136
   S 00073 00003 00005                                                                00137
   S 00074 00004 00005                                                                00138
   E 00071                                                                            00139
   V 00005 +70000000+02                                                               00140
   K 00005                                                                            00141
 • B 00001                          FOURIER SUBTRACTION (16)              B 00001     00142
   R 00075 00293                                                                      00143
   R 00067 00002                                                                      00144
   S 00068 00003 00005                                                                00145
   S 00069 00004 00005                                                                00146
   E 00066                                                                            00147
   V 00005 +65000000+02                                                               00148
   K 00005                                                                            00149
 • B 00001                          FOURIER MULTIPLICATION (21)           B 00001     00150
   R 00070 00111                                                                      00151
   R 00062 00002                                                                      00152
   S 00063 00003 00005                                                                00153
   S 00064 00004 00005                                                                00154
   E 00061                                                                            00155
   V 00005 +60000000+02                                                               00156
   K 00005                                                                            00157
 * B 00001                          FOURIER K-MULTIPLICATION (26)         B 00001     00158
   R 00057 00002                                                                      00159
   G 00414 00001 00003                                                                00160
```

```
  S 00059 CC0C4 C0C05                                                    00161
  E 00405                                                                00162
  V C0005 +55C0CCC0+02                                                   00163
  K C0005                                                                00164
• B C0001                    FOURIER TERM EXTRACTION (31)        B 00001 00165
  R 00052 0CCC2                                                          00166
  G C0418 0C001 C0C03                                                    00167
  G C0419 CC0C2 CCC03                                                    00168
  S 00054 C0004 CC005                                                    00169
  E C0415                                                                00170
  V 0C005 +5C0CCCC0+02                                                   00171
  K C0005                                                                00172
• B C0001                    FOURIER DIFFERENTIATION (36)        B 00001 00173
  R C0055 00305                                                          00174
  R C0047 00002                                                          00175
  S 00048 00003 C0005                                                    00176
  S 00049 C0004 C0005                                                    00177
  E C0046                                                                00178
  V 00005 +45CC0CC0+02                                                   00179
  K CC005                                                                00180
* B 00001                     FOURIER INTEGRATION (41)            B 00001 00181
  R 00042 CC002                                                          00182
  R 00050 00321                                                          00183
  S 00043 0C003 C0005                                                    00184
  S 00044 C0004 C0005                                                    00185
  E C0041                                                                00186
  V C0005 +40C0CCC0+02                                                   00187
  K C0005                                                                00188
• B 00001                    FOURIER ARGUMENT REPLACEMENT (46)   B 00001 00189
  R C0037 CC002                                                          00190
  S C0038 CC003 CCC05                                                    00191
  S 00039 CC004 CC005                                                    00192
  R 00045 00315                                                          00193
  E 00036                                                                00194
  V C0005 +35CC0CC0+02                                                   00195
  K 00005                                                                00196
• B 00001                       (51) FOURIER MTH ARGUMENT DIFFERENTIATE  B 00001 00197
  R C0032 CC002                                                          00198
  R 00040 00415                                                          00199
  S 00033 CC0C3 C0005                                                    00200
```

```
   S 00034 00004 00005                                                                00201
   E 00031                                                                            00202
   V 00005 +30000000+02                                                               00203
   K 00005                                                                            00204
•  B 00001                          (56)   FOURIER M-TH ARGUMENT INTEGRATE     B 00001 00205
   R 00027 00002                                                                      00206
   R 00035 00420                                                                      00207
   S 00028 00003 00005                                                                00208
   S 00029 00004 00005                                                                00209
   E 00026                                                                            00210
   V 00005 +25000000+02                                                               00211
   K 00025                                                                            00212
•  B 00001                          FOURIER PKG ADAPTER                       B 00001 00213
   A 00013 00050 00050                                                                00214
   G 00005 00001 00003                                                                00215
   H 00520 00050 00005                                                                00216
   A 00006 00005 00005                                                                00217
   A 00005 00006 00005                                                                00218
   R 00008 00005                                                                      00219
   A 00005 00005 00003                                                                00220
   R 00006 00012                                                                      00221
   C 00050 00008 00435                                                                00222
   S 00005 00050 00019                                                                00223
   D 00005 00005 00019                                                                00224
   U 00005 00005                                                                      00225
   H 00001 00003 00005                                                                00226
   E 00001                                                                            00227
•  B 00435                                                              B 00435 00228
   A 00510 00003 00511                                                                00229
   C 00517 00510 00436                                                                00230
•  B 00007                                                              B 00007 00231
   A 00006 00006 00011                                                                00232
   C 00006 00013 00016                                                                00233
   A 00003 00003 00011                                                                00234
   G 00008 00001 00003                                                                00235
   A 00006 00006 00050                                                                00236
   H 00520 00006 00008                                                                00237
   S 00006 00006 00050                                                                00238
   C 00005 00003 00007                                                                00239
•  B 00437                                                              B 00437 00240
```

```
  A C0008 C0050 C0050                                                    00241
  H 00520 CC008 C0012                                                    00242
  H 00521 C0008 C0012                                                    00243
  H 00522 CC008 CC012                                                    00244
  H 00523 0C0C8 CC012                                                    00245
  E 00010                                                                00246
• B 00436                                                    B C0436    00247
  I 00514 +70C0C0C0+03                                                   00248
  A 00514 00514 00050                                                    00249
  Y 00002 0051C 00514 00438                                              00250
  E 00437                                                                00251
• B 00438                                                    B C0438    00252
  H 00520 00050 C0011                                                    00253
  H 00521 0005C 00012                                                    00254
  H 00522 C0050 C0014                                                    00255
  H C0523 00050 00015                                                    00256
  E 00437                                                                00257
• B 00519                                                    B 00519    00258
  A 00008 00050 00050                                                    00259
  G 00018 00520 CC008                                                    00260
  A 00005 0C004 00018                                                    00261
  A 00005 0C005 00018                                                    00262
  A 00005 00005 00018                                                    00263
  H 00001 00004 C0018                                                    00264
  R 00006 C0012                                                          00265
  A 00510 0C004 00511                                                    00266
  C 00517 00510 00439                                                    00267
  C 00018 00012 00009 C0009                                              00268
  H 00001 00004 C0C11                                                    00269
  H C0002 0C004 C0012                                                    00270
  H 00003 00004 00014                                                    00271
  H 00004 00004 00015                                                    00272
  E 00002                                                                00273
* B 00009                                                    B 00009    00274
  A 00004 C0004 C0011                                                    00275
  A 00006 00006 C0011                                                    00276
  A 00018 CC006 CC008                                                    00277
  G 00018 00520 C0018                                                    00278
  H C0001 C0004 CC018                                                    00279
  C C0005 00004 C0C09                                                    00280
```

```
  E 00002                                                                  00281
• B 00439                                                        B 00439   00282
  I 00514 +700C0000+03                                                    00283
  A 00514 00514 00008                                                     00284
  R 00512 00012                                                           00285
  C 00011 00018 00509                                                     00286
  A 00512 00018 00018                                                     00287
  A 00512 00512 00018                                                     00288
  A 00512 00512 00011          NUMBER OF CELLS                            00289
• B 00509                                                        B 00509   00290
  Y 00003 00510 00512 00514    WRITE SERIES ON DRUM                       00291
  E 00002                                                                 00292
  V 00422 +42300000+03                                                    00293
  V 00423 +10000000+01                                                    00294
  V 00424 +00000000+00                                                    00295
  V 00425 +00505050+08                                                    00296
  V 00426 +50505050+08                                                    00297
  V 00511 +18000000+03         VALUE OF THIS K                            00298
  V 00011 +10000000+01                                                    00299
  V 00012 +00000000+00                                                    00300
  V 00014 +00505050+08                                                    00301
  V 00015 +50505050+08                                                    00302
  V 00019 +30000000+01                                                    00303
• B 00016                                                        B 00016   00304
  H 00520 00013 00050                                                     00305
  E 00010                                                                 00306
  K 00020                                                                 00307
  V 00003 -49000000+02                                                    00308
  V 00004 -30000000+01                                                    00309
  V 00005 +30000000+01                                                    00310
  V 00006 +00000000+00         (6)=0                                      00311
  V 00007 +10000000+01         (7)=1                                      00312
  V 00008 -10000000+01         (8)=-1                                     00313
  V 00009 +20000000+01         (9)=2                                      00314
  V 00010 -20000000+01         (10)=-2                                    00315
  V 00011 +50000000+00         (11)=1/2                                   00316
  V 00012 +67108864+08         (12)=TWO TO THE 26TH                       00317
  V 00013 +10000000+07         (13)=1,000,000                             00318
  V 00014 +10000000+05         (14)=10,000                                00319
  V 00015 +10000000+03         15=100                                     00320
```

```
  V 00016 +10CCCCCC-07            CRITERION                                    00321
  V 00017 +50CC000C+02                                                         00322
  V 00018 +49CCCCCC+02            (18)=49                                      00323
  V 00030 +9CCCCCC0+01                                                         00324
  V 00030 +1CCCC000+03                                                         00325
  V 00030 +200CCC00+03                                                         00326
  V 00030 +40CCCCC0+03                                                         00327
  V 00030 +80CCC000+03                                                         00328
  V 00030 +20CCCCC0+04                                                         00329
  V 00460 +00505050+08                                                         00330
  V 00461 +50505050+08                                                         00331
  V 00495 +99CCCC00+02                                                         00332
* B 00031                                                    B 00031          00333
  R 00204 00006                     REPLACE SERIES COUNTER BY ZERO INITIALLY   00334
  R 00177 00008                   INITIALIZE FLIP FLOP                        00335
  M 00033 00030 00009                                                          00336
  R 00422 00007                   (422)= MARKER                                00337
  R 00424 00006                                                                00338
  H 00500 00033 00006               GENERATED SERIES COUNTER IS ZERO INITIALY  00339
  G 00049 00500 00006             N1=NO OF TERMS IN A SERIES                   00340
  G 00050 00500 00030             N2=NO OF TERMS IN B SERIES                   00341
  M 00047 00049 00005             (47)= 3N SUB 1                               00342
  A 00032 00030 00005                                                          00343
  S 00360 00033 00009                                                          00344
  D 00360 00360 00005                                                          00345
  S 00360 00360 00005                                                          00346
  S 00360 00360 00005                                                          00347
  I 00056 +00000000+00            (56)= A SERIES COUNTER                      00348
* B 00034                                                    B 00034          00349
  A 00056 00056 00005             (56)+ 3                                      00350
  R 00057 00030                   (57)= B SERIES COUNTER                       00351
* B 00035                                                    B 00035          00352
  A 00057 00057 00005             (57)+ 3                                      00353
  G 00058 00498 00056             A SUB X                                      00354
  G 00059 00498 00057             B SUB Y                                      00355
  M 00060 00058 00059                                                          00356
  C 00006 00060 00036 00037                                                    00357
  R 00422 00008                                                                00358
  E 00198                                                                      00359
* B 00036                                                    B 00036          00360
```

```
  S 00061 00006 00060
  F 00038
* B 00037                                                        B 00037
  R 00061 00060            ABS. VAL AB
• B 00038                                                        B 00038
  C 00016 00061 00029 00039
• B 00029                                                        B 00029
  C 00057 00032 00040          1ST TERM OF B SERIES END MULTIPLICATI
  R 00422 00008            (422)= -1 MARKER
  E 00198
• B 00040                                                        B 00040
  C 00047 00056 00034
  R 00422 00008
  F 00198
• B 00039                                                        B 00039
  G 00062 00499 00056      A*
  C 00062 00006 00041 00042
• B 00041                                                        B 00041
  R 00063 00007
  R 00064 00062
  F 00043
• B 00042                                                        B 00042
  R 00063 00008
  S 00064 00006 00062      (64)=ABS. VAL. A**
* B 00043                                                        B 00043
  R 00160 00007
  R 00116 00007
  R 00200 00007
  R 00372 00007
  R 00065 00064
  G 00064 00500 00056      A* CONTINUED
  G 00082 00499 00057          B*
  C 00082 00006 00044 00045
• B 00044                                                        B 00044
  R 00083 00007            COS. OR SIN IND.
  R 00084 00082
  E 00046
* B 00045                                                        B 00045
  R 00083 00008            COS OR SIN IND.
  S 00084 00006 00082
```

```
* B 00046                                                                B 00046   00401
  R 00085 00084                                                                    00402
  G 00084 00500 00057          B* CONTINUED                                        00403
  A 00128 00065 00085                                                              00404
  S 00128 00128 00460          A* +B*                                              00405
  A 00094 00064 00084                                                              00406
  S 00094 00094 00461          A**+B**                                             00407
  C 00065 00085 00463 00468                                                        00408
  C 00064 00084 00463                                                              00409
* B 00468                                                                B 00468   00410
  A 00134 00085 00460                                                              00411
  S 00134 00134 00065          (139)= 1A*-B*1                                      00412
  A 00097 00084 00461                                                              00413
  S 00097 00097 00064          (96)= 1A*A*-B**1                                    00414
  R 00116 00008                                                                    00415
  E 00464                                                                          00416
* B 00463                                                                B 00463   00417
  A 00134 00065 00460                                                              00418
  S 00134 00134 00085                                                              00419
  A 00097 00064 00461                                                              00420
  S 00097 00097 00084                                                              00421
* B 00464                                                                B 00464   00422
  C 00128 00460 00465 00465    A* +B*1=0                                           00423
  C 00094 00461 00465 00465    1A** +B**1=0                                        00424
  R 00200 00006                                                                    00425
* B 00465                                                                B 00465   00426
  C 00134 00460 00466 00466    1A*-B*1=0                                           00427
  C 00097 00461 00466 00466    1A**-B**1=0                                         00428
  R 00372 00006                                                                    00429
* B 00466                                                                B 00466   00430
  C 00063 00006 00022 00023                                                        00431
  R 00422 00008                                                                    00432
  E 00198                                                                          00433
* B 00023                                                                B 00023   00434
  C 00083 00006 00024 00025                                                        00435
  E 00198                                                                          00436
* B 00025                     SIN SIN                                    B 00025   00437
  R 00135 00060                                                                    00438
  M 00136 00135 00011                                                              00439
  R 00137 00128                                                                    00440
```

```
  R 00138 CC136                                                          00441
  R 00139 CC134                                                          00442
  S 00136 CC006 C0136                                                    00443
  E C0028                                                                00444
• B C0024                          SIN COS                  B 00024    00445
  R 00135 C0060                                                          00446
  M 00136 00135 C0011                                                    00447
  S 00137 CC006 C0128                                                    00448
  R 00138 CC136                                                          00449
  S 00139 CC006 C0134                                                    00450
  M 00138 00138 00116                                                    00451
  M 00136 00136 CC160                                                    00452
  M 00136 00136 00200                                                    00453
  M 00138 C0138 CC372                                                    00454
  E 00028                                                                00455
• B 00022                                                  B 00022    00456
  C 00083 CCC06 00026 00027                                              00457
  E 00198                                                                00458
* B 00026                          COS COS                  B 00026    00459
  R 00135 CC060                                                          00460
  M 00136 00135 C0011                                                    00461
  R 00137 00128                                                          00462
  R 00138 C0136                                                          00463
  R C0139 CC134                                                          00464
  E 00028                                                                00465
• B 00027                                                  B 00027    00466
  R 00135 CC060                                                          00467
  M 00136 00135 CCC11                                                    00468
  S 00137 CCC06 00128                                                    00469
  S 00138 CCC06 00136                                                    00470
  S C0139 CC006 00134                                                    00471
  M 00138 CC138 C0116                                                    00472
  M C0136 C0136 00160                                                    00473
  M 00136 00136 C0200                                                    00474
  M C0138 CC138 CC372                                                    00475
• B C0028                                                  B 00028    00476
  R 00161 CC136                                                          00477
  R C0162 CC137                                                          00478
  R 00120 CC094                                                          00479
  E C0159                                                                00480
```

```
• B C0156                                                          B 00156   00481
  R 00161 0C138                                                              00482
  R 00162 00139                                                              00483
  R 00120 00097                                                              00484
* B 00159                                                          B 00159   00485
  R 00164 0C033                    164=2N                                    00486
  I 00407 +1CCCCCC00+01                                                      00487
  I 00165 +C0CC0C00+0C                                                       00488
  C 00161 00006 C0155 00155                                                  00489
  E 00158                                                                    00490
• B 00155                                                          B 00155   00491
  A 00164 00164 CC005              A COUNTER                                 00492
  G 00204 005C0 CC033                                                        00493
  C 00407 002C4 00411                                                        00494
  G 00166 00499 00164                STOREDA*                                00495
  G 00110 00500 00164                 STORED A* CONTINUED                    00496
  A 00165 00165 0C007                                                        00497
  C 00162 00166 00157 00157                                                  00498
  C 00120 00110 00157 C0157                                                  00499
  G 00167 00498 00164              STORED C                                  00500
  A 00168 00167 00161              C+A=NEW C                                 00501
• B 00201                                                          B 00201   00502
  H 00498 00164 00168              STORE SUM                                 00503
  E 00158                                                                    00504
* B 00411                                                          B 00411   00505
  H 00498 00164 00161                                                        00506
  H 00499 00164 00162              STORE C*                                  00507
  H 005C0 00164 00120              STORE C* CONT                             00508
  A 00164 00164 C0005                                                        00509
  H 00498 00164 00006                                                        00510
  H 00499 00164 00006                                                        00511
  H 005C0 00164 CC006                                                        00512
  R 00204 0CCC7                                                              00513
  H 005C0 00033 00204                                                        00514
  E 00158                                                                    00515
• B 00157                                                          B 00157   00516
  G 00204 005C0 C0033                                                        00517
  C 00204 00165 C0155                                                        00518
  A 00204 00204 CC007              (204)+1                                   00519
  H 005C0 00033 00204                                                        00520
```

```
  A 00164 00164 00005
  H 00498 00164 00161            STORE C
  H 00499 00164 00162            STORE C*
  H 00500 00164 00120            STORE C* CONT.
  A 00164 00164 00005
  H 00498 00164 00006
  H 00499 00164 00006
  H 00500 00164 00006
  C 00204 00360 00198 00158         END ARR IF NU OF TERMS LARGER THAN 2N-1
  E 00198
● B 00158                                                                      B 00158
  M 00177 00177 00008            177 -1 TO +1 AND BACK
  C 00177 00006 00156 00178
● B 00178                                                                      B 00178
  M 00151 00050 00005
  S 00122 00057 00030
  C 00151 00122 00035            LAST B TERM
  M 00152 00049 00005
  C 00152 00056 00034
  R 00422 00008                  LAST A TERM
● B 00198                                                                      B 00198
  C 00009 00204 00425
  M 00179 00204 00005            3 N SUB C
  I 00197 +00000000+00
  I 00205 +00000000+00
  S 00197 00179 00005
  R 00183 00033
  A 00019 00033 00030            2N+N
  S 00019 00019 00005
  S 00019 00019 00007
  A 00197 00197 00033            N SUB C-3
● B 00180                                                                      B 00180
  A 00205 00205 00007
  A 00183 00183 00005
  S 00184 00183 00005            OR ZER
  G 00185 00498 00183            C
  G 00186 00499 00183            C*
  G 00187 00500 00183            C**
● B 00181                                                                      B 00181
  A 00184 00184 00005
```

```
  G 002C0 005C1 C0184              C SUB X                                    00561
  G 002C3 00502 C0184                                                         00562
  G 002C2 005C3 C0184              C** SUB X                                  00563
  C C0006 C0185 0C193                                                         00564
  R 00191 00185                                                               00565
• B 00194                                                          B 00194    00566
  C 00006 0C2C0 00195                                                         00567
  R 00192 002C0                                                               00568
* B C0196                                                          B 00196    00569
  C 00191 00192 C0182 00190                                                   00570
  E C0182                                                                     00571
* B 00190                                                          B 00190    00572
  H 005C1 C0184 C0185                                                         00573
  H 005C2 00184 00186                                                         00574
  H 005C3 00184 C0187                                                         00575
  R C0185 C02C0                                                               00576
  R 00186 002C3                                                               00577
  R C0187 00202                                                               00578
• B C0182                                                          B 00182    00579
  C 00197 00184 00181                                                         00580
  H 00498 C0183 00185                                                         00581
  H 00499 00183 C0186                                                         00582
  H 00500 C0183 00187                                                         00583
  C 00183 C0019 00206                                                         00584
  C C0197 00183 C0180 C0425                                                   00585
  E 00425                                                                     00586
* B 00193                                                          B 00193    00587
  S 00191 C00C6 00185                                                         00588
  E C0194                                                                     00589
• B 00195                                                          B 00195    00590
  S 00192 0C0C6 00200                                                         00591
  E 00196                                                                     00592
• B 00206                                                          B 00206    00593
  H 005C0 C0033 00205                                                         00594
* B 00425                                                          B 00425    00595
  E 00499                                                                     00596
  C C00C6 00422 C0499                                                         00597
  A 00424 00424 0C007                                                         00598
  D 00204 0C030 C0005                                                         00599
  R 00164 0C033                                                               00600
```

```
  A 00164 00164 C0030              164= 2N +N                                    00601
  E 00158                                                                        00602
* B 00209                          B 209 = ADD                        B 00209    00603
  I 00207 +10C0CC00+01             (207)=ADD OR SUBTRACT IND.                    00604
  E 00210                                                                        00605
* B 00208                          B 208 = SUBTRACT                   B 00208    00606
  I 00207 -10CCCC0C+01                                                          00607
• B 00210                                                            B 00210    00608
  R 00204 0C006                                                                 00609
  R C0422 CCCC7                                                                 00610
  M C0033 CC030 CC009                                                           00611
  M 00218 005C0 00005              3N SUB 1                                     00612
  G 00219 00500 CC030                                                           00613
  M 00219 00219 CCC05              3N SUB 2                                     00614
  A C0219 00219 CCC30                                                           00615
  R 00223 CC030                    B STORAGE COUNTER                            00616
  R 00221 00033                    C STORAGE COUNTER                            00617
  I 00238 +C0CC0000+0C                                                          00618
* B 00211                                                            B 00211    00619
  A 00223 00223 CC005              B+3                                          00620
  G 00224 00498 00223              B                                            00621
  M C0224 00224 00207              + OR - B FOR ADD OR SUBTRACT                 00622
  H 00498 00223 00224              STORE + OR - B                               00623
  C 00219 0C223 00211                                                           00624
  I 00220 +00000000+0C             (220) = A COUNTER                            00625
• B 00212                                                            B 00212    00626
  A 00220 C0220 CC005              (220) +3                                     00627
  G 00225 00498 00220              A                                            00628
  G 00226 00499 00220              A*                                           00629
  G 00227 005C0 00220              A**                                          00630
  R 00222 CC030                                                                 00631
• B 00213                                                            B 00213    00632
  A 00222 00222 CC005              B COUNTER +3                                 00633
  G 00228 00498 00222              B                                            00634
  G 00229 00499 00222              B*                                           00635
  G 00230 005C0 C0222              B**                                          00636
  C 00226 00229 00214 C0214        A* NOT B* TO B214                            00637
  C 00227 00230 C0214 00214        A* NOT B** TO B214                           00638
  A 00225 00225 C0228              A+B                                          00639
  H 00498 00222 00006                                                           00640
```

```
  H 00499 00222 00006                                                    00641
  H 00500 00222 00006                                                    00642
  R 00471 00225                                                          00643
  C 00225 00006 00472                                                    00644
  S 00471 00006 00225                                                    00645
• B 00472                                                    B 00472    00646
  C 00471 00016 00239                                                    00647
  E 00215                                                                00648
• B 00214                                                    B 00214    00649
  C 00219 00222 00213                                                    00650
  C 00225 00006 00239 00239                                              00651
  E 00215                                                                00652
• B 00239                                                    B 00239    00653
  A 00221 00221 00005           C+3                                    00654
  A 00238 00238 00007                                                    00655
  H 00500 00033 00238                                                    00656
  R 00204 00238                                                          00657
  H 00498 00221 00225           STORE A                                  00658
  H 00499 00221 00226           STORE A*                                 00659
  H 00500 00221 00227           STORE A**                                00660
• B 00215                                                    B 00215    00661
  C 00218 00220 00212           LAST A TERM                              00662
* B 00216                                                    B 00216    00663
  R 00230 00030                                                          00664
• B 00217                                                    B 00217    00665
  A 00230 00230 00005                                                    00666
  G 00231 00498 00230           B                                        00667
  G 00232 00499 00230           B*                                       00668
  G 00233 00500 00230           B**                                      00669
  C 00231 00006 00235 00235     B=0                                      00670
  E 00236                                                                00671
• B 00235                                                    B 00235    00672
  A 00221 00221 00005                                                    00673
  A 00238 00238 00007                                                    00674
  H 00500 00033 00238                                                    00675
  R 00204 00238                                                          00676
  H 00498 00221 00231           STORE B                                  00677
  H 00499 00221 00232           STORE B*                                 00678
  H 00500 00221 00233           STORE B**                                00679
• B 00236                                                    B 00236    00680
```

```
  C 00219 00230 00217                                                    00681
  R 00422 00008                                                          00682
  E 00198                                                                00683
        FOURIER DIFFERENTIAL                                             00684
* B 00240                                                    B 00240     00685
  R 00204 00006                                                          00686
  R 00422 00007                                                          00687
  R 00247 00030                                                          00688
  M 00033 00030 00009                                                    00689
  R 00248 00033                                                          00690
  I 00238 +000000C0+00                                                   00691
  G 00255 00500 00030                                                    00692
  M 00255 00255 00005           3N                                       00693
  A 00255 00255 00030                                                    00694
* B 00241                                                    B 00241     00695
  A 00247 00247 00005                                                    00696
  R 00256 00007                                                          00697
  G 00249 00498 00247           A                                        00698
  G 00250 00499 00247           A*                                       00699
  G 00259 00500 00247           A* CONTINUED                             00700
  C 00250 00006 00246                                                    00701
  S 00250 00006 00250                                                    00702
  R 00256 00008                                                          00703
* B 00246                                                    B 00246     00704
  D 00251 00250 00013                                                    00705
  A 00251 00251 00012                                                    00706
  S 00251 00251 00012                                                    00707
  C 00251 00006 00257           COS TO 256, SIN TO 244                   00708
  E 00244                                                                00709
* B 00257                                                    B 00257     00710
  C 00256 00006 00242 00243           A IS + OR -                        00711
* B 00243                                                    B 00243     00712
  M 00252 00249 00251                                                    00713
  R 00253 00250                                                          00714
  E 00245                                                                00715
* B 00242                                                    B 00242     00716
  M 00252 00249 00251                                                    00717
  M 00252 00252 00008                                                    00718
  M 00253 00250 00008                                                    00719
* B 00245                                                    B 00245     00720
```

```
  A 00248 00248 CCC05                                                    00721
  A 00238 00238 CC007                                                    00722
  H 005C0 C0033 00238                                                    00723
  R 00204 CC238                    NUMBER OF TERMS TO ARRANGER           00724
  H 00498 00248 C0252                                                    00725
  H C0499 0C248 00253                                                    00726
  H 005C0 00248 00259               STORE A* CONTINUED                   00727
* B 00244                                                    B 00244     00728
  C 00255 00247 CC241                                                    00729
  R 00422 CCCC8                                                          00730
  E 00198                                                                00731
    FOURIER BAR, INT. SCALAR MULTIPLY BY A CONSTANT AND EXTRACT          00732
* B 00260                                                    B 00260     00733
  R 00276 CCC07                (276)=1 BAR OPERATION                   00734
  E 00262                                                                00735
* B 00261                                                    B 00261     00736
  R 00276 0C006                (276)=0 INTEGRATE                       00737
* B 00262                                                    B 00262     00738
  R 00204 CC006                                                          00739
  R 00422 CC007                                                          00740
  G C0277 005C0 C0030                                                    00741
  M 00277 00277 00005                 3N                                 00742
  A 00277 00277 C0030                                                    00743
  M 00033 00030 CCC09                                                    00744
  H 005C0 00033 C0C06                                                    00745
  R 00278 CC030                (278= SERIES COUNTER                    00746
  R 00279 CC033                (279= STURAGE COUNTER                   00747
  I 00238 +00CC0CCC+0C              TERM COUNTER                         00748
* B 00263                                                    B 00263     00749
  R 00258 CC0C7                (258)= SIN OR COS IND.                  00750
  A 00278 00278 CCC05          UPDATE (278)                            00751
  G 00280 00496 CC278          A                                       00752
  G C0281 00499 CC278          A*                                      00753
  G 00282 005C0 00278          A* CONTINUED                            00754
  C 00281 CC0C6 00264          A* GO TO 264                            00755
  S 00281 0C0C6 00281          -A* TO +A*                              00756
  R 00258 CC0C8                (258)=-1 SIN                            00757
* B 00264                                                    B 00264     00758
  D 00283 00281 CC013          A*/10 TO THE SIXTH                      00759
  A 00283 00283 C0C12                                                    00760
```

```
S 00283 00283 00012          (283)= I                                  00761
M 00284 00283 00013                                                    00762
S 00285 00281 00284                                                    00763
D 00286 00285 00014                                                    00764
A 00287 00286 00012                                                    00765
S 00287 00287 00012          (287)= J+50                               00766
M 00288 00287 00014                                                    00767
S 00289 00285 00288                                                    00768
D 00290 00289 00015                                                    00769
A 00291 00290 00012                                                    00770
S 00291 00291 00012          (291)= K+50                               00771
M 00292 00291 00015                                                    00772
S 00293 00289 00292                                                    00773
A 00294 00293 00012                                                    00774
S 00294 00294 00012          (294)= L+50                               00775
A 00205 00205 00007                                                    00776
D 00065 00282 00013                                                    00777
A 00066 00065 00012                                                    00778
S 00066 00066 00012          (66)= M+50                                00779
M 00068 00066 00013                                                    00780
S 00069 00282 00068                                                    00781
D 00070 00069 00014                                                    00782
A 00071 00070 00012                                                    00783
S 00071 00071 00012          (71)= N+50                                00784
M 00073 00071 00014                                                    00785
S 00074 00069 00073                                                    00786
D 00075 00074 00015                                                    00787
A 00076 00075 00012                                                    00788
S 00076 00076 00012          (76)= O+50                                00789
M 00078 00076 00015                                                    00790
S 00079 00074 00078                                                    00791
A 00080 00079 00012                                                    00792
S 00080 00080 00012          (80)= P+50                                00793
S 00296 00287 00017          J                                         00794
S 00297 00291 00017          K                                         00795
S 00298 00294 00017          L                                         00796
S 00066 00066 00017          M                                         00797
S 00071 00071 00017          N                                         00798
S 00076 00076 00017          O                                         00799
S 00080 00080 00017          P                                         00800
```

```
  C 00276 0C006 C0265              265= BAR, 266=INT.                                  00801
  E 00266                              TO INTEGRATION ROUTINE                          00802
• B C0265                                                                  B 00265   00803
  A 00300 00283 C0066              I+M =I*                                             00804
  S 00066 0C066 0CC66              M=0                                                 00805
  C 00300 00006 00267 00268        I*=0                                                00806
  C 00296 0C0C6 C0267 00268        J=0                                                 00807
  C 00297 0C0C6 00267 00268        K=0                                                 00808
  C 00298 C0006 00267 0C268        L=0                                                 00809
  C 00066 00006 00267 00268        M=0                                                 00810
  C 00071 CC006 00267 C0268        N=0                                                 00811
  C C0076 0C006 00267 00268        O=0                                                 00812
  C C0080 00006 00267 00268        P=0                                                 00813
  M C0283 00283 00258.                                                                 00814
  R 00312 0CC07                    (312)=+1 SIGN CHANGE ORD                            00815
  C 00283 0C006 00267 00270                                                            00816
• B 00268                                                                  B 00268   00817
  S 00300 0C006 C0300              -I* TO +I*                                          00818
  S 00296 0C0C6 C0296                                                                  00819
  S 00297 0C006 00297                                                                  00820
  S 00298 CC006 00298                                                                  00821
  S 00066 00006 C0066                                                                  00822
  S 00071 CC006 C0071                                                                  00823
  S 00076 C0006 C0076                                                                  00824
  S 00080 0C006 C0080                                                                  00825
  R C0312 00008                    312=-1 SIGN CHANGE INDICATOR                        00826
  C C0258 0CC06 00267                                                                  00827
  M 00280 00280 00312                                                                  00828
• B 00267                                                                  B 00267   00829
  C 00300 00495 CC198              I* 99 END                                           00830
  A 00301 00296 C0017              J+50                                                00831
  A 00302 00297 C0017              K+50                                                00832
  A 00303 00296 0C017              L+50                                                00833
  A 00251 00066 CC017              M+50                                                00834
  A 00252 00071 C0017              N+50                                                00835
  A 00253 C0076 C0017              O+50                                                00836
  A 00254 C0080 CC017              P+50                                                00837
  M 00304 00302 C0015                                                                  00838
  M 00305 00301 C0014                                                                  00839
  M 00300 00300 C0013                                                                  00840
```

```
  A 00306 00304 00303                                                    00841
  A 00307 00306 00305                                                    00842
  A 00307 00307 00300              A* ABS. VAL                           00843
  M 00307 00307 00258                                                    00844
  M 00251 00251 00013                                                    00845
  M 00252 00252 00014                                                    00846
  M 00253 00253 00015                                                    00847
  A 00251 00251 00252                                                    00848
  A 00251 00251 00253                                                    00849
  A 00251 00251 00254              A* CONTINUED                          00850
• B 00475                                                    B 00475     00851
  R 00161 00280                    A TO COLLAPSER                        00852
  R 00162 00307                    A* TO COLLAPSER                       00853
  R 00120 00251                    A                                     00854
  R 00164 00033                                                          00855
  I 00407 +10000000+01                                                   00856
  I 00165 +00000000+00                                                   00857
  C 00161 00006 00476 00476                                              00858
  E 00270                                                                00859
• B 00476                                                    B 00476     00860
  A 00164 00164 00005              A COUNTER                             00861
  G 00204 00500 00033                                                    00862
  C 00407 00204 00479                                                    00863
  G 00166 00499 00164              STORED A*                             00864
  G 00110 00500 00164              STORED A* CONTINUED                   00865
  A 00165 00165 00007                                                    00866
  C 00162 00166 00477 00477                                              00867
  C 00120 00110 00477 00477                                              00868
  G 00167 00498 00164              STORED C                              00869
  A 00168 00167 00161              C+A=NEW C                             00870
  H 00498 00164 00168                                                    00871
  E 00270                                                                00872
• B 00479                                                    B 00479     00873
  H 00498 00164 00161                                                    00874
  H 00499 00164 00162              STORE C*                              00875
  H 00500 00164 00120                                                    00876
  A 00164 00164 00005                                                    00877
  R 00204 00007                                                          00878
  H 00500 00033 00204                                                    00879
  E 00270                                                                00880
```

```
• B 00477                                                                B 00477   00881
  G 002C4 00500 CC033                                                              00882
  C 002C4 00165 CC476                                                              00883
  A CC2C4 002C4 CC007          (204) +1                                            00884
  H 00500 CC033 00204                                                              00885
  A 00164 00164 CCC05                                                              00886
  H 00498 C0164 C0161          STORE C                                             00887
  H 00499 00164 C0162          STORE C*                                            00888
  H 00500 0C164 00120          STORE C**                                           00889
  A 00164 00164 CCC05                                                              00890
  H 00498 00164 0CC06                                                              00891
  H 00499 00164 CCC06                                                              00892
  H 00500 00164 CCC06                                                              00893
  C 00204 00360 C0198 CC270    END ARRANGER IF NO OF TERM LARGER THAN 2N-1          00894
  R 00422 00008                                                                    00895
  E 00198                                                                          00896
• B 00269                                                                B 00269   00897
  A 00238 00238 0CCC7              UP COUNTER BY ONE                               00898
  H 005C0 00033 CC238            STORE NUMBER OF TERMS                             00899
  R 00204 CC238                 NUMBER OF TERMS TO ARRANGER                        00900
  A 00279 00279 CCC05                                                              00901
  H 00498 00279 CC280          STORE A                                             00902
  H C0499 00279 CC3C7          STORE A*                                            00903
  H 005C0 00279 C0251          STORE A* CONTINUED                                  00904
• B 00270                                                                B 00270   00905
  C 00277 0C278 0C263          LAST TERM END                                       00906
  R C0422 00008                                                                    00907
  E 00198                                                                          00908
  V 00321 +33CCCCC0+0C         SMALL N SUB 0                                       00909
  V 00322 +42C0CCC0+0C         SMALL N SUB 0 PRIME                                 00910
  V 00323 +40CCCCC0+0C         Y+ ALPHA-ETA                                        00911
  V 00324 +60CCCCC0+0C         Y PRIME + ALPHA+ETA                                 00912
• B 00266                                                                B 00266   00913
  C 00283 CC0C6 CC313          IS I=0                                              00914
  C 00296 00006 CC313 C0313    IS J=0                                              00915
  C 00297 CCCC6 CC313 C0313    IS K=0                                              00916
  C 00298 CC006 00313 C0313    IS L=0 (NO INTEGRATION)                             00917
  E 00270                                                                          00918
• B 00313                                                                B 00313   00919
  M C0301 00321 C0283          I SMALL N SUB 0                                     00920
```

```
  M 00302 00322 00296              J SMALL N SUB 0 PRIME                                  00921
  M 00303 00323 00321                                                                    00922
  M 00303 00303 00297              (303)= K N SUB 0 (Y+ALPHA-ETA)                        00923
  M 00304 00324 00321                                                                    00924
  M 00304 00304 00298              (304)= L N SUB 0 (Y PRIME+ALPHA+ETA)                  00925
  A 00305 00301 00302                                                                    00926
  A 00305 00305 00303                                                                    00927
  A 00305 00305 00304                                                                    00928
  C 00305 00006 00315 00315        DENOMINATOR NOT ZERO                                  00929
      T     DENOMINATOR IS ZERO                                                          00930
  P 00000 00007 PA                                                                       00931
  E 00006                                                                                00932
  E 00270                                                                                00933
* B 00315                                                          B 00315               00934
  D 00309 00280 00305                A/DEN.                                              00935
  C 00258 00006 00271 00272          SIN OR COS                                          00936
* B 00271                                                          B 00271               00937
  R 00280 00309                                                                          00938
  M 00307 00281 00008                -A*                                                 00939
  R 00251 00282                  STORE A* CONTINUED                                      00940
  E 00269                                                                                00941
* B 00272                                                          B 00272               00942
  M 00280 00309 00008                                                                    00943
  R 00307 00281                                                                          00944
  R 00251 00282                  STORE A* CONTINUED                                      00945
  E 00269                                                                                00946
* B 00330                                                          B 00330               00947
  M 00033 00030 00009                                                                    00948
  I 00331 +00000000+00                                                                   00949
  H 00500 00033 00006                                                                    00950
  H 00501 00033 00006                                                                    00951
  I 00329 +00000000+00                                                                   00952
  R 00328 00033                                                                          00953
* B 00334                                                          B 00334               00954
  A 00329 00329 00007                                                                    00955
  A 00331 00331 00005                                                                    00956
  A 00328 00328 00005                                                                    00957
  G 00335 00498 00331                GET A                                               00958
  G 00336 00499 00331                GET A*                                              00959
  G 00337 00500 00331                GET A* CONTINUED                                    00960
```

```
  M 00335 00335 00339          CA
  R 00452 00335
  C 00335 00006 00451
  S 00452 00006 00335
• B 00451                                                B 00451
  C 00016 00452 00499
  H 00498 00328 00335          STORE CA
  H 00499 00328 00336          STORE A*
  H 00500 00328 00337          STORE A* CONTINUED
  H 00500 00033 00329
  C 00500 00329 00334
  E 00499
• B 00345                                                B 00345
  V 00348 +00505050+08
  V 00349 +50505050+08
  M 00033 00030 00009
  R 00344 00033
  H 00500 00033 00500            NUMBER OF TERMS IN SERIES
  I 00351 +00000000+00
  I 00342 +00000000+00
• B 00346                                                B 00346
  A 00351 00351 00005
  A 00342 00342 00007
  A 00344 00344 00005
  G 00352 00499 00351          GET A*
  G 00353 00500 00351          GET A* CONTINUED
  C 00352 00348 00347 00347
  C 00353 00349 00347 00347
  G 00354 00498 00351
  H 00501 00033 00354           STORE  COEFFICIENT
  H 00502 00033 00352
  H 00503 00033 00353
  H 00500 00033 00007             TERM COUNTER =1
  E 00499
• B 00347                                                B 00347
  C 00500 00342 00346
  H 00500 00033 00007
  H 00501 00033 00006           COEFFICIENT = ZERO
  H 00502 00033 00348
  H 00503 00033 00349
```

```
  E 00499
* B 00365                                      MTH ARGUMENT DIFF          B 00365
  R 00204 00006
  R 00422 00007
  R 00247 00030
  M 00033 00030 00009
  R 00248 00033
  I 00238 +00000000+00
  G 00255 00500 00030
  M 00255 00255 00005
  A 00255 00255 00030
* B 00366                                                                 B 00366
  A 00247 00247 00005
  G 00249 00498 00247                          A
  G 00250 00499 00247                          A*
  G 00259 00500 00247                          A* CONTINUED
  D 00251 00259 00013
  A 00251 00251 00012
  S 00251 00251 00012
  S 00251 00251 00017                          MTH ARGUMENT
  C 00251 00006 00367 00367                     MTH ARG ZERO OMIT TERM
  E 00369
* B 00367                                                                 B 00367
  C 00250 00006 00368 00370                    (368=COS) 370=SIN
* B 00368                                                                 B 00368
  M 00252 00249 00251                          M (A)
  M 00252 00252 00008                          -M (A)
  M 00253 00250 00008                          COS TO SIN
  E 00371
* B 00370                                                                 B 00370
  M 00252 00249 00251
  M 00253 00250 00008                          SIN TO COS
* B 00371                                                                 B 00371
  A 00248 00248 00005
  A 00238 00238 00007
  H 00500 00033 00238                          STORE NO. OF TERMS
  R 00204 00238
  H 00498 00248 00252                          STORE + OR - MA
  H 00499 00248 00253                          STORE A*
  H 00500 00248 00259                          STORE A* CONTINUED
```

```
• B 00369                                                          B 00369   01041
  C C0255 C0247 00366                                                        01042
  R 00422 CC008                                                              01043
  E 00198                                                                    01044
• B 00375                                                          B 00375   01045
  R 00204 0C0C6                                                              01046
  R 00422 CCCC7                                                              01047
  G 00277 005C0 00030                                                        01048
  M 00277 C0277 CC005                                                        01049
  A 00277 0C277 CC030          3N                                            01050
  M 00033 C0030 0CC09                                                        01051
  R 00278 CC030                (278)=SERIES COUNTER                          01052
  R C0279 CC033                (279)=STORAGE COUNTER                         01053
  I 00238 +C0CCCCCC+0C         (238)=TERM COUNTER                            01054
• B 00376                                                          B 0C376   01055
  A 00278 0C278 CC005                                                        01056
  G 00280 C0498 C0278          A                                             01057
  G C0281 00499 0C278          A*                                            01058
  G C0282 C05C0 C0278          A* CONTINUED                                  01059
• B 00377                                                          B 00377   01060
  D 00283 00282 C0013                                                        01061
  A 00283 C0283 CC012                                                        01062
  S 00283 00283 C0012                                                        01063
  S 00283 00283 C0017                                                        01064
  C 00283 0C006 00378 00379    (378=COS (379)=SIN                            01065
  E C0380                                                                    01066
• B 00378                                                          B 00378   01067
  D 00284 C0280 00283          A/M                                           01068
  M 00285 00281 CCC08          COS TO SIN                                    01069
  E C0381                                                                    01070
• B 00379                                                          B 00379   01071
  D 00284 C0280 C0283                                                        01072
  M C0284 C0284 CCC08             -A TO +A                                   01073
  M 00285 00281 CC008          SIN TO COS                                    01074
• B 00381                                                          B 00381   01075
  A 00238 00238 0C007          TERM COUNTER UP                               01076
  A 00279 00279 CC005                                                        01077
  H 005C0 CC033 0C238          STORE NUMBER OF TERMS                         01078
  R 002C4 0C238                   TERM COUNTER TO ARRANGR                    01079
  H 00498 00279 00284                                                        01080
```

```
  H 00499 00279 00285                                                    01081
  H 00500 00279 00282                                                    01082
• B 00380                                                      B 00380  01083
  C 00277 00278 00376                                                    01084
  R 00422 00008                                                          01085
  E 00198                                                                01086
  K 00000                                                                01087
  K 41600                    PRINT OUT MEMORY FUNCTION                   01088
  Q 90000 45202                                                          01089
  Q 90001 45201                                                          01090
  V 00006 +00000000+00                                                   01091
• B 00001                                                      B 00001  01092
  R 90000 00005                                                          01093
  E 90001                                                                01094
• B 00005                                                      B 00005  01095
  R 90000 00006                                                          01096
  E 00002                                                                01097
  K 00000                                                                01098
  K 41000                                                                01099
                           P-TH ORDER BESSEL FUNCTION                    01100
                            OF X                                         01101
                           INPUTS P, X                                   01102
                           OUTPUT J SUB P OF X                           01103
• B 00001                                                      B 00001  01104
  G 00015 00001 00003                                                    01105
  G 00016 00002 00003                                                    01106
  R 00017 00010            COMPUTE X TO THE P                            01107
  R 00018 00011             TWO TO THE P AND                             01108
  R 00019 00011             P FACTORIAL                                  01109
  R 00020 00011                                                          01110
  C 00011 00015 00006                                                    01111
• B 00005                                                      B 00005  01112
  A 00017 00017 00011                                                    01113
  M 00018 00018 00016                                                    01114
  A 00019 00019 00019                                                    01115
  M 00020 00020 00017                                                    01116
  C 00015 00017 00005                                                    01117
• B 00006                  COMPUTE J SUB P                     B 00006  01118
  R 00024 00010                                                          01119
  R 00021 00018                                                          01120
```

```
     M 00022 00019 00020                                                    01121
     D 00027 00021 00022                                                    01122
     M 00023 00016 00016                                                    01123
     S 00023 00010 00023                                                    01124
   • B 00007                                                    B 00007     01125
     A 00024 00024 00011                                                    01126
     M 00021 00021 00023                                                    01127
     A 00025 00024 00015                                                    01128
     M 00022 00024 00022                                                    01129
     M 00022 00022 00025                                                    01130
     M 00022 00022 00014                                                    01131
     D 00026 00021 00022                                                    01132
     R 00028 00027                                                          01133
     A 00027 00028 00026                                                    01134
     C 00028 00027 00007 00007                                              01135
     H 00001 00004 00027                                                    01136
     E 00002                                                                01137
     V 00010 +00000000+00                                                   01138
     V 00011 +10000000+01                                                   01139
     V 00012 +20000000+01                                                   01140
     V 00013 +50000000+01                                                   01141
     V 00014 +40000000+01                                                   01142
     K 00000                                                                01143
     K 41100                                                                01144
     Q 91601 41601                P O M                                     01145
     Q 03600 00001                LAMBDA1                                   01146
     Q 04200 00002                LAMBDA2                                   01147
     Q 04800 00003                LAMBDA3                                   01148
     Q 05400 00004                LAMBDA4                                   01149
     Q 06000 00005                NU                                        01150
     Q 06600 00006                NU/1+NU                                   01151
     Q 07200 00007                W                                         01152
     Q 07800 00008                NSUBO DELTA                               01153
     Q 08400 00009                H/H SUBO                                  01154
     Q 09000 00010                HSUB O/H                                  01155
     Q 09600 00011                CAP. PSI                                  01156
     Q 10200 00012                CAP UPSILON                               01157
     Q 10800 00013                DELTA                                     01158
     Q 11400 00014                                                          01159
     Q 12000 00015                                                          01160
```

```
Q 12600 00016                                                          01161
Q 13200 00017                                                          01162
Q 13800 00018                                                          01163
Q 14400 00019                                                          01164
Q 15000 00020                                                          01165
Q 15600 00021                                                          01166
Q 16200 00022                                                          01167
Q 16800 00023                                                          01168
Q 17400 00024                                                          01169
Q 18000 00025                                                          01170
Q 18600 00026                                                          01171
Q 19200 00027                                                          01172
Q 19800 00028                                                          01173
Q 20400 00029                                                          01174
Q 21000 00030                                                          01175
Q 21600 00031                                                          01176
Q 22200 00032                                                          01177
Q 22800 00033                                                          01178
Q 23400 00034                                                          01179
Q 24000 00035                                                          01180
Q 24600 00036                                                          01181
Q 25200 00037                                                          01182
Q 25800 00038                                                          01183
Q 90051 00051          SQUARE ROOT FUNCTION                            01184
Q 90071 00071        SINE FUNCTION                                     01185
Q 90075 00075     COSINE FUNCTION                                      01186
Q 90016 00216 NUMERICAL CRITERION                                      01187
Q 90030 00230 NUMBER OF CELLS                                          01188
Q 90101 00101 SERIES MOVE                                              01189
Q 90111 00111 SERIES ADD                                               01190
Q 90116 00116 SERIES SUBTRACT                                          01191
Q 90121 00121 SERIES MULTIPLY                                          01192
Q 90700 00700 OPERATING CELLS                                          01193
Q 90126 00126 SCALAR MULTIPLY                                          01194
Q 90131 00131 ARGUMENT EXTRACT                                         01195
Q 90136 00136 DIFFERENTIATION                                          01196
Q 90141 00141 INTEGRATION                                              01197
Q 90146 00146 BAR FUNCTION                                             01198
Q 90151 00151  MTH ARGUMENT DIFFERENTIATE                              01199
Q 90156 00156   MTH ARGUMENT INTEGRATE                                 01200
```

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Q 90521 00521                    INT. CONST. N SUB 0                              01201
Q 90522 00522                    INT. CONST. N PRIME SUB 0                        01202
Q 90523 00523                    INT. CONST. Y+ALPHA-ETA                          01203
Q 90524 00524                    INT. CONST. YPR.+ALPHA+ETA                       01204
Q 93101 41001                      BESSEL FUNCTION                                01205
C 90901 41301                       TAYLOR SERIES EXPANSION                       01206
Q 90903 41311                     DIFF  TAYLOR EXPANSION                         01207
Q 90001 45001                    SORT AND PRINT                                   01208
Q 91201 45201                    P.O.M.                                           01209
Q 90103 00051                    SQ. ROOT                                         01210
V 00005 +89826279-01                VALUE OF CAP I SUB 0                         01211
V 00006 +10000000+01             (6)= A SUB 0                                     01212
V 00007 +54908070-01             (7)= E SUB 0                                     01213
V 00008 +22802713+00             (8)= N SUB 0                                     01214
V 00010 +39494471+03             (10)= A PRIME                                    01215
V 00011 +16792260-01             (11)= E PRIME                                    01216
V 00012 +17201970-01             (12)= N PRIME                                    01217
V 00013 +00000000+00             (13)= SMALL I*=0                                 01218
V 00018 +00000000+00             (18)=0= N SUB 0 Y PRIME                          01219
V 00019 +10000000-07             (19)= CRITERION                                  01220
V 00020 +10000000+01             (20)=1                                           01221
V 00021 +50000000+00             (21) =1/2                                        01222
V 00022 -10000000+01             (22)=-1                                          01223
V 00023 +00000000+00             (23)=0                                           01224
V 00024 +20000000+01             (24)=2                                           01225
V 00025 +49000000+02                                                              01226
V 00026 +30000000+01             (26)=3                                           01227
V 00027 +10000000+07                                                              01228
V 00028 +10000000+05                (28) IS 10 TO THE FOURTH                     01229
V 00029 -15000000+01             (29)=-3/2                                        01230
V 00030 +10000000+01                                                              01231
V 00031 +00000000+00             SERIES =0                                        01232
V 00032 +00505050+08                                                              01233
V 00033 +50505050+08                                                              01234
V 00035 +10000000+01             COS OMEGA                                        01235
V 00036 +10000000+01                                                              01236
V 00037 +00505150+08                                                              01237
V 00038 +50505050+08                                                              01238
V 00040 +10000000+01                                                              01239
V 00041 +10000000+01             SIN OMEGA                                        01240
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V C0042 -00505150+08                                                    01241
V 00043 +50505050+08                                                    01242
V 00045 +10000000+01                                                    01243
V 00046 +10000000+01                                                    01244
V 00047 +00505051+08          COS OMEGA PRIME                           01245
V C0048 +50505050+08                                                    01246
V 00050 +10000000+01                                                    01247
V 00051 +10000000+01          (50)= SERIES FORM OF ONE                  01248
V 00052 +00505050+08                                                    01249
V 00053 +50505050+08                                                    01250
V C0054 -00505050+08                                                    01251
V 00055 +10000000-03                                                    01252
V C0055 +10000000-04                                                    01253
V 00055 +10000000-12                                                    01254
V 00055 +10000000-08           SERIES TEMPORARY MULTIPLICATION CRITERION 01255
V 00055 +10000000-10                                                    01256
V 00055 +10000000-19                                                    01257
V C0055 +10000000-11                                                    01258
V 00055 +10000000-07                                                    01259
V C0055 +10000000-05                                                    01260
V 00060 +10000000+01                                                    01261
V C0061 +10000000+01          SIN OMEGA PRIME                           01262
V 00062 -00505051+08                                                    01263
V 00063 +50505050+08                                                    01264
V 00065 +10000000+01                                                    01265
V 00066 +00000000+00          0 SERIES                                  01266
V 00067 +00505050+08                                                    01267
V 00068 +50505050+08                                                    01268
V 00070 +10000000+01                                                    01269
V C0071 +10000000+01                                                    01270
V 00072 +00505050+08          COS THETA SERIES                          01271
V 00073 +50515050+08                                                    01272
V 00075 +10000000+01                                                    01273
V 00076 +10000000+01                                                    01274
V 00077 -00505050+08          SIN THETA SERIES                          01275
V C0078 +50515050+08                                                    01276
V C0089 +50000000+01                                                    01277
V C0089 +80000000+01                                                    01278
V 00090 +01505050+08          COS G                                     01279
V 00091 +50505050+08                                                    01280
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V 00098 +COCOCOOO+OC          (98)=0=D OMEGA PR./DT                          01281
V 00099 +10COCCOO-06          NEW CRIT                                       01282
V 00130 -40COCCCO+01                                                         01283
V 00160 +35493600+06          (160)= M PRIME                                 01284
V 00171 +15COCCOO+01                                                         01285
V 00173 +25COCCCO+01                                                         01286
V 00176 +4375CCOO+01          (176)=35/8                                     01287
V 00177 +375CCOOO+01          (177)=15/4                                     01288
V 00178 +375COCCC+OC          (178)=3/8                                      01289
V 00181 +40COCCCO+01                                                         01290
V 00182 +75CCCCCO+01                                                         01291
V 00183 +175CCCOO+02                                                         01292
V 00184 +50000000+01          (184)= 5                                       01293
V 00267 -30COCCOO+01                                                         01294
V 00324 +10COCCCO-07                                                         01295
V 00398 +300CCOOO+03          NO. OF OPERATING C6263 IS 300                  01296
V 00399 +60000000+03          NO. OF OPERATING C6263 IS 600                  01297
V 00399 +10000000+05          (NO. OF CELLS IS 10,000)                       01298
V 90016 +10CCCOOO-03               MULTIPLICATION CRITERION                  01299
V 90030 +30CCCOOO+03            NUMBER OF OPER  CELSS IS 300                 01300
V 00401 +10CCCOOO-1C                                                         01301
V 00401 +10CCCCOO-08          CRIT. IS 1C TO -9TH                            01302
V 00401 +10CCCOOO-09                                                         01303
V 00401 +10000000-05                                                         01304
V 00401 +10000000-07                                                         01305
V 00403 +10000C00-06          CRIT. IS 10 TO -7TH                            01306
V 00408 +194CCOOO-02                                                         01307
V 00430 +00505149+08                                                         01308
V 00431 +50505050+08                                                         01309
V 00432 +00505248+08                                                         01310
V 00433 +50505050+08                                                         01311
V 00434 +00505347+08                                                         01312
V 00435 +50505050+08                                                         01313
V 00436 +00505446+08                                                         01314
V 00437 +50505050+08                                                         01315
V 00460 -00505149+08                                                         01316
V 00461 +50505050+08                                                         01317
V 00462 -00505248+08                                                         01318
V 00463 +50505050+08                                                         01319
V 00464 -00505347+08                                                         01320
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  V 00465 +50505050+08                                                                  01321
  V 00466 -00505446+08                                                                  01322
  V 00467 +5050505C+08                                                                  01323
  V 00491 +10CCCCCC-03                                                                  01324
  V 00492 +1CCOCCCO-01                                                                  01325
• B 00001                                                                  B 00001      01326
  Q 90698 00698                                                                         01327
  Y C0001 90698                                                                         01328
  R 90016 004C1                          CRIT  IS TEN TC MINUS EIGHT                    01329
    T  HANSEN LUNAR THECRY AS MODIFIED BY DR. MUSEN                                     01330
  P 00018 00020 PA                                                                      01331
  P 00018 CC020 TA                                                                      01332
• B 00101                                                                  B 00101      01333
  R 90030 C0398                      CHANGE SERIES LENGTH                             01334
  R C0015 00023                      N SUBP Y=C                                       01335
  R C0017 CC023                      N SUB C ETA=0                                    01336
  R 00016 0C023                      N SUB 0 ALPHA=0                                  01337
  R C0084 00023                            (84) = 0 INITIALLY                         01338
  M 00123 00029 CCC07                -3/2 SMALL E SUB 0                               01339
  M 00124 CC007 CCC07                                                                 01340
  S 00125 00020 C0124                1- E SUB 0 SQ.                                   01341
  F C0126 9C051 C0125                SQ RT. (1-                                       01342
  R 00155 00126                                                                       01343
  R 00402 CC126                                                                       01344
  D C0156 00020 00126                (156) =                                          01345
  D 00133 0C007 00126                                                                 01346
  M 00126 00126 CCC24                                                                 01347
  D 00126 00126 CC007                2 SQ RT. (1-E0 SQ)/2                             01348
  M 00127 00124 C0021                1/2 E SUB C SQ.                                  01349
  M 00128 CC024 CCC07                2 E SUB 0                                        01350
  S 00128 CC023 C0128                -2 E SUB 0                                       01351
  M 00129 00124 C0029                                                                 01352
  S 00129 00023 C0129                + 3/2 E SUB 0 SQ.                                01353
  M C0131 CCC06 00008                (N SUB 0)(A SUB 0)                               01354
  D 00132 00131 C0125                (N SUB C)(A SUB 0)/1-E SUB 0 SQ.                 01355
  M 00140 00029 CC011                                                                 01356
  M C0141 00011 C0011                                                                 01357
  S C0142 00020 C0141                1- E PRIME SQ.                                   01358
  F C0143 90051 C0142                                                                 01359
  M 00143 00143 C0024                                                                 01360
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  D 00143 00143 00011                                                    01361
  D 00150 00020 00007          (150)= 1/E SUB 0                          01362
  M 00152 00132 00024                                                    01363
  M 00153 00152 00150                                                    01364
  M 00154 00005 00021          1/2 I SUB0                                01365
  D 00157 00020 00125          (157)= 1/SQ(1-E SUB0 SQ)                  01366
  M 00158 00007 00024          2E SUB0                                   01367
  R 00161 00006                                                          01368
  M 00165 00161 00161          (165)=A SQ.                               01369
  M 00166 00165 00160          M PRIME A SQ                              01370
  M 00167 00010 00010          (167)=A PRIME SQ                          01371
  M 00168 00167 00010          (168)=A PRIME CUBED                       01372
  M 00169 00168 00010          (169)=A PRIME 4TH                         01373
  M 0017C 00169 00010          (170)=A PRIME 5TH                         01374
  D 00172 00166 00168          M PRIME A SQ/A PRIME CUBED                01375
  M 00174 00166 00161                                                    01376
  D 00175 00174 00169          (175)=M PRIME A CUB/A PR. 4TH             01377
  M 00179 00175 00161                                                    01378
  D 00180 00179 00010          (180)=M PRIME A 4TH/A PR.5TH              01379
  D 00192 00007 00125          (192)=(E SUB 0/1-E SUB 0 SQ)              01380
  M 00195 00156 00131                                                    01381
  D 00196 00195 00024                                                    01382
  F 00197 90071 00013          (197)= SIN I PRIME                        01383
  M 00198 00197 00098            (198)=SIN I PR) D UMEGA PR./DT           01384
  M 00199 00198 00021          (199)= 1/2 SIN I PAR OM.PR./PAR T         01385
  S 00265 00023 00123          265= 3/2 E SUB 0                          01386
  R 00102 00022                (102)=P COUNTER=-1 INIATALLY              01387
  R 00106 00023                (106)=TERM COUNTER                        01388
  R 00104 00052                (104)=+00505050+08                        01389
  R 00105 00053                (105)=+50505050+08                        01390
  R 00108 00054                (108)=-00505050+08                        01391
• B 00107                                                  B 00107       01392
  A 00106 00106 00026          (106)+3                                   01393
  A 00105 00105 00027                                                    01394
  A 00102 00102 00020          (102)+1=P SUB N-1                         01395
                                                                         01396
  A 00110 00102 00020          (110)= P SUB N                            01397
  M 00111 00110 00007                                                    01398
  R 00103 00111                                                          01399
  A 00112 00110 00020          (112)= P SUB N+1                          01400
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  R 00113 00111                                                                  01401
                                                                                 01402
  F 00114 93101 00102          114= J SUB N-1                                    01403
  F 00115 93101 00110          (115)= J SUB N                                    01404
  F 00116 93101 00112          (116)= J SUB N+1                                  01405
  C 00019 00115 00121                                                            01406
  D 00117 00115 00110          (117)= J SUB N/P                                  01407
  S 00118 00114 00116                                                            01408
  D 00118 00118 00024                                                            01409
  D 00118 00118 00110          (118)= J PR/P                                     01410
  R 00600 00110                                                                  01411
  H 00598 00106 00118          A1 SERIES PREL.                                   01412
  H 00599 00106 00104                                                            01413
  H 00600 00106 00105                                                            01414
  R 00900 00110                                                                  01415
  H 00898 00106 00117          B1 SERIES PREL                                    01416
  H 00899 00106 00108                                                            01417
  H 00900 00106 00105                                                            01418
  R 01200 00110                                                                  01419
  H 01198 00106 00118          C1 SERIES PREL                                    01420
  H 01199 00106 00104                                                            01421
  H 01200 00106 00105                                                            01422
  R 01500 00110                                                                  01423
  D 00119 00117 00110          D1 SER. PREL.                                     01424
  H 01498 00106 00119                                                            01425
  H 01499 00106 00104                                                            01426
  H 01500 00106 00105                                                            01427
  R 01800 00110                                                                  01428
  H 01798 00106 00115          E1 SER. PREL.                                     01429
  H 01799 00106 00104                                                            01430
  H 01800 00106 00105                                                            01431
  C 00025 00110 00107                                                            01432
• B 00121                                                    B 00121           01433
  R 00102 00022                102= 1 IN.                                        01434
  R 00106 00023                                                                  01435
  R 00104 00052                (104)=+00505050+08                                01436
  R 00105 00053                (105)=+50505050+08                                01437
• B 00122                                                    B 00122           01438
  A 00106 00106 00026          (106)+3                                           01439
  A 00104 00104 00028          PG' TO (P+1) G'                                   01440
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A 00102 00102 00020              (102)= P SUB N-1                                    01441
                                                                                     01442
A 00110 00102 00020              (110)= P SUB N                                      01443
M 00111 00110 00011                                                                  01444
R 00103 00111                                                                        01445
A 00112 00110 00020              (112)= P SUB N+1                                    01446
R 00113 00111                                                                        01447
F 00114 93101 00102              (114)= J SUB N-1                                    01448
F 00115 93101 00110              (115)= J SUB N                                      01449
F 00116 93101 00112              (116)= J SUB N+1                                    01450
C 00019 00115 00136                                                                  01451
D 00117 00115 00110              (117)= J SUB N/P                                    01452
S 00118 00114 00116                                                                  01453
D 00118 00118 00024                                                                  01454
D 00118 00118 00110              (118)= J PR/P                                       01455
R 03000 00110                    (3000)= G1 SER. TEMP.                               01456
H 02998 00106 00118                                                                  01457
H 02999 00106 00104                                                                  01458
H 03000 00106 00105                                                                  01459
M 00108 00104 00022                                                                  01460
R 03300 00110                    (3300)= H1 TEMP.                                    01461
H 03298 00106 00117                                                                  01462
H 03299 00106 00108                                                                  01463
H 03300 00106 00105                                                                  01464
R 02100 00110                                                                        01465
H 02098 00106 00115                                                                  01466
H 02099 00106 00104                                                                  01467
H 02100 00106 00105                                                                  01468
C 00025 00110 00122                                                                  01469
* B 00136                                                          B 00136           01470
F 90700 90101 00600              A1 TO OPER. CELLS                                   01471
F 00600 90126 00024                                                                  01472
F 90700 90101 00050                                                                  01473
F 90700 90126 00123                                                                  01474
F 00600 90111 00600              A1 IN 600                                           01475
F 90700 90101 00900                                                                  01476
F 00900 90126 00126              (900)= SERIES B1                                    01477
F 90700 90101 00050                                                                  01478
F 90700 90126 00127               1/2 E SUB 0 SQ. IN SERIES FORM                     01479
F 06000 90111 00050                                                                  01480
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F 907C0 90101 012C0                                                    01481
F 907C0 90126 00128          -2 E SUB C (SERIES C1                     01482
F C12C0 90111 C6CC0          SERIES C1                                 01483
F 907C0 90101 00050                                                    01484
F 907C0 90126 00129            L/2 E SUB 0 SQ IN SERIES FORM           01485
F C6000 90111 0C050          1+3/2 E SUB 0 SQ IN SER. FORM             01486
F 907C0 90101 01500                                                    01487
F 90700 90126 00130          3/2 E SUB 0 SQ. IN SER. FORM              01488
F 015C0 90111 06000          (1500)= SERIES D1                         01489
F 907C0 901C1 C1800                                                    01490
F 90700 90126 0C024                                                    01491
F 01800 90111 0C050          (1800)= SERIES E1                         01492
F 907C0 90101 02100                                                    01493
F 907C0 90126 C0024                                                    01494
F 02100 90111 00050          (2100)= SERIES F1                         01495
R 00031 00140                (140)= -3/2 E PRIME                       01496
F 90700 901C1 03000                                                    01497
F 907C0 90126 C0024                                                    01498
F 03000 90111 CC030          (3000)= G1                                01499
F 90700 90101 03300                                                    01500
F 03300 90126 C0143          (3300)= H1                                01501
F 90700 90101 01500                                                    01502
F 02400 90126 00132          (2400)= M SUB 3 SERIES                    01503
   T       SERIES  M3                                                  01504
F C0000 9C001 02400                                                    01505
F 90700 901C1 C09C0                                                    01506
F 907C0 90126 C0132                                                    01507
F 90700 90126 00133                                                    01508
F 02700 90126 00022                                                    01509
   T       SERIES  N3                                                  01510
F 00000 9C001 02700                                                    01511
R 90030 00399                    SET SERIES LENGTH TO 200              01512
F C0412 9C071 C0154              SIN 1/2 I SUB 0                       01513
F 907C0 90101 C0050                                                    01514
F 03600 90126 C0412                 LAMBDA 1                           01515
F 0420C 90101 C0C65          (4200)= L2=0 INIT.                        01516
F 04800 901C1 C0C65          (4800)= L3=C INIT.                        01517
F 00414 9C075 00154             COS 1/2 I SUB 0                        01518
F 90700 901C1 0C050                                                    01519
F C54C0 90126 C0414               LAMBDA J                             01520
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F 06000 90101 00065              (6000)= NU=0 INIT.                                  01521
F 06600 90101 00065              (6600)= NU/1+NU                                     01522
F 07200 90101 00065              (7200)= W SERIES                                    01523
F 07800 90101 00065              (7800)= N SUB 0 DELTA Z SERIES                      01524
F 08400 90101 00050              (8400)= H/H SUB 0                                   01525
F 09000 90101 00050              (9000)= H SUB 0/H                                   01526
F 09600 90101 00065              (9600)= CAP. PSI                                    01527
F 10200 90101 00065              (10200)= CAP. UPSILON                               01528
F 10800 90101 00065              (10800)= DELTA SERIES                               01529
F 00080 90101 00065              (80)= C SUB 1 IN SER. FORM                          01530
F 00085 90101 00065              (85)= C SUB 2 IN SER. FORM                          01531
F 90700 90101 00040                                                                  01532
    T1                           SIN G PRIME                                         01533
F 00000 90001 00040                                                                  01534
F 12000 90121 00900              II (SINE OMEGA)                                     01535
    T1                                                                               01536
F 00000 90001 00900                                                                  01537
    T1                           II SIN OMEGA                                        01538
F 00000 90001 12000                                                                  01539
F 90700 90101 00035                                                                  01540
F 90700 90121 00600              I (COS OMEGA)                                       01541
    T1      I COS OMEGA                                                              01542
F 00000 90001 90700                                                                  01543
F 12000 90116 12000              (12000)= III                                        01544
    T1      III                                                                      01545
F 00000 90001 12000                                                                  01546
F 90700 90101 00600                                                                  01547
F 12600 90121 00040              (12600)= I SINE OMEGA                               01548
F 90700 90101 00900                                                                  01549
F 90700 90121 00035                                                                  01550
F 12600 90111 12600              (12600)= IV SERIES                                  01551
    T1                     IV SERIES                                                 01552
F 00000 90001 12600                IV SERIES                                         01553
F 90700 90101 03300                                                                  01554
F 13200 90121 00060                                                                  01555
F 90700 90101 03000                                                                  01556
F 90700 90121 00045                                                                  01557
F 13200 90116 13200                   III PRIME                                      01558
    T1                                                                               01559
F 00000 90001 13200                                                                  01560
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F 90700 901C1 03000                                                    01561
F 13800 90121 00060                                                    01562
F 907C0 90101 C33C0                                                    01563
F 90700 90121 C0045                                                    01564
F 13800 90111 13800              (13800)= IV PRIME                     01565
   T1            IV  PRIME                                             01566
F 00000 9C001 138C0                                                    01567
F 90700 90101 02100                                                    01568
F 144C0 90121 02100              (14400)= V PRIME SQ                   01569
   T1             V PRIME SQUARED                                      01570
F 00000 9C001 144C0                                                    01571
F 90700 90101 12CC0                                                    01572
F 15000 90121 13200              (15000)= (III)(III PRIME)             01573
   T1     III III PRIME                                                01574
F 00000 9C001 15CC0                                                    01575
F 90700 90101 12600                                                    01576
F 15600 90121 13800              (15600)= (IV)(IV PRI)                 01577
   T1          IV  IV PRIME                                            01578
F 00000 90001 156C0                                                    01579
F 907C0 901C1 15000                                                    01580
F 90700 90116 15600                                                    01581
   T1               III III PRIME - IV IV PRIME                        01582
F 00000 9C001 907C0                                                    01583
F 19800 90121 144C0              (19800)= VI                           01584
   T1                  VI                                            01585
F 0CC00 9C001 19800                                                    01586
F 907C0 90101 15000                                                    01587
F 90700 90111 156C0                                                    01588
F 20400 90121 14400              (20400)= VIII                         01589
   T1          VIII                                                    01590
F C00C0 90001 20400                                                    01591
F 907C0 90101 12600                                                    01592
F 15000 90121 13200              (15000)= (IV)(III PR.)                01593
   T1            IV    III PR                                          01594
F 00000 9C001 15C00                                                    01595
F 90700 90101 12000                                                    01596
F 15600 90121 13800              (15600)= III.IV PRIME                 01597
   T1      III   IV PRIME                                              01598
F 0C0C0 9C0C1 15600                                                    01599
F 90700 90101 15C00                                                    01600
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F 907C0 9C111 15600                                                          01601
F 21C00 90121 14400              (2100)= VII                                 01602
    T1      VII                                                              01603
F C0CC0 9C001 21CC0                                                          01604
F 907CC 9C1C1 15CC0                                                          01605
F 90700 90116 15600                                                          01606
F 25800 9C121 144C0                    = IX                                  01607
    T1    IX                                                                 01608
F C0CC0 9CCC1 25800                                                          01609
* B 00135                        MAJOR LOOP                          B 00135 01610
A 00084 00084 CCC20              UP MAJOR LOOP COUNTER 1                     01611
    T ITERATION NUMBER                                                       01612
P 00084 CCC20 TA    1505C3                          SSN                      01613
P 00084 C0020 PA    1505C3                          SSN                      01614
    T                                                                        01615
F 90700 901C1 C6000                                                          01616
F 90700 90111 CCC50              (90700)= 1+NU                               01617
F 12000 90121 19800              (12000)= S SUB 1                            01618
F 12600 90121 21CC0              (12600)= S SUB 2                            01619
F 13200 90121 20400              (13200)= S SUB 3                            01620
F 13800 90121 25800              (13800)= S SUB 4                            01621
F 90700 90101 042C0                                                          01622
F 144CC 90121 04200              (14400)= L2 SQ.                             01623
    T1        LAMBDA 2 SQ                                                    01624
F 00000 9CC01 14400                                                          01625
F 907C0 90101 C3600                                                          01626
F 907C0 90121 C3600              (90700)= L1 SQ.                             01627
    T1         L 1 SQ                                                        01628
F C0CC0 9CCC1 9C700                                                          01629
F 90700 90116 144C0                                                          01630
    T1            L 1 SQ - L2 SQ                                             01631
F C0C00 9C001 90700                                                          01632
F 14400 90121 12CC0              (14400)= (L1 SQ-L2 SQ) S1                   01633
F 90700 90101 03600                                                          01634
F 90700 90121 C4200                                                          01635
F 90700 90121 126C0                                                          01636
F 15CC0 90126 CC024              (15CC0)= 2 L1 L2 S2                         01637
F 90700 90101 C48C0                                                          01638
F 15600 90121 04800              (15600)= L3 SQ.                             01639
F 907C0 90101 C54C0                                                          01640
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F 90700 90121 05400                 L AMBDA 4 SQ.                                01641
F 90700 90116 15600                                                              01642
F 15600 90121 13200           (15600)= (L4 SQ.-L3 SQ) S3                         01643
F 90700 90101 04800                                                              01644
F 90700 90121 05400                                                              01645
F 90700 90121 13800                                                              01646
F 16200 90126 00024           (16200)= 2 L3 L4                                   01647
F 90700 90101 14400                                                              01648
F 90700 90116 15000                                                              01649
F 90700 90111 15600                                                              01650
F 21600 90116 16200           (21600)= S                                         01651
F 90700 90101 06000                                                              01652
F 90700 90111 00050                                                              01653
F 90700 90121 01200                                                              01654
F 22200 90121 02100           (222000)= P                                        01655
F 90700 90101 04200                                                              01656
F 14400 90121 12600                                                              01657
F 90700 90101 03600                                                              01658
F 90700 90121 12000                                                              01659
F 17400 90116 14400           (17400)= SIGMA 1                                   01660
F 90700 90101 03600                                                              01661
F 14400 90121 12600                                                              01662
F 90700 90101 04200                                                              01663
F 90700 90121 12000                                                              01664
F 90700 90111 14400                                                              01665
F 18000 90126 00022           (18000)= SIGMA 2                                   01666
F 90700 90101 04800                                                              01667
F 14400 90121 13200           L3 S3                                              01668
F 90700 90101 05400                                                              01669
F 90700 90121 13800                                                              01670
F 90700 90111 14400                                                              01671
F 18600 90126 00022           (18600)= SIGMA 3                                   01672
F 90700 90101 04800                                                              01673
F 14400 90121 13800           L3 S4                                              01674
F 90700 90101 05400                                                              01675
F 90700 90121 13200           L4 S3                                              01676
F 19200 90116 14400           (19200)= SIGMA 4                                   01677
F 90700 90101 06000                                                              01678
F 12000 90121 06000           (12000)= NU SQ.                                    01679
F 90700 90101 12000                                                              01680
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F 12600 90121 06000              (12600)= NU CUBED                          01681
F 90700 90101 12600                                                         01682
F 13200 90121 06000              (13200)= NU 4TH                            01683
F 90700 90101 13200                                                         01684
F 13800 90121 06000              (13800)= NU 5TH                            01685
F 90700 90101 06000                                                         01686
F 90700 90116 12000                                                         01687
F 90700 90111 12600                                                         01688
F 90700 90116 13200                                                         01689
F 06600 90111 13800              (6600)= NU/(1+NU)                          01690
F 90700 90101 00050                                                         01691
F 11400 90116 06600              (11400)= 1/1+NU                            01692
F 90700 90101 00050                                                         01693
F 12000 90116 01200              (1- RHO/A)                                 01694
F 90700 90101 08400                                                         01695
F 90700 90121 08400                                                         01696
F 13800 90116 00050                                                         01697
F 90700 90101 13800                                                         01698
F 90700 90121 01200                                                         01699
F 12000 90121 12000              (12000)= C                                 01700
R 00031 00124                    (30)= E SUB 0 IN SER.                      01701
F 90700 90101 00050                                                         01702
F 90700 90116 00030              1- E SUB 0 SQ                              01703
F 12600 90116 01200                                                         01704
F 90700 90101 06600                                                         01705
F 12600 90121 12600              (12600)= B                                 01706
F 90700 90101 00050                                                         01707
F 90700 90116 00030                                                         01708
F 90700 90116 01500                                                         01709
F 90700 90116 12600              A-B                                        01710
F 90700 90111 12000              A-B+C                                      01711
F 15600 90126 00153              (15600)= M SUB 1                           01712
    T1                 M SUB1                                               01713
F 00000 90001 15600                                                         01714
F 90700 90101 01800                                                         01715
F 13200 90116 00050                   SUBTRACT 1                            01716
F 90700 90101 13800                                                         01717
F 12000 90121 13200                                                         01718
F 90700 90101 06600                                                         01719
F 12600 90121 01800              (12600)= B                                 01720
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F 90700 90101 00050                                                    01721
F 90700 90116 12600                                                    01722
F 13200 90116 12000                                                    01723
F 90700 90101 13200                                                    01724
F 90700 90121 00900                                                    01725
F 90700 90126 00152                                                    01726
F 16200 90126 00156          (16200)= N SUB 1                          01727
   T1           N SUB 1                                                01728
F 00000 90001 16200                                                    01729
F 90700 90101 00900                                                    01730
F 90700 90121 01200                                                    01731
F 12000 90126 00157                                                    01732
F 90700 90101 13800                                                    01733
F 12000 90121 12000          (12000)= C                                01734
F 90700 90101 06600                                                    01735
F 12600 90121 00900          (12600)= B                                01736
F 90700 90101 00600                                                    01737
F 90700 90126 00024                                                    01738
M 00031 00007 00026          30= 3 E SUB 0 IN SER                      01739
F 13200 90111 00030                                                    01740
F 90700 90156 13200                                                    01741
F 90700 90126 00156          (90700)= A                                01742
F 90700 90116 12600                                                    01743
F 90700 90111 12000                                                    01744
F 24600 90126 00152          (24600)= M SUB 2                          01745
   T1           M SUB 2                                                01746
F 00000 90001 24600                                                    01747
F 90700 90151 00600          DIFF. WITH RES. TO GAMMA                  01748
F 90700 90121 00900                                                    01749
F 90700 90126 00156                                                    01750
F 12000 90126 00007                                                    01751
F 90700 90101 13800             (H/H SUB 0 S)SQ.                       01752
F 12000 90121 12000          (12000)= C                                01753
F 12600 90151 00900                                                    01754
F 90700 90101 06600                                                    01755
F 90700 90121 12600                                                    01756
F 12600 90126 00402             (12600 ) = B                           01757
R 00031 00158                                                          01758
F 90700 90101 00030                                                    01759
F 13200 90111 00600          (13200)= A                                01760
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F 90700 90101 12600                                                    01761
F 90700 90111 12000                                                    01762
F 90700 90116 13200                                                    01763
F 90700 90126 00152                                                    01764
F 25200 90126 00156              (25200)= N SUB 2                      01765
F 90700 90101 22200                                                    01766
F 90700 90121 22200                                                    01767
F 14400 90101 90700                STORE P SQ. IN 14400                01768
F 12000 90126 00021              1/2 P SQ.                             01769
F 90700 90101 21600                                                    01770
F 90700 90121 21600                                                    01771
F 15000 90101 90700                STORE S SQ.  IN 15000               01772
   T1       S SQUARED                                                  01773
F 00000 90001 15000                                                    01774
F 90700 90126 00171              3/2 S SQ.                             01775
F 90700 90116 12000              3/2 S SQ.-1/2 P SQ.                   01776
F 90700 90121 02100                                                    01777
   T1          CAP OMEGA 1 WITHOUT MUL FACTOR                          01778
F 00000 90001 90700 0                                                  01779
I 00172 +56909150-02               OMEGA 1 MULTIPLIER                  01780
R 90016 00401                                                          01781
F 12000 90126 00172              (12000)= CAP. OMEGA 1                 01782
R 90016 00491                      CRIT TEN TO MINUS 4                 01783
F 90700 90101 14400                                                    01784
F 90700 90121 21600              SP SQ.                                01785
F 12600 90126 00029              - 3/2 SP SQ                           01786
F 90700 90101 15000                                                    01787
F 90700 90121 21600                                                    01788
F 90700 90126 00173                                                    01789
F 90700 90111 12600                                                    01790
F 90700 90121 02100                                                    01791
I 00175 +14054000-04               OMEGA 2 MULTIPLIER                  01792
R 90016 00401                      CRIT. TEN TO-8                      01793
F 12600 90126 00175              (12600)= TEMP. CAP. OMEGA 2           01794
R 90016 00492                        CRIT TEN TO MINUS 2               01795
F 90700 90101 14400                                                    01796
F 90700 90121 14400                                                    01797
F 13200 90126 00178              3/8 P 4TH                             01798
F 90700 90101 14400                                                    01799
F 90700 90121 15000                                                    01800
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F 13800 90126 00177                15/4 S SQ  P SQ                          01801
F 90700 90101 15000                                                         01802
F 90700 90121 15000                                                         01803
F 90700 90126 00176          35/8 S 4TH.                                    01804
F 90700 90116 13800                                                         01805
F 90700 90111 13200                                                         01806
F 90700 90121 02100                                                         01807
I 00180 +36000000-07             OMEGA 3 MULTIPLIER                        01808
R 90016 00401                    CRIT. TEN TO-8                            01809
F 13200 90126 00180          (13200)= OMEGA 3                               01810
F 90700 90101 12000                                                         01811
F 90700 90111 12600                                                         01812
F 22800 90111 13200          (22800)= OMEGA                                 01813
    T1     OMEGA                                                            01814
F 00000 90001 22800                                                         01815
F 23400 90151 22800          (23400)= PAR. OMEGA/PAR GAMMA                  01816
F 90700 90101 12000                                                         01817
F 12000 90126 00024                                                         01818
F 90700 90101 12600                                                         01819
F 12600 90126 00026                                                         01820
F 90700 90101 13200                                                         01821
F 90700 90126 00181                                                         01822
F 90700 90111 12000                                                         01823
F 24000 90111 12600                                                         01824
R 90016 00491                     CRIT TEN TO MINUS 4                       01825
F 90700 90101 14400             P SQ TO OP CELLS                            01826
F 90700 90121 21600          SP SQ.                                         01827
F 12000 90126 00182          (12000)= 15/2 (S P SQ.)                        01828
F 90700 90101 15000                                                         01829
F 90700 90121 21600                                                         01830
F 90700 90126 00183          35/2 S CUBED                                   01831
F 90700 90116 12000                                                         01832
F 90700 90121 02100                                                         01833
R 90016 00401                    CRIT. TEN TO-8                             01834
F 12000 90126 00180          (12000)= C                                     01835
R 90016 00055                    CHANGE CRITERION                           01836
F 90700 90101 14400                                                         01837
F 12600 90126 00029              -3/2 P SQ.                                 01838
F 90700 90101 15000                                                         01839
F 90700 90126 00182          (15/2) S SQ.                                   01840
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F 90700 90111 12600                                                    01841
F 90700 90121 02100                                                    01842
R 90016 00401                    CRIT. TEN TO-8                        01843
F 12600 90126 00175              (12600)= B                            01844
R 90016 00055                    CHANGE CRITERION                      01845
F 90700 90101 21600                                                    01846
F 90700 90126 00026              35                                    01847
F 90700 90121 02100                                                    01848
R 90016 00401                    CRIT. TEN TO-8                        01849
F 90700 90126 00172              (90700)= A                            01850
F 90700 90111 12600                                                    01851
F 21600 90111 12000              (21600)=(A/R)(A PR/R PR)(P OM./PS)     01852
F 90700 90101 24000                                                    01853
F 12000 90121 16200                                                    01854
F 90700 90101 23400                                                    01855
F 90700 90121 15600                                                    01856
F 16200 90111 12000              (16200)= T SUB 1                      01857
    T1           T SUB 1                                               01858
F 00000 90001 16200                                                    01859
F 90700 90101 24000                                                    01860
F 12600 90121 25200                                                    01861
F 90700 90101 23400                                                    01862
F 90700 90121 24600                                                    01863
F 24600 90111 12600              (24600)= T SUB 2                      01864
    T1           T SUB 2                                               01865
F 00000 90001 24600                                                    01866
F 90700 90101 24000                                                    01867
F 13200 90121 02700                                                    01868
F 90700 90101 23400                                                    01869
F 90700 90121 02400                                                    01870
F 22200 90111 13200              (22200)= T SUB 3                      01871
F 90700 90101 16200                                                    01872
F 00000 90901 00000                                                    01873
F 16200 90101 90700              (16200)= F SUB 1 TEMP.                01874
    T1           F SUB 1                                               01875
F 00000 90001 16200                                                    01876
F 90700 90101 24600                                                    01877
F 00000 90901 00000                                                    01878
F 24600 90101 90700              (24600)= F SUB 2 TEMP                 01879
    T1           F SUB 2                                               01880
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F 00000 9C001 24600                                                    01881
F 90700 90101 22200                                                    01882
F 00000 9C901 00000                                                    01883
F 22200 90101 9C700          (22200)= F SUB 3 TEMP                     01884
R 00311 00015                311= N SUB C Y PREVIOUS                   01885
R 00312 00016                312= N SUB C ALPHA PREVIOUS               01886
R 00313 00017                313= N SUB C ETA PREVIOUS                 01887
F 90700 90101 24600                                                    01888
F 00230 90131 00052          (231)= CONSTANT TERM F2                   01889
F 90700 90101 08400                                                    01890
F 90700 90126 00192                                                    01891
F 90700 90126 00024                                                    01892
F 90700 90111 10200          ADD UPSILON                               01893
F 00235 90131 00052          (236)= CONST. TERM                        01894
D 00015 00231 00236          (15)= N SUB 0 Y                           01895
F 90700 90101 00050                                                    01896
F 90700 90126 00015                                                    01897
    T1                       N SUB 0 Y                                 01898
F 00000 9C001 90700                                                    01899
F 90700 90101 09600                                                    01900
F 90700 90126 00015                                                    01901
    T1         N SUB C Y(   )                                          01902
F 00000 9C001 90700 0                                                  01903
F 16200 90111 16200          (16200)= D UPSILON/DT                     01904
    T1   D UPSILON/DT                                                  01905
F 00000 9C001 16200                                                    01906
S 00193 00023 00015          (193)= -(N SUB 0)(Y)                      01907
F 90700 90101 08400                                                    01908
F 90700 90126 00024                                                    01909
F 90700 90126 00192                                                    01910
F 90700 90111 10200          ADD UPSILON                               01911
F 90700 90126 00193                                                    01912
F 24600 90111 24600          (24600)= D PSI/DT                         01913
F 90700 90101 21600                                                    01914
F 90700 90121 08400                                                    01915
F 21600 90126 00196          (21600)= G I MULTIPLIER                   01916
F 90700 90101 03600                                                    01917
F 12000 90121 04800          L1 L3                                     01918
F 90700 90101 04200                                                    01919
F 90700 90121 05400          L2 L4                                     01920
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F 907C0 90116 12C00                                                    01921
F 12000 90121 19200          (12000)= C                                01922
F 907C0 90101 03600                                                    01923
F 12600 90121 05400          L1 L4                                     01924
F 907C0 90101 04200                                                    01925
F 907C0 90121 04800          L2 L3                                     01926
F 90700 90111 12600                                                    01927
F 12600 90121 18600          (12600)= B                                01928
F 907C0 90101 04800                                                    01929
F 13200 90121 04800                                                    01930
F 907C0 90101 05400                                                    01931
F 90700 90121 05400                                                    01932
F 907C0 90111 13200          L3 SQ.+L4 SQ.                             01933
F 907C0 90121 18C00                                                    01934
F 907C0 90116 12600                                                    01935
F 907C0 90116 12C00          A-B-C                                     01936
F 22800 90121 21600          (22800)= GI                               01937
F 90700 90101 03600                                                    01938
F 12000 90121 05400          L1 L4                                     01939
F 907C0 90101 04200                                                    01940
F 90700 90121 04800          L2 L3                                     01941
F 90700 90111 12C00                                                    01942
F 12000 90121 19200          (12000)= C                                01943
F 90700 90101 03600                                                    01944
F 12600 90121 04800          L1 L3                                     01945
F 90700 90101 04200                                                    01946
F 90700 90121 05400          L2 L4                                     01947
F 907C0 90116 12600                                                    01948
F 12600 90121 18600          (12600)= B                                01949
F 90700 90101 054C0                                                    01950
F 13200 90121 05400          L4 SQ                                     01951
F 90700 90101 04800                                                    01952
F 907C0 90121 04800          L3 SQ                                     01953
F 90700 90111 13200          L4 SQ+L3 SQ.                              01954
F 90700 90121 17400                                                    01955
F 907C0 90126 00022          MUL. BY -1                                01956
F 90700 90116 12600                                                    01957
F 90700 90111 12000          -A-B+C                                    01958
F 23400 90121 21600          (23400)= G2                               01959
F 90700 90101 03600                                                    01960
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F 12000 90121 04800              L1 L3                                  01961
F 90700 90101 04200                                                     01962
F 90700 90121 05400              L2 L4                                  01963
F 90700 90116 12000                                                     01964
F 12000 90121 18000              (12000)= C                             01965
F 90700 90101 03600                                                     01966
F 12600 90121 05400              L1 L4                                  01967
F 90700 90101 04200                                                     01968
F 90700 90121 04800                                                     01969
F 90700 90111 12600                                                     01970
F 12600 90121 17400              (12600)= B                             01971
F 90700 90101 03600                                                     01972
F 13200 90121 03600              L1 SQ.                                 01973
F 90700 90101 04200                                                     01974
F 90700 90121 04200              L2 SQ.                                 01975
F 90700 90111 13200                                                     01976
F 90700 90121 19200                                                     01977
F 90700 90126 00022                                                     01978
F 90700 90111 12600                                                     01979
F 90700 90111 12000              -A+B+C                                 01980
F 24000 90121 21600              (24000)= G3                            01981
   T1         G 3                                                       01982
F 00000 90001 24000                                                     01983
F 90700 90101 03600                                                     01984
F 12000 90121 05400              L1 L4                                  01985
F 90700 90101 04200                                                     01986
F 90700 90121 04800              L2 L3                                  01987
F 90700 90111 12000              L2 L3+L1 L4                            01988
F 12000 90121 18000              (12000)= C                             01989
F 90700 90101 03600                                                     01990
F 12600 90121 04800              L1 L3                                  01991
F 90700 90101 04200                                                     01992
F 90700 90121 05400                                                     01993
F 90700 90116 12600                                                     01994
F 12600 90121 17400              (12600)= B                             01995
F 90700 90101 03600                                                     01996
F 13200 90121 03600              L1 SQ.                                 01997
F 90700 90101 04200                                                     01998
F 90700 90121 04200              L2 SQ.                                 01999
F 90700 90111 13200                                                     02000
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F 90700 90121 18600                                                    02001
F 90700 90111 12600                                                    02002
F 90700 90116 12000                                                    02003
F 19200 90121 21600          (19200)= G4                               02004
F 90700 90101 22800                                                    02005
F 00000 90901 00000                                                    02006
F 17400 90101 90700          (17400)= H SUB 1 TEMP.                    02007
F 90700 90101 23400                                                    02008
F 00000 90901 00000                                                    02009
F 18000 90101 90700          (18000)= H SUB 2 TEMP                     02010
F 90700 90101 24000                                                    02011
F 00000 90901 00000                                                    02012
F 18600 90101 90700          (18600)= H SUB 3 TEMP.                    02013
F 90700 90101 19200                                                    02014
F 00000 90901 00000                                                    02015
F 19200 90101 90700          (19200)= H SUB 4 TEMP.                    02016
F 90700 90101 18000                                                    02017
F 00240 90131 00052          (241)= CONST. IN H SUB 2 SER.             02018
F 90700 90101 03600                                                    02019
F 00245 90131 00052          (246)= CONST. IN LAMBDA 1                 02020
D 00016 00241 00246          (16)= N SUB 0 ALPHA                       02021
F 90700 90101 00050                                                    02022
F 90700 90126 00016                                                    02023
   T1                        N SUB 0 ALPHA                             02024
F 00000 90001 90700                                                    02025
F 90700 90101 18600                                                    02026
F 00250 90131 00052          (251)= CONST. IN H3                       02027
F 90700 90101 05400                                                    02028
F 00255 90131 00052          (256)= CONST. IN LAMBDA 4                 02029
D 00017 00251 00256                                                    02030
S 00017 00023 00017          (17)= N SUB 0 ETA                         02031
F 90700 90101 00050                                                    02032
F 90700 90126 00017                                                    02033
   T1                        N SUB 0 ETA                               02034
F 00000 90001 90700                                                    02035
F 90700 90101 05400                                                    02036
F 12000 90121 00075          L4 SIN THETA                              02037
F 90700 90101 04800                                                    02038
F 90700 90121 00070          L3 COS THETA                              02039
F 90700 90111 12000                                                    02040
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F 12000 90126 00199                                                    02041
F 90700 90101 04200                                                    02042
F 90700 90126 00016              N SUB 0 ALPHA L2                      02043
F 90700 90111 17400                                                    02044
F 17400 90116 12000              (17400)= (DL1/DT)                     02045
S 00190 00023 00016              (190)= -N SUB 0 ALPHA                 02046
F 90700 90101 04800                                                    02047
F 12000 90121 00075              L3 SIN THETA                          02048
    T1           L 3 SIN THETA                                         02049
F 00000 90001 12000                                                    02050
F 90700 90101 05400                                                    02051
F 90700 90121 00070              L4 COS THETA                          02052
F 90700 90116 12000                                                    02053
F 12000 90126 00199                                                    02054
    T1      L3 + L4 TIMES ZERO                                         02055
F 00000 90001 12000                                                    02056
F 90700 90101 03600                                                    02057
F 90700 90126 00190              -N SUB 0 ALPHA L1                     02058
F 90700 90111 18000              PLUS H2                               02059
F 18000 90111 12000              (18000)= DL2/DT                       02060
S 00189 00023 00017              (189)= -N SUB 0 ETA                   02061
F 90700 90101 03600                                                    02062
F 12000 90121 00070              L1 COS THETA                          02063
F 90700 90101 04200                                                    02064
F 90700 90121 00075              L2 SIN THETA                          02065
F 90700 90111 12000                                                    02066
F 12000 90126 00199                                                    02067
F 90700 90101 05400                                                    02068
F 90700 90126 00017                                                    02069
F 90700 90111 18600                                                    02070
F 18600 90111 12000              (18600)= DL3/DT                       02071
F 90700 90101 04200                                                    02072
F 12000 90121 00070              L2 COS THETA                          02073
F 90700 90101 03600                                                    02074
F 90700 90121 00075                                                    02075
F 90700 90116 12000                                                    02076
F 12000 90126 00199                                                    02077
F 90700 90101 04800                                                    02078
F 90700 90126 00189                                                    02079
F 90700 90111 19200                                                    02080
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F 19200 90111 12000              (19200)= D L4/DT                                  02081
A 00260 00015 00016                                                                02082
S 00260 00260 00017                                                                02083
D 00261 00260 00008              (261)= Y+ALPHA-ETA                                02084
A 00262 00016 00018                                                                02085
A 00262 00262 00017                                                                02086
D 00263 00262 00008              (263)= Y PR.+ALPHA+ETA                            02087
R 90521 00008                    N SUB 0 TO INT. ROUTINE                           02088
R 90522 00012                    N PRIME TO INT. ROUTINE                           02089
R 90523 00261                    Y+ALPHA-ETA TO INT. ROUTINE                       02090
R 90524 00263                    Y PR.+ALPHA-ETA TO INT. ROUTINE                   02091
F 16200 90141 16200              (16200)= BRACKET UPSILON                          02092
F 24600 90141 24600              (24600)= BRACKET PSI                              02093
F 22200 90141 22200              (22200)= BR. 1+SUB 0/H                            02094
F 90700 90101 24600                                                                02095
F 09600 90101 90700                                                                02096
    T1          PSI                                                                02097
F 00000 90001 09600                                                                02098
F 03600 90141 17400              (03600)= L1 BRACKET                               02099
F 04200 90141 18000                                                                02100
F 04800 90141 18600                                                                02101
F 05400 90141 19200              (05400)= L4 BRACKET                               02102
F 90700 90101 10800                                                                02103
F 12000 90121 10800              (12000)= DELTA SQ.                                02104
F 12600 90121 12000              DELTA CUBED                                       02105
F 13200 90121 12600              DELTA 4TH                                         02106
F 13800 90121 13200              DELTA 5TH                                         02107
F 90700 90101 12000                                                                02108
F 90700 90116 12600                                                                02109
F 90700 90111 13200                                                                02110
F 90700 90116 13800                                                                02111
F 12000 90126 00024              (1200)= 2(D2-D3+D4-D5)                             02112
F 90700 90101 16200                                                                02113
F 12600 90126 00123              (12600)= -3/2 E SUB 0 BR. UPSILON                  02114
F 90700 90101 22200                                                                02115
F 13200 90126 00026              (13200)= 3 BR.(H SUB 0/H)                          02116
F 90700 90101 12000                                                                02117
F 90700 90111 12600                                                                02118
F 23400 90116 13200              (23400)= BRACKET CH1                              02119
F 90700 90101 00600                                                                02120
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F 00000 90903 00000                                                    02121
F 18000 90101 90700             (1800)= Q SUB 1                        02122
F 90700 90101 00900                                                    02123
F 00000 90903 00000                                                    02124
F 18600 90101 90700             (18600)= Q SUB 2                       02125
F 90700 90101 01500                                                    02126
F 00000 90903 00000                                                    02127
F 19200 90101 90700             (19200)= Q SUB 3                       02128
R 00031 00265                   (31)= 3/2 E SUB 0                      02129
F 90700 90146 00600             BAR RHO/A COS PHI                      02130
F 12000 90111 00030                                                    02131
F 90700 90101 16200                                                    02132
F 12000 90121 12000             (12000)= B                             02133
F 12600 90146 00900             BAR RHO/A SIN PHI                      02134
F 90700 90101 09600                                                    02135
F 90700 90121 12600                                                    02136
F 90700 90111 23400             A+C                                    02137
F 24600 90111 12000             (24600)= BR. W SUB 0                   02138
   T1           BR W SUB C                                             02139
F 00000 90001 24600                                                    02140
F 90700 90101 06000                                                    02141
F 12000 90121 06000             (12000)= NU SQ.                        02142
F 90700 90101 12000                                                    02143
F 12600 90121 12000             (12600)= NU FOURTH                     02144
F 90700 90101 12600                                                    02145
F 13200 90121 12000             (13200)= NU SIXTH                      02146
F 90700 90101 12600                                                    02147
F 90700 90121 12600             (90700)= NU EIGHT                      02148
F 90700 90111 13200                                                    02149
F 90700 90111 12600                                                    02150
F 12000 90111 12000             (12000)= NU/1-NU SQ                    02151
F 90700 90101 00050                                                    02152
F 90700 90111 07200                                                    02153
F 90700 90121 12000                                                    02154
F 12000 90126 00008             (12000)= L                             02155
D 00266 00193 00155             (266)= -N SUB 0 Y/SQ.RT.(1-E SUB 0 SQ   02156
F 90700 90101 19200                                                    02157
F 12600 90126 00266             (12600)= -C                            02158
F 90700 90101 18600                                                    02159
F 90700 90126 00008                                                    02160
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F 13200 90121 C9600          (1320C)= B                                    02161
F 90700 90101 16200                                                        02162
F 90700 90111 C0085                                                        02163
F 90700 90126 C0C08          (N SUB 0 C2+BR. UPSILON)                      02164
F 90700 90121 18000                                                        02165
F 90700 90111 13200                                                        02166
F 90700 90111 12600                                                        02167
F 12C00 90111 12000          (12000)= A+B-C+D+E=BIG B                       02168
F 90700 90101 24600                                                        02169
F 90700 90126 CCC08                                                        02170
F 12600 90111 12000          (12600)= N SUB 0 BR W+B                       02171
F 90700 90146 01500          BAR (RHO/A) SQ.                               02172
F 13200 90126 00266          (13200)= -C                                   02173
F 90700 90101 12600                                                        02174
F 90700 90111 13200                                                        02175
F 00270 90131 00052          (271)= A1                                     02176
F C0275 90131 0CC90          (276)= A2                                     02177
F 90700 90101 CC050                                                        02178
F 90700 90126 00265                                                        02179
F 13800 90146 00600          BAR RHO/A COS PHI                             02180
F 90700 90111 13800                                                        02181
F C0280 90131 00090          (281)= BETA                                   02182
M 00286 00276 00007          (286)= A2 E SUB 0                             02183
M 00287 00281 CC008                                                        02184
M 00288 00287 00024          (288)= 2 BETA N SUB 0                         02185
D 00289 00286 C0288          (289)= A2 F SUB 0/2 BETA N SUB 0              02186
M 00290 CC008 00026          (290)= 3 N SUB 0                              02187
D 00291 00271 00290          (291)= A1/3 N SUB 0                           02188
A C0081 00291 00289          (81)= C SUB 1                                 02189
D 00292 C0288 0C024                                                        02190
D 00293 00276 00292                                                        02191
S 00086 0C023 00293          (86)= C SUB 2                                 02192
F 90700 90146 00600          BAR RHO/A COS PHI                             02193
F 90700 90111 00030                                                        02194
F 90700 90126 00008                                                        02195
F 13800 90126 00086          (13800)= B                                    02196
F 90700 90101 00085                                                        02197
F 14400 90126 00123          (14400)= -3/2 E SUB 0                         02198
F 90700 90101 00080                                                        02199
F 90700 90126 00267                                                        02200
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F 90700 90111 14400                                                    02201
F 90700 90126 00008              (90700)= A                            02202
F 90700 90111 13800                                                    02203
F 90700 90111 13200              A+B-C                                 02204
F 90700 90111 12600              (90700)= DN/DELTA Z                   02205
    T1          DN/DELTA-Z                                             02206
F 00000 90001 90700                                                    02207
F 07800 90141 90700              (07800)= N SUB 0 DELTA Z               02208
F 90700 90101 07800                                                    02209
    T1     N SUB 0 DELTA Z                                             02210
F 00000 90001 90700                                                    02211
F 00470 90131 00460                                                    02212
F 00475 90131 00462                                                    02213
F 00480 90131 00464                                                    02214
F 00485 90131 00466                                                    02215
F 90700 90101 00470                                                    02216
F 90700 90111 00475                                                    02217
F 90700 90111 00480                                                    02218
F 12000 90111 00485                                                    02219
    T1          SUBTRACT SERIES                                        02220
F 00000 90001 12000                                                    02221
F 90700 90101 07800                                                    02222
F 07800 90116 12000              N SUB 0 DELTA 2                       02223
F 90700 90101 07800                                                    02224
F 07800 90126 00020                                                    02225
    T1          N SUB 0 DELTA Z                                        02226
F 00000 90001 07800                                                    02227
F 90700 90101 00080                                                    02228
F 10800 90111 22200              (10800)= DELTA SERIES                 02229
F 90700 90101 00050                                                    02230
F 09000 90111 10800              (09000)= H SUB 0/H                    02231
    T1          H SUB 0/H                                              02232
F 00000 90001 09000                                                    02233
F 90700 90101 16200                                                    02234
F 10200 90111 00085              (10200)= UPSILON                      02235
    T1          UPSILON                                                02236
F 00000 90001 10200                                                    02237
F 90700 90101 10800                                                    02238
F 12000 90121 10800              (12000)= DELTA SQ                     02239
F 12600 90121 10800              (12600)= DELTA CUBED                  02240
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F 13200 90121 10800          (13200)= DELTA 4TH                          02241
F 13800 90121 10800          (13800)= DELTA 5TH                          02242
F 90700 90101 00050                                                      02243
F 90700 90116 10800          (1-D)                                       02244
F 90700 90111 12000          (1-D+D2)                                    02245
F 90700 90116 12600          (1-D+D2+D3)                                 02246
F 90700 90111 13200          (1-D+D2-D3+D4)                              02247
F 08400 90116 13800          (8400)= NEW H/H SUB 0                       02248
F 90700 90101 12000                                                      02249
F 90700 90116 12600          D2-D3                                       02250
F 90700 90111 13200                                                      02251
F 90700 90116 13800                                                      02252
F 12000 90126 00024          (12000)= 2(D2-D3+D4-D5)                      02253
F 90700 90101 10200                                                      02254
F 12600 90126 00123          (12600)= -3/2 E SUB 0 UPSILON               02255
F 90700 90101 10800                                                      02256
F 13200 90126 00026          (13200)= +3 DELTA                           02257
F 90700 90101 12000                                                      02258
F 90700 90111 12600                                                      02259
F 23400 90116 13200          (23400)= CH 1                               02260
    T1          CHI                                                      02261
F 00000 90001 23400                                                      02262
F 90700 90146 00600          BAR RHO/A COS PHI                           02263
F 90700 90111 18000                                                      02264
F 90700 90111 00030          R BAR/A COS+ BAR+3/2 E SUB 0                02265
F 12000 90121 10200          (12000)= B                                  02266
F 90700 90146 00900                                                      02267
F 90700 90111 18600                                                      02268
F 90700 90121 09600                                                      02269
F 90700 90111 23400                                                      02270
F 07200 90111 12000          (07200)= w BAR                              02271
    T1          W BAR                                                    02272
F 00000 90001 07200                                                      02273
F 90700 90101 10800                                                      02274
F 90700 90111 07200                                                      02275
F 90700 90126 00021          1/2 (DELTA+W BAR)                           02276
F 12000 90121 06000          1/2 (DELTA+W BAR* NU                        02277
F 90700 90101 10800                                                      02278
F 90700 90116 07200                                                      02279
F 90700 90126 00021                                                      02280
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F 06000 90116 12000              (6000)= NU                                  02281
F 90700 90101 06000                                                          02282
F 00440 90131 00430                                                          02283
F 00445 90131 00432                                                          02284
F 00450 90131 00434                                                          02285
F 00455 90131 00436                                                          02286
F 90700 90116 00440                                                          02287
F 90700 90116 00445                                                          02288
F 90700 90116 00450                                                          02289
F 90700 90116 00455                                                          02290
F 90700 90126 00020                                                          02291
F 06000 90101 90700                                                          02292
    T1       NU SERIES                                                       02293
F 00000 90001 06000                                                          02294
F 90700 90101 04200                                                          02295
    T1            LAMBDA 2 BRACKET                                           02296
F 00000 90001 90700                                                          02297
F 90700 90116 04800              L2-L3                                       02298
    T1            L2-L3                                                      02299
F 00000 90001 90700                                                          02300
F 12000 90121 90700              (L2-L3) SQ.                                 02301
    T1            (L1- L2) SQ                                                02302
F 00000 90001 12000                                                          02303
F 90700 90101 03600                                                          02304
F 90700 90111 05400              L1+L4                                       02305
F 90700 90121 90700              (L1+L4) SQ.                                 02306
F 90700 90111 12000                                                          02307
F 00300 90131 00052              (301)= 11                                   02308
F 90700 90101 04200                                                          02309
F 90700 90111 04800              L2+L3                                       02310
F 12000 90121 90700                                                          02311
F 90700 90101 03600                                                          02312
F 90700 90116 05400                                                          02313
F 90700 90121 90700                                                          02314
F 90700 90111 12000                                                          02315
F 00305 90131 00052              (306)= 12                                   02316
F 00315 90071 00154              (315)= SIN 1/2 I SUB 0                      02317
F 00316 90075 00154              (316)= COS 1/2 I SUB 0                      02318
A 00317 00315 00316              (317)= COS 1/2 IO+SIN 1/2 IO                02319
S 00318 00316 00315              (318)= COS 1/2 IO-SIN 1/2 IO                02320
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  M 00322 00317 00024        (322)= 2(317)
  M 00323 00318 00024        (323)= 2(318)
  R 00327 00023
• B 00325                                              B 00325
  M 00328 00327 00327        (328)= X SQ.
  A 00326 00301 00328
  D 00329 00326 00322
  S 00329 00023 00329        -(Q+X SQ.)/P
  S 00330 00327 00329
  C 00023 00330 00391
  F 00392
• B 00391                                              B 00391
  S 00330 00023 00330
• B 00392                                              B 00392
  R 00327 00329              (327)= A
  C 00330 00324 00325
  R 00333 00023              (333)= 0
• B 00331                                              B 00331
  M 00332 00333 00333        X SQ
  A 00334 00332 00306
  D 00335 00334 00323
  S 00336 00335 00333
  C 00023 00336 00393
  E 00394
• B 00393                                              B 00393
  S 00336 00023 00336
• B 00394                                              B 00394
  R 00333 00335
  C 00336 00324 00331
  A 00341 00327 00333
  M 00341 00341 00021        (341)= 1/2 (A+B)
  S 00342 00327 00333
  M 00342 00342 00021        (342)= 1/2 (A-B)
  A 00343 00341 00315        (343)= SIN 1/2 I+1/2 (A+B)
  A 00344 00342 00316        (344)= COS 1/2 IO+1/2 (A-B)
  F 90700 90101 00050
  F 90700 90126 00343
  F 03600 90111 03600        (3600)= NEW LAMBDA 1
  F 90700 90101 00050
  F 90700 90126 00344
```

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  F 05400 90111 05400          (5400)= NEW LAMBDA 4                                02361
  R 90016 00055                   CHANGE NUMERICAL CRITERION                       02362
  S 00345 00015 00311          DELTA N SUB 0 Y                                     02363
  S 00346 00016 00312          DELTA N SUB 0 ALPHA                                 02364
  S 00347 00017 00313          DELTA N SUB 0 ETA                                   02365
  C 00023 00345 00355                                                              02366
* B 00356                                                          B 00356         02367
  C 00023 00346 00357                                                              02368
* B 00360                                                          B 00360         02369
  C 00023 00347 00358                                                              02370
* B 00359                                                          B 00359         02371
  C 00345 00324 00135                                                              02372
  C 00346 00324 00135                                                              02373
  C 00347 00324 00135                                                              02374
  V 00594 +15000000+02                                                             02375
  C 00084 00594 00135                                                              02376
  E 91201                                                                          02377
• B 00355                                                          B 00355         02378
  S 00345 00023 00345                                                              02379
  E 00356                                                                          02380
* B 00357                                                          B 00357         02381
  S 00346 00023 00346                                                              02382
  E 00360                                                                          02383
* B 00358                                                          B 00358         02384
  S 00347 00023 00347                                                              02385
  E 00359                                                                          02386
• B 00201                                                          B 00201         02387
  F 12000 90101 00050          (12000)= N SUB 0 DZ ACC.                            02388
  F 12600 90146 90700          (12600)= SERIES ACC.                                02389
  F 13200 90101 90700          (13200)= DER. T SUB I CELL                          02390
  R 00187 00020                (187)= 1/N FACTORIAL                                02391
  R 00185 00023                (185)= COUNTER (ITER.) =0                           02392
• B 00186                                                          B 00186         02393
  A 00185 00185 00020                                                              02394
  F 13200 90151 13200          DIFFERENTIAL                                        02395
  F 90700 90101 07800                                                              02396
  F 12000 90121 12000          (12000)= N DELTA Z TO THE NTH                       02397
  D 00187 00187 00185                                                              02398
  F 90700 90146 13200          BAR T SUB I                                         02399
  F 90700 90121 12000          MUL. BY N DELTA Z TO THE NTH                        02400
```

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  F 90700 90126 C0187                                                    02401
  F 12600 90111 12600           ADD TO SUM                               02402
  C C0184 00185 00186                                                    02403
  F 90700 90101 12600                                                    02404
  E 00202                                                                02405
• B 00211                                                    B 00211     02406
  F 12000 901C1 CC050           (12000)= N DZ ACC. CELLS                 02407
  F 12600 90101 00065           ZERO SERIES TO ACC. CELLS                02408
  F 13200 90146 90700                                                    02409
  R C0187 00020                                                          02410
  R C0185 CC023                                                          02411
• B 00389                                                    B 00389     02412
  A 00185 00185 C0020                                                    02413
  F 13200 90136 13200           DIFF. BARRED SERIES                      02414
  F 90700 901C1 07800                                                    02415
  F 12000 90121 12C00           (12000)= N DZ TO THE NTH                 02416
  D 00187 00187 C0185                                                    02417
  F 90700 901C1 13200                                                    02418
  F 90700 90121 12C00           MUL. BY DELTA Z TO THE NTH               02419
  F 90700 90126 00187                                                    02420
  F 12600 90111 12600           ADD TO SUM                               02421
  C 00184 00185 C0389           NO. OF ITERATION =5 END                  02422
  F 90700 90101 12600                                                    02423
  E 00212                                                                02424
  K C0000                                                                02425
  K 45000                       SORT AND PRINT                           02426
  Q 90700 CC7C0                                                          02427
  Q 90701 00701                                                          02428
  Q 90702 00702                                                          02429
  Q 90703 00703                                                          02430
  Q 99000 00191                                                          02431
  Q 99001 00192                                                          02432
  Q 99002 C0194                                                          02433
  Q 99003 00195                                                          02434
       SORT AND PRINT                                                    02435
• B 00001                                                    B 00001     02436
  P C0000 00011 TA                                                       02437
     T                                                                   02438
  V 00009 +7CC0CC00+03                                                   02439
  V 00010 +C00CCCC0+0C          (10)=0                                   02440
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  V 00011 +10000000+01          (11)=+1                                    02441
  V 00012 +20000000+01          (12)=2                                     02442
  V 00013 +30000000+01                                                     02443
  V 00014 +67108864+08          (14)=2 TO THE 26TH                         02444
  V 00015 +10000000+07          15=10 TO THE SIXTH                         02445
  V 00016 +10000000+05          (16)=10000                                 02446
  V 00017 +10000000+03          (17)=100                                   02447
  V 00018 +50000000+02          (18)=50                                    02448
  V 00019 -10000000+01          (19)=-1                                    02449
  V 00096 -44301000+05                                                     02450
  V 00099 +45001000+05                                                     02451
  A 00097 00003 00099                                                      02452
  C 00097 00018 00098                                                      02453
  Y 00002 00097 00009 00095                                                02454
* B 00094                                                  B 00094         02455
  R 00003 00096                                                            02456
* B 00098                                                  B 00098         02457
  G 00025 00001 00003           (25)=NO OF TERMS I,K                       02458
  M 00026 00025 00013                                                      02459
  A 00040 00026 00003                                                      02460
  S 00040 00040 00012                                                      02461
  I 00027 +00000000+00          K=                                         02462
  I 00030 -10000000+07          J                                          02463
  I 00034 +00000000+00                                                     02464
* B 00029                                                  B 00029         02465
  A 00030 00030 00015           J                                          02466
  S 00028 00003 00012                                                      02467
  A 00034 00034 00015           J+1                                        02468
* B 00035                                                  B 00035         02469
  A 00028 00028 00013                                                      02470
  G 00031 00001 00028           A                                          02471
  G 00032 00002 00028           A*                                         02472
  G 00033 00003 00028           A**                                        02473
  R 00023 00011                                                            02474
  C 00032 00010 00037 00038                                                02475
* B 00038                                                  B 00038         02476
  S 00032 00010 00032                                                      02477
  M 00023 00023 00019           COS OR SIN IND.                            02478
* B 00037                                                  B 00037         02479
  C 00032 00034 00036                                                      02480
```

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C 00030 00032 00036                                                    02481
D 00045 00032 00015          A*                                        02482
A 00046 00045 00014                                                    02483
S 00047 00046 00014          (47)=P+50                                 02484
M 00048 00047 00015                                                    02485
S 00049 00032 00048                                                    02486
D 00050 00049 00016                                                    02487
A 00051 00050 00014                                                    02488
S 00052 00051 00014          (52)=Q+50                                 02489
M 00053 00052 00016                                                    02490
S 00054 00049 00053                                                    02491
D 00055 00054 00017                                                    02492
A 00056 00055 00014                                                    02493
S 00057 00056 00014          (57)=R+50                                 02494
M 00058 00057 00017                                                    02495
S 00059 00054 00058                                                    02496
A 00060 00059 00014                                                    02497
S 00060 00060 00014          (61)=S+50                                 02498
R 00082 00031                A                                         02499
R 00083 00047                    P                                     02500
S 00084 00052 00018          Q                                         02501
S 00085 00057 00018          R                                         02502
S 00086 00060 00018          S                                         02503
R 00087 00023                COS OR SIN                                02504
D 00065 00033 00015                                                    02505
A 00066 00065 00014                                                    02506
S 00066 00066 00014          (66)=I                                    02507
M 00067 00066 00015                                                    02508
S 00068 00033 00067                                                    02509
D 00069 00068 00016                                                    02510
A 00070 00069 00014                                                    02511
S 00070 00070 00014          (70)=J+50                                 02512
M 00071 00070 00016                                                    02513
S 00072 00068 00071                                                    02514
D 00073 00072 00017                                                    02515
A 00074 00073 00014                                                    02516
S 00074 00074 00014          (74)=K+50                                 02517
M 00075 00074 00017                                                    02518
S 00076 00072 00075                                                    02519
A 00076 00076 00014                                                    02520
```

```
  S C0076 CC076 C0014              (76)=L+50                                  02521
  S 00088 C0066 CC018              I                                          02522
  S C0089 CC070 CC018              J                                          02523
  S 00C90 CC074 CC018              K                                          02524
  S 00091 0C076 C0018              L                                          02525
  F 00000 00101 00082                                                         02526
  A 00027 C0027 C0011                                                         02527
• B 00036                                                      B 00036      02528
  C C0040 00028 C0035              I I TO 35                                  02529
  C 00025 00027 00029              I K TO 29                                  02530
  E C0002                                                                     02531
* B 00039                                                      B 00039      02532
  A 00027 CC027 C0011                                                         02533
  E 00036                                                                     02534
• B 00095                                                      B 00095      02535
  R 90700 99000                                                               02536
  R 90701 990C1                                                               02537
  R 90702 99002                                                               02538
  R 90703 99003                                                               02539
  E 00094                                                                     02540
  K 00100                                                                     02541
   TERM PRINT RCUTINE                                                         02542
• B C0001                                                      B C0001      02543
  G 00015 00001 CC003                                                         02544
  F 00019 00121 0C015                                                         02545
  S 00020 C0020 00011                                                         02546
  R C0016 00011                                                               02547
  C C0019 00010 CC007 CC006                                                   02548
  R 00030 0C010                                                               02549
  R 00031 0C010                                                               02550
  E 00008                                                                     02551
• B C0006                                                      B 00006      02552
  S 00016 00010 00011                                                         02553
  S C0019 00010 0C019                                                         02554
* B C0007                                                      B 00007      02555
  D 00030 00019 CC012                                                         02556
  A C0030 00030 00013                                                         02557
  S 00030 00030 0C013                                                         02558
  M C0031 00030 0C012                                                         02559
  S 00031 00019 0C031                                                         02560
```

```
  M 00030 00030 00016
• B 00008                                                              B 00008
  R 00029 00030
  R 00030 00031
  G 00017 00006 00003
  G 00031 00041 00017
  G 00032 00002 00003
  G 00033 00003 00003
  G 00034 00004 00003
  G 00035 00005 00003
  G 00036 00007 00003
  G 00037 00008 00003
  G 00038 00009 00003
  G 00039 00010 00003
  F 00033 00051 00033
  F 00034 00051 00034
  F 00035 00051 00035
  F 00036 00051 00036
  F 00037 00051 00037
  F 00038 00051 00038
  F 00039 00051 00039
      T
  P 00020 00011 TA    0808C3                      SSN
      T   .        X 10 X    ( A  B  C  D  E  F  G  H)
  P 00029 00011 TA  1 0102080904030103010301030103010301030103SNNSANSASASASASASA
                      0103                        SA
      T
  P 00000 00011 TA
  P 00000 00011 TA
  E 00002
  V 00010 +00000000+00
  V 00011 +10000000+01
  V 00012 +10000000+08
  V 00013 +67108864+08
  W 00040  SIN
  W 00041
  W 00042  COS
  K 00050
   PROGRAM TO CONVERT NUMERIC TO ALPHA
• B 00001                                                              B 00001
```

```
  G 00006 00001 CCCC3                                                    02601
  R C0018 CC016                                                          02602
  C 00006 00011 00005                                                    02603
  R C0018 CC017                                                          02604
  S C0006 00010 CC006                                                    02605
• B C0005                                                    B 00005     02606
  D 00007 00006 C0012                                                    02607
  A CCCC7 CC007 C0015                                                    02608
  S C0008 0C007 CC015                                                    02609
  M C0008 CC008 C0012                                                    02610
  S C0009 CC006 CCC08                                                    02611
  M C0018 00018 CCC13                                                    02612
  A C0018 C0018 CCC08                                                    02613
  A 00018 CC018 C0014                                                    02614
  M 00018 CC018 CCC13                                                    02615
  A C0018 CC018 CCC09                                                    02616
  A C0018 C0018 C0014                                                    02617
  H 00001 CCC04 C0018                                                    02618
  F C0002                                                                02619
  V 00010 +COCCCCCC+0C                                                   02620
  V 00011 -10CCCCCC+01                                                   02621
  V 00012 +100CCCCC+02                                                   02622
  V 00013 +1000CCCC+03                                                   02623
  V C0014 +9CCCCCCC+02                                                   02624
  V 00015 +67108864+08                                                   02625
  W 00016     +                                                          02626
  W C0017     -                                                          02627
  K C0050                                                                02628
        PRINT OUT MEMCRY                                                 02629
  Q 90000 49152                    PATHFINDER                            02630
  Q 9C008 CC008                                                          02631
  Q 00031 CCCC1                                                          02632
  Q 00032 CCCC2                                                          02633
  Q 00033 CCCC3                                                          02634
  Q 00034 CCCC4                                                          02635
  Q 00035 CCCC5                                                          02636
  V C0003 +COCCCCCC+0C                                                   02637
  V C0004 +452CCCC0+05                                                   02638
• B 00001                PRINT OUT MEMORY PROGRAM USES LOCATIONS 1 TO 148  B 00001  02639
  R 00150 9C008                                                          02640
```

```
R 90008 00149                                                                    02641
    T  MYSTIC FLOATING POINT DECIMAL MEMORY PRINT  FIVE PER LINE                 02642
P 00001 00008 TA                                                                 02643
    T                                                                            02644
P 00001 00008 TA                                                                 02645
R 00010 00003                                                                    02646
S 00010 00010 00007                                                              02647
    T     PATHFINDER REACS                                                       02648
P 90000 00008 TA    0505050706                          SSSSN                    02649
    T                                                                            02650
P 00001 00008 TA                                                                 02651
• B 00005                                                          B 00005       02652
A 00010 00010 00007                                                              02653
S 00010 00010 00008                                                              02654
G 00011 00031 00010                                                              02655
G 00013 00032 00010                                                              02656
G 00015 00033 00010                                                              02657
G 00017 00034 00010                                                              02658
G 00019 00035 00010                                                              02659
C 00011 00009 00006 00006                                                        02660
C 00013 00009 00006 00006                                                        02661
C 00015 00009 00006 00006                                                        02662
C 00017 00009 00006 00006                                                        02663
C 00019 00009 00006 00006                                                        02664
A 00010 00010 00008                                                              02665
C 00004 00010 00005                                                              02666
I 00003 +C00C0000+00                                                             02667
I 00004 +45200C00+05                                                             02668
R 90008 00150                                                                    02669
E 00002                                                                          02670
• B 00006                                                          B 00006       02671
F 00011 00021 00011                                                              02672
F 00013 00021 00013                                                              02673
F 00015 00021 00015                                                              02674
F 00017 00021 00017                                                              02675
F 00019 00021 00019                                                              02676
A 00010 00010 00008                                                              02677
P 00010 00008 TA    0602C9030109030109030109030109030    NSNNSNNSNNSNNSNN         02678
C 00004 00010 00005                                                              02679
I 00003 +0000C000+00                                                             02680
```

```
  I C0004 +45200CC0+05                                                    02681
  R 9C0C8 00150                                                           02682
  E C0002                                                                 02683
  V 00007 +50CCCC00+01                                                    02684
  V 00008 +100CCCC0+01                                                    02685
  V C0009 +00CCCCOC+0C                                                    02686
  K C0020                                                                 02687
* B 00001              CUTPUT CONVERTER USES LOCATIONS 1 TO 128    B 00001  02688
  I C0005 +10000CCC+01                                                    02689
  I 00006 +10CCCCC0+02                                                    02690
  I 00007 +67108864+08                                                    02691
  A 00007 CC007 C0007                                                     02692
  I 00008 +CCCCC000+0C                                                    02693
  D C0009 00005 CC007                                                     02694
  I C0011 +450CCCC0+02                                                    02695
  H 00030 00008 C0009                                                     02696
* N C0001                                                      N 00001  02697
  A C0008 C0008 CCC05                                                     02698
  M C0009 CC0C9 CCC06                                                     02699
  H 00030 C0008 00C09                                                     02700
  C C0011 00008 00001                                                     02701
  I C0005 +000CCCC0+00                                                    02702
  I 00006 +67108864+08                                                    02703
  A 00006 0C006 0C006                                                     02704
  I C00C7 +100C0CC0+01                                                    02705
  I 00008 +70000CC0+01                                                    02706
  I 00009 +50CCCC00+01                                                    02707
* N 00001                                                      N 00001  02708
  V C0017 +10CCCC00+09                                                    02709
  V 00018 +99999999+07                                                    02710
  V 00019 +80CCCC00+01                                                    02711
  G 00010 00001 C0003                                                     02712
  A 00010 0C005 00010                                                     02713
  I 00025 +10000CC0+01                                                    02714
  C 00010 0C0C5 C0020                                                     02715
  S 00010 0C005 C0010                                                     02716
  I 00025 -1000CCC0+01                                                    02717
  C 0C010 00005 0C020                                                     02718
* B 00129                                                      B 00129  02719
  H 00001 0C004 00005                                                     02720
```

```
  H 00002 00004 00005                      02721
  E 00002                                  02722
• B 00020                        B 00020   02723
  C 00007 00010 00022                      02724
  F 00012 00076 00010                      02725
  C 00012 00008 00021                      02726
  S 00011 00008 00012                      02727
  G 00013 00030 00011                      02728
  M 00014 00010 00013                      02729
  M 00015 00014 00006                      02730
  A 00012 00012 00007                      02731
  E 00023                                  02732
* B 00021                        B 00021   02733
  S 00011 00012 00008                      02734
  G 00013 00030 00011                      02735
  D 00014 00010 00013                      02736
  D 00015 00014 00006                      02737
  A 00012 00012 00007                      02738
  A 00015 00015 00009                      02739
  C 00015 00018 00023                      02740
  A 00015 00015 00009                      02741
  E 00023                                  02742
• B 00022                        B 00022   02743
  D 00016 00007 00010                      02744
  F 00012 00076 00016                      02745
  A 00011 00012 00019                      02746
  S 00012 00005 00012                      02747
  G 00013 00030 00011                      02748
  M 00014 00010 00013                      02749
  M 00015 00014 00006                      02750
  C 00017 00015 00023                      02751
  G 00013 00029 00011                      02752
  M 00015 00010 00013                      02753
  A 00012 00012 00007                      02754
• B 00023                        B 00023   02755
  M 00015 00015 00025                      02756
  H 00001 00004 00015                      02757
  H 00002 00004 00012                      02758
  E 00002                                  02759
• B 00076                        B 00076   02760
```

```
  G 00080 CC076 C0078                                                    02761
  R 00081 C0082                                                          02762
  R 00084 CC005                                                          02763
• B C0085                                                      B 00085   02764
  D 00081 C0081 C0083                                                    02765
  C 00007 00081 C0086                                                    02766
  A C0084 C0084 C0081                                                    02767
  C 00084 CC090 C0089                                                    02768
  G 00087 CC091 CC084                                                    02769
  C 00080 C0087 C0085                                                    02770
  S 00084 CC084 CC081                                                    02771
  C 00087 00080 CC085                                                    02772
  A C0084 CC084 C0081                                                    02773
• B 00086                                                      B 00086   02774
  H C0076 00079 C0084                                                    02775
  E 00077                                                                02776
  V 00028 +1CCCCCCC+08                                                   02777
  V 00082 +64CCCCCC+02                                                   02778
  V C0083 +2CCCCCCC+01                                                   02779
• B 00089                                                      B 00089   02780
  S 00084 C0084 C0081                                                    02781
  E 00085                                                                02782
  V 00090 +37CCCCCC+02                                                   02783
  V 00091 +1CCCCCCC+01                                                   02784
  V 00092 +1CCCCCCC+02                                                   02785
  V 00093 +1CCCCCCC+03                                                   02786
  V 00094 +1CCCCCCC+04                                                   02787
  V C0095 +1CCCCCCC+05                                                   02788
  V 00096 +1CCCCCCC+06                                                   02789
  V 00097 +1CCCCCCC+C7                                                   02790
  V 00098 +1CCCCCCC+08                                                   02791
  V 00099 +1CCCCCCC+09                                                   02792
  V 00100 +1CCCCCCC+1C                                                   02793
  V C0101 +1CCCCCCC+11                                                   02794
  V C0102 +1CCCCCCC+12                                                   02795
  V 00103 +1CCCCCCC+13                                                   02796
  V 00104 +1CCCCCCC+14                                                   02797
  V 00105 +1CCCCCCC+15                                                   02798
  V 00106 +1CCCCCCC+16                                                   02799
  V 00107 +1CCCCCCC+17                                                   02800
```

```
V 00108 +1CCCCCCC+18                                                    02801
V 00109 +1CCCCCCC+19                                                    02802
V 00110 +1CCCCCCC+2C                                                    02803
V 00111 +1CCCCCCC+21                                                    02804
V 00112 +1CCCCCCC+22                                                    02805
V 00113 +1CCCCCCC+23                                                    02806
V 00114 +1CCCCCCC+24                                                    02807
V 00115 +1CCCCCCC+25                                                    02808
V 00116 +1CCCCCCC+26                                                    02809
V 00117 +1CCCCCCC+27                                                    02810
V 00118 +1CCCCCCC+28                                                    02811
V 00119 +1CCCCCCC+29                                                    02812
V 00120 +1CCCCCCC+30                                                    02813
V 00121 +1CCCCCCC+31                                                    02814
V 00122 +1CCCCCCC+32                                                    02815
V 00123 +1CCCCCCC+33                                                    02816
V 00124 +1CCCCCCC+34                                                    02817
V 00125 +1CCCCCCC+35                                                    02818
V 00126 +1CCCCCCC+36                                                    02819
V 00127 +1CCCCCCC+37                                                    02820
V 00128 +1CCCCCCC+38                                                    02821
K 00000                                                                 02822
V 00602 +42200000+03                                                    02823
V 00696 +10100000+03                                                    02824
V 00691 +181CCCCC+03                                                    02825
V 41520 +20000000+01                                                    02826
                                                                        02827
                                                                        02828
                                                                        02829
                                                                        02830
30 41101                                                                02831
                                                                        02832
                                                                        02833
                                                                        02834
                                                                        02835
                                                                        02836
                                                                        02837
                                                                        02838
                                                                        02839
                                                                        02840
```

K = CCCOO LINE 02841 PAGE 072

02841
02842
02843

K = CCOOO LINE 02844 PAGE 072

FUNCTION INDEX BY PAGE

K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE
00050	001	00004									
00070	001	00028									
00100	003	00084									
00110	004	00133									
00115	004	00141									
00120	004	00149									
00125	004	00157									
00130	005	00164									
00135	005	00172									
00140	005	00180									
00145	005	00188									
00150	005	00196									
00155	006	00204									
00180	006	00212									
00200	008	00307									
41600	028	01088									
41000	028	01099									
41100	029	01144									
45000	061	02426									
45100	064	02541									
45150	065	02598									
45200	066	02628									
45220	068	02687									

FUNCTION INDEX BY K-CARD

K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE
00050	001	00004									
00070	001	00028									
00100	003	00084									
00110	004	00133									
00115	004	00141									
00120	004	00149									
00125	004	00157									
00130	005	00164									
00135	005	00172									
00140	005	00180									
00145	005	00188									
00150	005	00196									
00155	006	00204									
00180	006	00212									
00200	008	00307									
41000	028	01099									
41100	029	01144									
41600	028	01088									
45000	061	02426									
45100	064	02541									
45150	065	02598									
45200	066	02628									
45220	068	02687									

FUNCTION INDEX BY K-CARD

K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE	K =	PAGE	LINE
00050	001	00004									
00070	001	00028									
001C0	003	00084									
00110	004	00133									
00115	004	00141									
00120	004	00149									
00125	004	00157									
00130	005	00164									
00135	005	00172									
00140	005	00180									
00145	005	00188									
00150	005	00196									
00155	006	00204									
00180	006	00212									
002C0	008	00307									
41000	028	01099									
41100	029	01144									
416C0	028	01088									
45000	061	02426									
451C0	064	02541									
45150	065	02598									
452C0	066	02628									
45220	068	02687									

Appendix B

Explanation of Program Commands

Table B1

CAMEO Codes for Alphanumeric Characters.

Character	Card Code	Octal Code	CAMEO Code
Blank	Blank	60	00
.	12-3-8	33	18
)	12-4-8	34	19
+	12	20	20
$	11-3-8	53	28
*	11-4-8	54	29
-	11	40	30
/	0-1	61	31
,	0-3-8	73	38
(	0-4-8	74	39
=	3-8	72	48
'	4-8	14	49
A	12-1	21	61
B	12-2	22	62
C	12-3	23	63
D	12-4	24	64
E	12-5	25	65
F	12-6	26	66
G	12-7	27	67
H	12-8	30	68
I	12-9	31	69
J	11-1	41	71
K	11-2	42	72
L	11-3	43	73
M	11-4	44	74
N	11-5	45	75
O	11-6	46	76
P	11-7	47	77
Q	11-8	50	78
R	11-9	51	79
S	0-2	62	82
T	0-3	63	83
U	0-4	64	84
V	0-5	65	85
W	0-6	66	86

Table B1

CAMEO Codes for Alphanumeric Characters.

Character	Card Code	Octal Code	CAMEO Code
Blank	Blank	60	00
.	12-3-8	33	18
)	12-4-8	34	19
+	12	20	20
$	11-3-8	53	28
*	11-4-8	54	29
-	11	40	30
/	0-1	61	31
,	0-3-8	73	38
(	0-4-8	74	39
=	3-8	72	48
'	4-8	14	49
A	12-1	21	61
B	12-2	22	62
C	12-3	23	63
D	12-4	24	64
E	12-5	25	65
F	12-6	26	66
G	12-7	27	67
H	12-8	30	68
I	12-9	31	69
J	11-1	41	71
K	11-2	42	72
L	11-3	43	73
M	11-4	44	74
N	11-5	45	75
O	11-6	46	76
P	11-7	47	77
Q	11-8	50	78
R	11-9	51	79
S	0-2	62	82
T	0-3	63	83
U	0-4	64	84
V	0-5	65	85
W	0-6	66	86

Table B1 (Cont'd)

Character	Card Code	Octal Code	CAMEO Code
X	0-7	67	87
Y	0-8	70	88
Z	0-9	71	89
Zero	0	00	90
1	1	01	91
2	2	02	92
3	3	03	93
4	4	04	94
5	5	05	95
6	6	06	96
7	7	07	97
8	8	10	98
9	9	11	99

Table B2

CAMEO Operators to Control Encoding for the Advanced Mystic Machine.

Name	Symbol	Effect on Encoding Control Registers
Key	K(0)	Clear the Q-table of all previous entries and set the K register to zero.
Key	K(p)	Add the number p to the K register.
Origin	O(p)	Set the L register to the number p.
Cue	Q(p, q)	Add the pair p, q to the Q-table of address equivalents.
Transfer	30(p)	Terminate encoding and begin execution of the compiled program at location p.

Table B3

CAMEO Operators to Support Encoding for the Advanced Mystic Machine.

Name	Symbol	Function in Support of Encoding
Begin-point	B(p)	Make location p a logical flow connector for the commands which follow.
Value-given	V(p, m, n)	Record in location p the floating point number (m, n) for use as a given value in the object program.
Word-given	W(p, l)	Record in location p the symbol l as a coded floating point integer for use as a given word in the object program.

Table B4

CAMEO Operators Representing Advanced Mystic Commands.

Name	Symbol	Advanced Mystic Command
Add	A(p, q, r)	Add the contents of locations q and r and place the sum into location p.
$Compare_1$	C(p, q, r, s)	Compare the contents of location p with the contents of location q. If contents-of-p exceeds contents-of-q transfer to location r, if contents-of-q exceeds contents-of-p transfer to location s, if contents-of-p equals contents-of-q continue with next instruction.
$Compare_2$	C(p, q, r)	Compare the contents of p and the contents of q. If contents-of-p exceeds contents-of-q, transfer to location r. Otherwise continue.
Divide	D(p, q, r)	Divide the contents of location q by the contents of location r and place the quotient into location p.
End	E(p)	Exit from the current instruction sequence by transferring to location p.
Function (Note 1)	F(p, q, r)	Store in location q + 1 the point-of-return, in cell q + 2 the number r - q, in cell q + 3 the number p - q, and transfer to location q.

Table B4 (Cont'd)

Name	Symbol	Advanced Mystic Command
Get	G(p, q, r)	Get into location p the contents of the location specified by the number q plus the contents of location r.
Hold	H(p, q, r)	Hold the contents of location r in the location specified by the number p plus the contents of location q.
Initialize	I(p, m, n)	Initialize location p to the value (m, n) a normalized floating point number.
Jump	J(p)	Jump to the program in system storage designated by the contents of location p.
$Load_1$ (Notes 2, 4)	L(p, q, a, b, $c_1 \ldots c_{18}$, $d_1 \ldots d_{18}$)	Load into successive locations beginning with p, contents-of-q records from the alphanumeric input medium indicated by a; where the i-th word in each record is the integer equivalent of an input field, c_i characters long, of type d_i, and b such sets of field descriptors follow in succeeding command records.
$Load_2$ (Notes 2, 4)	L(p, q, r)	Load into successive locations beginning with p, contents-of-q words from the machine-word input medium indicated by r.
Multiply	M(p, q, r)	Multiply the contents of locations q and r and place the product into location p.
Name	N(p)	Name location p a logical flow connector for the coding which follows.
$Print_1$ (Notes 3, 4, 5)	P(p, q, a, b $c_1 \ldots c_{18}$, $d_1 \ldots d_{18}$)	Print from successive locations beginning with p, contents-of-q entitled records on the alphanumeric medium indicated by a; where the i-th field of each record, c_i characters long, of type d_i is determined from the i-th integer of the record, and b such sets of field descriptors follow in succeeding command records.
$Print_2$	P(p, q, r)	Print from successive locations beginning with p, contents-of-q words on the machine-word-output medium indicated by r.

Table B4 (Cont'd)

Name	Symbol	Advanced Mystic Command
Replace	R(p, q)	Replace the contents of location p by the contents of location q.
Subtract	S(p, q, r)	Subtract the contents of location r from the contents of location q and place remainder into location p.
Title	$T(t_1 \ldots t_{71})$	Load the title register positions 1-71 with characters t_1 to t_{71}.
Unpack	U(p, q)	Unpack the integer portion of the floating point number stored in location q and store the integer in location p. The contents of location q remain unaltered.
Xtracode	$X(p, x_1 \ldots x_{13})$	Transfer to the machine language subroutine located at p, with interface vector $x_1 \ldots x_{13}$.

(Note 1)	This instruction makes it possible to transfer to a function and after its execution, continue to the next instruction. Normally r contains the input to the function and p is to contain the output.
(Note 2)	In case the input medium is tape, a special interpretation is placed on the contents of q as follows: if q is zero backspace one file, if q is the negative integer -n, backspace n records.
(Note 3)	In case the output medium is tape, a special interpretation is placed on the contents of q as follows: if a is zero, write end-of-file; if q is negative, rewind.
(Note 4)	The field a contains four characters. The leftmost is one of (C, P, T) for Card, Printer, Tape, respectively. The next is one of (A, B, C, D, E, F, G, H, I) for selection of units within the type. The next is either blank or B, for decimal or (Binary) machine-word, respectively. The field $c_1 \ldots c_{18}$ consists of eighteen two-digit numbers. The field $d_1 \ldots d_{18}$ consists of eighteen letters, where each is one of (A, N, F, S) for Alphabetic, Numeric, Full-numeric and Skipped. In case d_i is A, c_i must not exceed 4; in case d_i is N, c_i must not exceed 9; in case d_i is F, c_i must not exceed 8; when d_i is S, c_i may be as large as 15.
(Note 5)	An entitled record is the logical sum of the given record and the contents of the title register.

Table B5

CAMEO Operators to Utilize 1107 Drum.

Name	Symbol	Advanced Mystic Command
Drum Clear	Y00001(p)	Clear drum and set up drum I/O. p, the maximum number of cells allowed for a series, is (nominally 10,000).
Drum Read	Y00002(p)(q)r	Read from drum storage to main memory: p, series number,* q, main memory destination of series, and r, alternate return point for zero series.
Drum Write	Y00003(p)(q)r	Write series on drum from main memory: p, series number,* q, number of words in series,** and r, absolute memory location of series.

*Each series placed on the drum is tagged with a number between 1 and 50. This number multiplied by p from Y00001 determines the drum location of the series.

**This number is stored according to the series number in absolute memory locations 1 thru 50 after each drum write.

Appendix C

Sample Series Printout

IV IV [illegible]

$-4.9917579 \times 10^{-01} \times$ COS(00A+01B+01C+01D+01E+00F+00G+00H)

$4.9917579 \times 10^{-01} \times$ COS(00A+01B-01C+01D-01E+00F+00G+00H)

$4.1175244 \times 10^{-02} \times$ COS(00A+01B+01C+01D+00E+00F+00G+00H)

$-4.1175244 \times 10^{-02} \times$ COS(00A+01B-01C+01D+00E+00F+00G+00H)

$-1.3694059 \times 10^{-02} \times$ COS(00A+01B+01C+01D+02E+00F+00G+00H)

$1.3694059 \times 10^{-02} \times$ COS(00A+01B-01C+01D-02E+00F+00G+00H)

$1.2575207 \times 10^{-02} \times$ COS(00A+00B+01C+01D+01E+00F+00G+00H)

$-1.2575207 \times 10^{-02} \times$ COS(00A+00B+01C-01D+01E+00F+00G+00H)

$-4.1908492 \times 10^{-03} \times$ COS(00A+02B+01C+01D+01E+00F+00G+00H)

$4.1908492 \times 10^{-03} \times$ COS(00A+02B-01C+01D-01E+00F+00G+00H)

$-1.0372843 \times 10^{-03} \times$ COS(00A+00B+01C+01D+00E+00F+00G+00H)

$1.0372843 \times 10^{-03} \times$ COS(00A+00B+01C-01D+00E+00F+00G+00H)

$-5.6351070 \times 10^{-04} \times$ COS(00A+01B+01C+01D+03E+00F+00G+00H)

$5.6351070 \times 10^{-04} \times$ COS(00A+01B-01C+01D-03E+00F+00G+00H)

$3.4568832 \times 10^{-04} \times$ COS(00A+02B+01C+01D+00E+00F+00G+00H)

$-3.4568832 \times 10^{-04} \times$ COS(00A+02B-01C+01D+00E+00F+00G+00H)

$$3.4497995 \times 10^{-04} \times \cos(00A+0CB+01C+01D+02E+00F+00G+00H)$$

$$-3.4497995 \times 10^{-04} \times \cos(00A+0CB+01C-01D+02E+00F+00G+00H)$$

$$-1.8859974 \times 10^{-04} \times \cos(00A+01B+01C+01D-01E+00F+00G+00H)$$

$$1.8859974 \times 10^{-04} \times \cos(00A+01B-01C+01D+01E+00F+00G+00H)$$

$$-1.1496899 \times 10^{-04} \times \cos(00A+02B+01C+01D+02E+00F+00G+00H)$$

$$1.1496899 \times 10^{-04} \times \cos(00A+02B-01C+01D-02E+00F+00G+00H)$$

$$-5.2776650 \times 10^{-05} \times \cos(00A+03B+01C+01D+01E+00F+00G+00H)$$

$$5.2776650 \times 10^{-05} \times \cos(00A+03B-01C+01D-01E+00F+00G+00H)$$

$$-2.7482634 \times 10^{-05} \times \cos(00A+01B+01C+01D+04E+00F+00G+00H)$$

$$2.7482634 \times 10^{-05} \times \cos(00A+01B-01C+01D-04E+00F+00G+00H)$$

$$1.7603356 \times 10^{-05} \times \cos(00A+01B+01C-01D+01E+00F+00G+00H)$$

$$-1.7603356 \times 10^{-05} \times \cos(00A+01B-01C-01D-01E+00F+00G+00H)$$

$$1.4195928 \times 10^{-05} \times \cos(00A+0CB+01C+01D+03E+00F+00G+00H)$$

$$-1.4195928 \times 10^{-05} \times \cos(00A+0CB+01C-01D+03E+00F+00G+00H)$$

$$4.7511939 \times 10^{-06} \times \cos(00A+0CB+01C+01D-01E+00F+00G+00H)$$

$$-4.7511939 \times 10^{-06} \times \cos(00A+0CB+01C-01D-01E+00F+00G+00H)$$

$$-4.7309754 \times 10^{-06} \times \cos(00A+02B+01C+01D+03E+00F+00G+00H)$$

$$4.7309754 \times 10^{-06} \times \cos(00A+02B-01C+01D-03E+00F+00G+00H)$$

$$4.3533591 \times 10^{-06} \times \cos(00A+03B+01C+01D+00E+00F+00G+00H)$$

$$-4.3533591 \times 10^{-06} \times \cos(00A+03B-01C+01D+00E+00F+00G+00H)$$

$$-3.4510529 \times 10^{-06} \times \cos(00A+01B+01C+01D-02E+00F+00G+00H)$$

$$3.4510529 \times 10^{-06} \times \cos(00A+01B-01C+01D+02E+00F+00G+00H)$$

$$-1.5833963 \times 10^{-06} \times \cos(00A+02B+01C+01D-01E+00F+00G+00H)$$

$$1.5833963 \times 10^{-06} \times \cos(00A+02B-01C+01D+01E+00F+00G+00H)$$

$$-1.4725399 \times 10^{-06} \times \cos(00A+01B+01C+01D+05E+00F+00G+00H)$$

$$1.4725399 \times 10^{-06} \times \cos(00A+01B-01C+01D-05E+00F+00G+00H)$$

$$-1.4520386 \times 10^{-06} \times \cos(00A+01B+01C-01D+00E+00F+00G+00H)$$

$$1.4520386 \times 10^{-06} \times \cos(00A+01B-01C-01D+00E+00F+00G+00H)$$

$$-1.4478398 \times 10^{-06} \times \cos(00A+03B+01C+01D+02E+00F+00G+00H)$$

$$1.4478398 \times 10^{-06} \times \cos(00A+03B-01C+01D-02E+00F+00G+00H)$$

$$-7.8771268 \times 10^{-07} \times \cos(00A+04B+01C+01D+01E+00F+00G+00H)$$

$$7.8771268 \times 10^{-07} \times \cos(00A+04B-01C+01D-01E+00F+00G+00H)$$

$$6.9234092 \times 10^{-07} \times \cos(00A+0CB+01C+01D+04E+0QF+00G+00H)$$

$$-6.9234092 \times 10^{-07} \times \cos(00A+0CB+01C-01D+04E+00F+00G+00H)$$

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