

Análise de Antenas

Prof. Fernando J. S. Moreira

Lista 1 - Entregar dia 09 de outubro de 2024.

0 - Estudar o Capítulo 3 do "Balanis de Antenas", 4a. Edição.

1 - Considere os pontos $P_1 = (3, 2, 1)$ e $P_2 = (-1, -2, -3)$, localizados pelas respectivas coordenadas Cartesianas (x, y, z) . Determine (usando sempre que necessário a notação $\vec{v} = v_x\hat{x} + v_y\hat{y} + v_z\hat{z}$):

- a) os vetores posição $\vec{P}_1$ e $\vec{P}_2$;
- b) o vetor $\vec{R}$ apontando de P_1 para P_2 ;
- c) o vetor unitário $\hat{R}$, onde $\vec{R} = |\vec{R}|\hat{R}$;
- d) o ângulo entre $\hat{R}$ e $\hat{x}$.

2 - O vetor $\vec{a} = \hat{x}$ é calculado no ponto $x = 3$, $y = 3/\sqrt{3}$ e $z = 6/\sqrt{3}$. Expresse $\vec{a}$ em vetores de base

- a) cilíndricos ($\vec{a} = a_\rho\hat{\rho} + a_\phi\hat{\phi} + a_z\hat{z}$)
- b) e esféricos ($\vec{a} = a_r\hat{r} + a_\theta\hat{\theta} + a_\phi\hat{\phi}$).

3 - Balanis, problema 3.5 (4a. Edição).

4 - Em problemas envolvendo radiação de campos eletromagnéticos, é importante não confundir as coordenadas do ponto de *observação* (representado pelo vetor posição $\vec{r}$) com as do ponto que localiza uma fonte de corrente (vetor posição $\vec{r}'$). Prove que:

$$\nabla\Psi = -\left(jk + \frac{1}{|\vec{r} - \vec{r}'|}\right) \frac{(\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|} \Psi = -\nabla'\Psi,$$

onde os operadores ∇ e ∇' operam sobre $\vec{r}$ e $\vec{r}'$, respectivamente, e

$$\Psi = \frac{\exp(-jk|\vec{r} - \vec{r}'|)}{|\vec{r} - \vec{r}'|}.$$

5 - Mostre que

$$\begin{aligned}
 (\vec{J} \cdot \nabla) \nabla \Psi &= J_x \frac{\partial}{\partial x} \nabla \Psi + J_y \frac{\partial}{\partial y} \nabla \Psi + J_z \frac{\partial}{\partial z} \nabla \Psi \\
 &= \left[\left(\frac{3}{|\vec{r} - \vec{r}'|^2} + \frac{j3k}{|\vec{r} - \vec{r}'|} - k^2 \right) \frac{[\vec{J} \cdot (\vec{r} - \vec{r}')] (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|} \right. \\
 &\quad \left. - \left(\frac{1}{|\vec{r} - \vec{r}'|} + jk \right) \vec{J} \right] \frac{\Psi}{|\vec{r} - \vec{r}'|}.
 \end{aligned}$$

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Lista 2 - Entregar dia 16 de outubro de 2024.

0 - Estudar Capítulos 2 e 3 do Balanis, 4a. Edição.

1 - Balanis, problema 2.7 (4a. Edição).

2 - Balanis, problema 2.33 (4a. Edição), itens a–d.

3 - O campo distante para qualquer antena *finita* (tem que ser finita, senão não podemos definir uma região de campo distante) pode ser representado através da seguinte notação fasorial de onda TEM esférica:

$$\begin{aligned}\vec{E}(\vec{r}) &= \left[F(\theta, \phi) \hat{\theta} + P(\theta, \phi) \hat{\phi} \right] \exp(-jkr)/r, \\ \vec{H}(\vec{r}) &= \left[\hat{r} \times \vec{E}(\vec{r}) \right] / \eta,\end{aligned}$$

onde $\eta \approx 120\pi \Omega$ para o vácuo. Um modelo muito utilizado para representar (aproximadamente) a radiação dos alimentadores utilizados em antenas refletoras é o modelo *coseno-elevado* (RCF–*Raised Cosine Feed*), dado por:

$$\begin{aligned}F(\theta, \phi) &= \begin{cases} \cos^e \theta \cos \phi, & \text{para } \theta \leq 90^\circ, \\ 0, & \text{para } \theta > 90^\circ, \end{cases} \\ P(\theta, \phi) &= \begin{cases} -\cos^h \theta \sin \phi, & \text{para } \theta \leq 90^\circ, \\ 0, & \text{para } \theta > 90^\circ, \end{cases}\end{aligned}$$

onde os parâmetros e e h controlam o *formato* do diagrama do alimentador nos planos $y = 0$ e $x = 0$, respectivamente (note que o máximo de radiação ocorre na direção $\hat{z}$). Para o modelo RCF, determine:

- o fasor campo distante $\vec{H}$;
- a densidade de potência média;
- a potência radiada;
- a diretividade (incluindo seu valor máximo e a direção onde este ocorre).
- Substitua $\vec{E}$ e $\vec{H}$ nas equações de Maxwell fasoriais (meios sem fontes) e discuta sobre as condições necessárias para que o modelo RCF seja Maxwelliano.

4 - Continuando o problema anterior e assumindo $e = h$, determine:

- a) o valor de e para uma diretividade (máxima) de 10 dB;
- b) a largura de meia potência do diagrama de radiação para este $e = h$;
- c) a polarização deste alimentador (na direção $\theta = 0^\circ$). Dica: utilize a base Cartesiana pois a coordenada ϕ não é definida na direção $\theta = 0^\circ$.

5 - Na lista anterior você provou que:

$$\nabla \Psi = - \left(jk + \frac{1}{|\vec{r} - \vec{r}'|} \right) \frac{(\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|} \Psi = -\nabla' \Psi ,$$

$$\begin{aligned} (\vec{J} \cdot \nabla) \nabla \Psi &= J_x \frac{\partial}{\partial x} \nabla \Psi + J_y \frac{\partial}{\partial y} \nabla \Psi + J_z \frac{\partial}{\partial z} \nabla \Psi \\ &= \left[\left(\frac{3}{|\vec{r} - \vec{r}'|^2} + \frac{j3k}{|\vec{r} - \vec{r}'|} - k^2 \right) \frac{[\vec{J} \cdot (\vec{r} - \vec{r}')] (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|} \right. \\ &\quad \left. - \left(\frac{1}{|\vec{r} - \vec{r}'|} + jk \right) \vec{J} \right] \frac{\Psi}{|\vec{r} - \vec{r}'|}, \end{aligned}$$

onde os operadores ∇ e ∇' operam sobre $\vec{r}$ e $\vec{r}'$, respectivamente, e

$$\Psi = \frac{\exp(-jk|\vec{r} - \vec{r}'|)}{|\vec{r} - \vec{r}'|} .$$

Com a ajuda destes resultados, substitua a integral de $\vec{A}$ em função da densidade de corrente $\vec{J}$ nas expressões de $\vec{E}$ e $\vec{H}$ de modo a obter integrais que forneçam o campo eletromagnético diretamente de $\vec{J}$ (ou seja, sem a necessidade de calcular $\vec{A}$ e as derivadas correspondentes). Dica: note que as integrais são avaliadas em $\vec{r}'$, enquanto que ∇ opera em $\vec{r}$. Logo, ∇ pode ser passado para dentro das integrais e $\vec{J}(\vec{r}')$ não é operada por ∇ .

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Lista 3 - Entregar dia 23 de outubro de 2024.

0 - Estudar Capítulos 2 e 3 do Balanis, 4a. Edição. Nas notas de aula, estudar Capítulos 2 e 3.

1 - Balanis, problemas 2.43, 2.44 e 2.45 (4a. Edição).

2 - Balanis, problema 2.48 (4a. Edição).

3 - Balanis, problema 2.104 (4a. Edição). Qual seria o resultado se uma das antenas tivesse polarização linear e a outra circular?

4 - Balanis, problema 2.107 (4a. Edição).

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Lista 4 - Entregar dia 30 de outubro de 2024.

- 0 - Estudar Seções 4.1–4.7 e 5.1–5.6 do Balanis, 4a. Edição.
- 1 - Balanis, problemas 4.2 e 4.10b (4a. Edição).
- 2 - Balanis, problema 4.20 (4a. Edição).
- 3 - Balanis, problema 4.34 (4a. Edição).
- 4 - Balanis, problemas 4.54 e 4.70 (4a. Edição).
- 5 - Balanis, problema 6.3 (4a. Edição). Repita o problema para a configuração dada na figura do problema 6.7, mantendo as mesmas excitações dos elementos.

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Lista 5 - Entregar dia 06 de novembro de 2024.

0 - Estudar Seções 6.1–6.12, 7.1, 7.2, 7.4, 7.5 (além de ler as introduções sobre os diferentes métodos do Capítulo 7) e 8.5–8.7 do Balanis, 4a. Edição.

1 - Balanis, problema 6.90 (4a. Edição). Não precisa fazer verificação computacional.

2 - Balanis, problema 6.94 (4a. Edição).

A seguir vem a primeira parte de um trabalho que consiste na elaboração de um programa para a análise de uma antena refletora através da Óptica Física. Você deve entregar as 6 partes do trabalho na data indicada pelo professor.

Trabalho (parte 1) - Assuma uma abertura circular de raio a (em metros), centrada na origem e localizada em $z = 0$. Nesta abertura existe uma distribuição superficial de corrente elétrica $\vec{J}_s$ ($= 1 \hat{x}$ A/m no presente caso) e, conseqüentemente, o campo distante radiado por esta corrente é dado por:

$$\begin{aligned}\vec{E}(\vec{r}) &\approx -j \frac{k\eta}{4\pi} \frac{e^{-jkr}}{r} \int_0^{2\pi} \int_0^a \left\{ \vec{J}_s(\vec{r}') - [\vec{J}_s(\vec{r}') \cdot \hat{r}] \hat{r} \right\} e^{jk\hat{r} \cdot \vec{r}'} \rho' d\rho' d\phi' \\ &= \left[E_\theta(\theta, \phi) \hat{\theta} + E_\phi(\theta, \phi) \hat{\phi} \right] \exp(-jkr)/r .\end{aligned}$$

Utilizando a linguagem de sua preferência, crie um programa para o cálculo das componentes E_θ e E_ϕ (sem o fator de onda esférica) em função da direção de observação θ e ϕ .

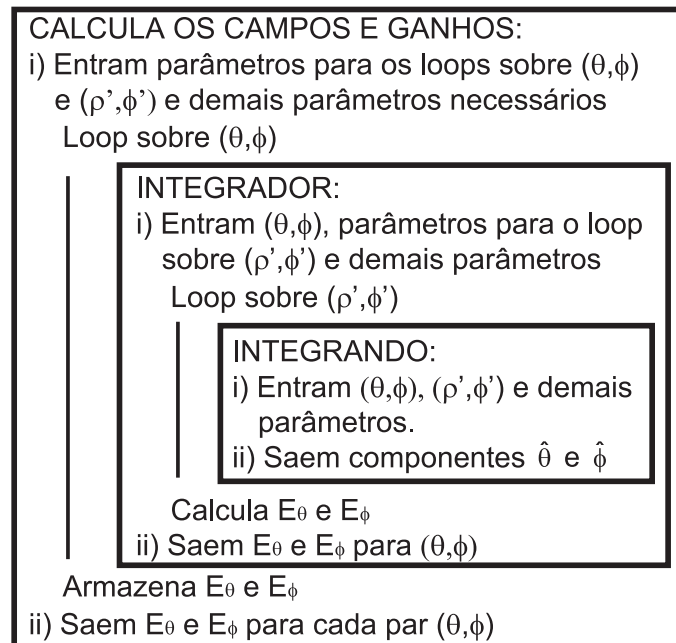
Lembre-se que esta é a primeira parte de um trabalho que tem como objetivo chegar a um programa para a análise de antenas refletoras através da Óptica Física. Tente seguir o fluxograma apresentado na figura abaixo.

Após a figura é apresentada uma rotina em FORTRAN (SMPSON) para o integrador (apenas como sugestão). Note que o Jacobiano ρ' já é incluído nesta rotina e não precisa ser levado em conta pela rotina do integrando (chamada aqui de SVINTGD). Note também que as integrais em ρ' e ϕ' são

avaliadas pelo método de Simpson. Além disso, o número de integrações em ϕ' é proporcional ao raio ρ' (assim, os anéis interiores terão menos pontos que os exteriores, uniformizando a grade). Os dados de entrada são RMIN (= 0 neste caso), RMAX (= a neste caso) e NRADAL (número de anéis usados para a integração). A saída é dada por ETOT (utilize as duas primeiras posições para armazenar E_θ e E_ϕ), HTOT (não vai ser usado), e PWRR (a ser usado no futuro para o cálculo da potência incidente no refletor).

Já que o presente caso tem solução analítica, utilize-a para depurar o programa. Assuma $a/\lambda = 50$.

Na data indicada pelo professor, para esta parte do trabalho você tem que fornecer o arquivo com a listagem do programa e também a listagem impressa, junto com gráficos dos módulos das componentes E_θ e E_ϕ (sem o fator de onda esférica), calculados numericamente e analiticamente (plote um resultado por cima do outro, para comparações), normalizados em decibéis, para $\phi = 0^\circ$ e 90° . Um gráfico para $-10^\circ \leq \theta \leq 10^\circ$ e outro para $0^\circ \leq \theta \leq 90^\circ$.



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C
C*****
C.... SUBROUTINE THAT EVALUATES THE INTEGRAL IN POLAR COORDINATES
C*****
C
      SUBROUTINE SMPSON (RMIN,RMAX,NRADAL,ETOT,HTOT,PWRR)
C
C THIS SUBROUTINE EVALUATES THE DOUBLE INTEGRAL OF THE INTEGRAND
C SVINTGD(RI,PHII,DE,DH,DP). THE INTEGRATION REGION IS A CIRCULAR
C AREA WITH A CENTRAL CIRCULAR HOLE. THE CENTER OF THE CIRCLES IS
C LOCATED AT THE ORIGIN.
C
C RI AND PHII ARE THE USUAL POLAR COORDINATES. THE INNER INTEGRAL IS ON
C PHII, AND RUNS FROM 0 TO TWOPI. THE OUTER INTEGRAL IS ON RI, AND RUNS
C FROM RMIN TO RMAX.
C SIMPSON'S RULE IS USED IN BOTH RI AND PHII INTEGRATION (NESTED PROCEDURE).
C NRADAL IS THE NUMBER OF INTERVALS USED BY SIMPSON'S RULE IN THE RADIAL
C DIRECTION--IF NRADAL IS NOT EVEN SMPSON WILL USE THE GREATER CLOSEST EVEN
C NUMBER. NMCIRC IS THE LARGEST NUMBER OF INTERVALS USED BY SIMPSON'S RULE
C CIRCUNFERENTIAL INTEGRATION (IT WILL OCCUR WHEN RI=RMAX). SMPSON MAKES
C NMCIRC=2*PI*NRADAL (IF NMCIRC IS NOT EVEN SMPSON WILL USE THE GREATER
C CLOSEST EVEN NUMBER).
C
C THE NUMBER OF INTERVALS ACTUALLY USED BY SMPSON IN THE CIRCUNFERENTIAL
C DIRECTION IS NMCIRC ONLY WHEN RI=RMAX. FOR A GIVEN RI THE NUMBER OF
C INTERVALS IS THE GREATER CLOSEST EVEN NUMBER TO (RI*NMCIRC)/RMAX. IN THIS
C WAY THE NUMBER OF INTERVALS IS REDUCED FROM NMCIRC (WHEN RI=RMAX) TO 2
C (WHEN RI=0, WHENEVER RMIN=0) FOR EFFICIENT INTEGRATION.
C
C INPUT VARIABLES: RMIN,RMAX,NRADAL.
C OUTPUT VARIABLES: ETOT(1),ETOT(2),ETOT(3),HTOT(1),HTOT(2),HTOT(3),PWRR.
C SMPSON ASSUMES THAT SVINTGD(...,PHII,...)=SVINTGD(...,PHII+TWOPI,...)
C THE RESULT OF THE INTEGRAL IS IN ETOT(...), HTOT(...), AND PWRR. NOTE THAT
C PWRR IS EVALUATED ONLY ON THE FIRST CALL OF THE SUBROUTINE.
C
C-----
C THE JACOBIAN RI IS ALREADY INCLUDED INSIDE THIS ROUTINE.
C-----
C
C A. PRATA, JR. - UNIVERSITY OF SOUTHERN CALIFORNIA - 28/DEC/1985
C
C.....
C VERSION 2 - FERNANDO J. S. MOREIRA - USC, JANUARY 26, 1993.
C.....
C
      SAVE IFIRST
C
      COMPLEX ETOT(3),HTOT(3)
      COMPLEX DE(3),DH(3)

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      COMPLEX VINRE1,VINRE2,VINRE3,VINRH1,VINRH2,VINRH3
C
      PARAMETER(TWOPI=6.2831853)
C
C  INITIALIZING THE FLAG IFIRST. DATA DOES IT ONLY IN THE FIRST CALL OF THE
C  SUBROUTINE
C
      DATA IFIRST/1/
C
C  DETERMINATION OF AN EVEN NMCIRC
C
      NMCIRC=IFIX(TWOPI*NRADAL+0.5)
      NMCIRC=2*((NMCIRC+1)/2)
      IF (NMCIRC .EQ. 0) NMCIRC=2
C
C  INTEGRATION ON RI
C
C  MAKING SURE WE HAVE AN EVEN "NRADAL"
C
      NR=2*((NRADAL+1)/2)
      IF (NR .EQ. 0) NR=2
C
C  DETERMINING THE STEP SIZE IN THE RADIAL INTEGRATION
C
      HR=(RMAX-RMIN)/FLOAT(NR)
      HRO3=HR/3.
C
C  INITIALIZING THE INTEGRATION RESULTS
C
      ETOT(1)=(0.,0.)
      ETOT(2)=(0.,0.)
      ETOT(3)=(0.,0.)
      HTOT(1)=(0.,0.)
      HTOT(2)=(0.,0.)
      HTOT(3)=(0.,0.)
      IF (IFIRST .EQ. 1) PWRR=0.
C
      NPOINT=NR+1
      VNMCRG=FLOAT(NMCIRC)
C
      DO 10 I=1,NPOINT
          RI=RMIN+FLOAT(I-1)*HR
C
C  INTEGRATION ON PHII
C
C  COMPUTING THE NUMBER OF INTERVALS FOR THE CIRCUNFERENTIAL INTEGRATION
C
      NPHI=IFIX(VNMCRG*RI/RMAX)
C

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C MAKING SURE WE HAVE AN EVEN "NPHI"
C
      NPHI=2*((NPHI+1)/2)
      IF (NPHI .EQ. 0) NPHI=2
C
C DETERMINING THE STEP SIZE IN THE CIRCUNFERENTIAL INTEGRATION
C
      HPHI=TWOPI/FLOAT(NPHI)
      HPHIO3=HPHI/3.
      ANHPRI=HPHI03*RI
C
      VINRE1=(0.,0.)
      VINRE2=(0.,0.)
      VINRE3=(0.,0.)
      VINRH1=(0.,0.)
      VINRH2=(0.,0.)
      VINRH3=(0.,0.)
      IF (IFIRST .EQ. 1) VINRP=0.
C
      DO 20 J=1,NPHI
        PHII=FLOAT(J-1)*HPHI
C
C CALLING THE INTEGRAND
C
        CALL SVINTGD (RI,PHII,IFIRST,DE,DH,DP)
C
        AUX=2.
        IF ((J/2)*2 .EQ. J) AUX=4.
        VINRE1=VINRE1+AUX*DE(1)
        VINRE2=VINRE2+AUX*DE(2)
        VINRE3=VINRE3+AUX*DE(3)
        VINRH1=VINRH1+AUX*DH(1)
        VINRH2=VINRH2+AUX*DH(2)
        VINRH3=VINRH3+AUX*DH(3)
        IF (IFIRST .EQ. 1) VINRP=VINRP+AUX*DP
C
      20    CONTINUE
C
C END OF PHII INTEGRATION
C
      AUX=2.
      IF ((I/2)*2 .EQ. I) AUX=4.
      IF ((I .EQ. 1) .OR. (I .EQ. NPOINT)) AUX=1.
      AN=ANHPRI*AUX
      ETOT(1)=ETOT(1)+AN*VINRE1
      ETOT(2)=ETOT(2)+AN*VINRE2
      ETOT(3)=ETOT(3)+AN*VINRE3
      HTOT(1)=HTOT(1)+AN*VINRH1
      HTOT(2)=HTOT(2)+AN*VINRH2

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        HTOT(3)=HTOT(3)+AN*VINRH3
        IF (IFIRST .EQ. 1) PWRR=PWRR+AN*VINRP
C
      10 CONTINUE
C
C END OF RI INTEGRATION
C
      ETOT(1)=HR03*ETOT(1)
      ETOT(2)=HR03*ETOT(2)
      ETOT(3)=HR03*ETOT(3)
      HTOT(1)=HR03*HTOT(1)
      HTOT(2)=HR03*HTOT(2)
      HTOT(3)=HR03*HTOT(3)
      IF (IFIRST .EQ. 1) PWRR=HR03*PWRR
C
C SETING THE FLAG IFIRST TO ZERO
C
      IFIRST=0.
C
      RETURN
      END

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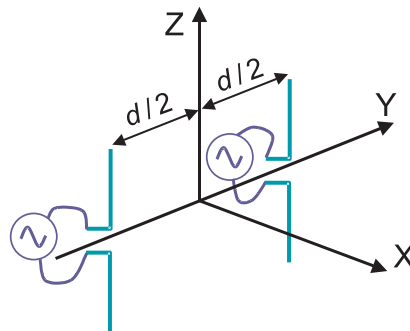
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Lista 6 - Entregar dia 13 de novembro de 2024.

0 - Estudar Balanis Capítulo 8 (4a. edição) e “revisar” as Seções 12.1–12.6.

1 - Sejam dois dipolos de meia onda excitados (individualmente) por geradores idênticos, como ilustrado na figura, onde $d = 0,7\lambda$. Cada gerador possui $V_g = 1$ V (tensão de pico) e $Z_g = 75\Omega$.

- a) Determine a potência radiada pelo conjunto.
- b) Determine $\vec{E}$ na região de campo distante.



2 - Ponha um plano condutor elétrico perfeito por trás dos dois dipolos do problema anterior (no plano $x = -0,35\lambda$) e refaça-o.

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Lista 7 - Entregar dia 04 de dezembro de 2024.

0 - Estudar Balanis, Seções 12.1–12.6.

1 - Balanis, problema 12.5 (4a. Edição). Note que os eixos foram definidos de maneira diferente da usual (mantenha a geometria do Balanis). Determine a direção do máximo de radiação (θ e ϕ) e compare-a à direção da onda incidente. Na direção do máximo de radiação, determine a diretividade da abertura.

2 - Idem para o problema 12.6 do Balanis (4a. Edição). A diretividade é a mesma do problema anterior?

3 - Este problema irá auxiliá-lo no trabalho computacional. Determine o campo distante de uma abertura circular uniformemente iluminada, localizada sobre um plano condutor elétrico perfeito. Repita o problema para o caso da mesma abertura, só que agora bloqueada centralmente por um disco circular condutor elétrico perfeito, obviamente com raio menor do que o da abertura inicial.

Trabalho (parte 2) - No exercício anterior você resolveu analiticamente o problema de uma abertura circular bloqueada, com distribuição de campo uniforme na parte não bloqueada (ou seja, a abertura não é uniforme, pois existe bloqueio). Modifique o programa implementado na primeira parte do trabalho para resolver este problema. Compare os resultados com a solução analítica. Use um bloqueio com diâmetro 10 vezes menor do que o diâmetro da abertura.

Na data indicada pelo professor, para esta parte do trabalho você tem que fornecer o arquivo com a listagem do programa e também a listagem impressa, junto com gráficos dos módulos das componentes E_θ e E_ϕ (sem o fator de onda esférica), calculados numericamente e analiticamente (plote um resultado por cima do outro, para comparações), normalizados em decibéis, para os planos $\phi = 0^\circ$ e 90° . Um gráfico para $-10^\circ \leq \theta \leq 10^\circ$ e outro para $0^\circ \leq \theta \leq 90^\circ$.

Trabalho (parte 3) - Continuando o trabalho, altere o programa desenvolvido para que a saída seja o ganho da abertura (e não mais o campo elétrico distante) em função da direção (θ, ϕ) . Neste caso, calcule os ganhos referentes às polarizações principal (CO-Pol.) e cruzada (CX-Pol.):

$$G_{CO,CX} = \frac{2\pi r^2 |\vec{E}_{CO,CX}|^2}{\eta P_{inc}}$$

onde P_{inc} é a potência “incidente” na abertura,

$$\vec{E} = \vec{E}_{CO} + \vec{E}_{CX} = \left(\vec{E} \cdot \hat{\rho}_{CO} \right) \hat{\rho}_{CO} + \left(\vec{E} \cdot \hat{\rho}_{CX} \right) \hat{\rho}_{CX} ,$$

e, de acordo com a terceira definição de Ludwig [1] e para uma polarização principal correspondendo à direção $\hat{x}$ em $\theta = 0$,

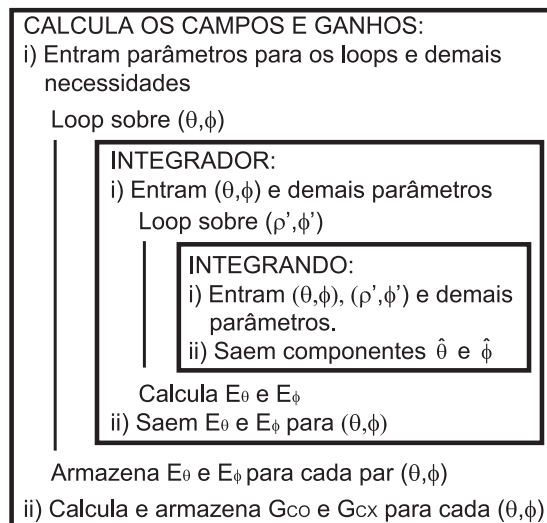
$$\begin{aligned} \hat{\rho}_{CO} &= \cos \phi \hat{\theta} - \sin \phi \hat{\phi} , \\ \hat{\rho}_{CX} &= \sin \phi \hat{\theta} + \cos \phi \hat{\phi} . \end{aligned}$$

Para a distribuição uniforme de corrente da primeira parte do trabalho ($\vec{J}_s = 1 \hat{x}$ A/m), P_{inc} é dada por (você saberia dizer por quê?):

$$P_{inc} = \frac{\eta \pi a^2}{8} \quad \text{Watts} ,$$

onde a é o raio da abertura em metros e $\eta \approx 120 \pi \Omega$.

Neste caso, o novo fluxograma do programa passa a ser o seguinte:



Para conferir os resultados é apresentada a tabela abaixo. Note que os valores de ganho foram “truncados” em -100 dBi e que os valores de $|E_\theta|$ para $\phi = 90^\circ$ são desprezíveis (na realidade, nulos). Note também que o ganho máximo corresponde ao da abertura uniforme (confira).

Finalmente, note que os resultados abaixo foram gerados com NRADAL=31, o que só fornece boa precisão até $\theta \approx 9^\circ$ para uma abertura com 100λ de diâmetro. Para que a precisão fosse boa para qualquer valor de θ precisaríamos de $\text{NRADAL} \approx 201$. Você saberia dizer como tais estimativas foram obtidas? Pense no assunto e discuta com o professor. Dica: tem a ver com o número de oscilações do integrando e uma amostragem de aproximadamente 4 pontos por oscilação para uma boa precisão.

Na data indicada pelo professor, para esta parte do trabalho você tem que fornecer o arquivo com a listagem do programa e também a listagem impressa, junto com gráficos dos ganhos da polarização principal (G_{CO}) para a abertura circular uniforme da primeira parte do trabalho, nos planos $\phi = 0^\circ$ e 90° . Um gráfico para $-10^\circ \leq \theta \leq 10^\circ$ e outro para $0^\circ \leq \theta \leq 90^\circ$. Nos gráficos, os ganhos devem ser apresentados entre -50 dBi e 50 dBi.

Referências

- [1] A. C. Ludwig, “The Definition of Cross Polarization,” IEEE Transactions on Antennas and Propagation, vol. AP-21, no. 1, pp. 116–119, January 1973.

PARTE 3 DO TRABALHO
ABERTURA CIRCULAR UNIFORME (RAIO = 50 LAMBDA, J = 1 \hat{x}) COM NRADAL=31

GRADE		CAMPO DISTANTE [SEM EXP(-JKR)/R]				GANHO	
THETA	PHI	ETHETA		E PHI		COPOL	CXPOL
(DEG)	(DEG)	AMPL(VOLTS)	PHASE(DEG)	AMPL(VOLTS)	PHASE(DEG)	(GAIN dBi)	
0.00	0.00	0.14794E+07	-90.00	0.00000E+00	0.00	49.94	-100.00
1.00	0.00	0.18472E+06	90.00	0.00000E+00	0.00	31.87	-100.00
2.00	0.00	0.46141E+05	90.00	0.00000E+00	0.00	19.82	-100.00
3.00	0.00	0.10265E+04	-89.60	0.00000E+00	0.00	-13.23	-100.00
4.00	0.00	0.17211E+05	-89.94	0.00000E+00	0.00	11.26	-100.00
5.00	0.00	0.16420E+05	-89.89	0.00000E+00	0.00	10.85	-100.00
6.00	0.00	0.76206E+04	-89.60	0.00000E+00	0.00	4.18	-100.00
7.00	0.00	0.18360E+04	87.49	0.00000E+00	0.00	-8.18	-100.00
8.00	0.00	0.70626E+04	89.09	0.00000E+00	0.00	3.52	-100.00
9.00	0.00	0.65676E+04	88.74	0.00000E+00	0.00	2.89	-100.00

10.00	0.00	0.20510E+04	85.13	0.00000E+00	0.00	-7.22	-100.00
11.00	0.00	0.30354E+04	-86.31	0.00000E+00	0.00	-3.81	-100.00
12.00	0.00	0.54303E+04	-87.88	0.00000E+00	0.00	1.24	-100.00
13.00	0.00	0.38755E+04	-87.40	0.00000E+00	0.00	-1.69	-100.00
14.00	0.00	0.38658E+03	76.95	0.00000E+00	0.00	-21.71	-100.00
15.00	0.00	0.42036E+04	91.69	0.00000E+00	0.00	-0.99	-100.00
16.00	0.00	0.39447E+04	97.30	0.00000E+00	0.00	-1.54	-100.00
17.00	0.00	0.46277E+04	-99.51	0.00000E+00	0.00	-0.15	-100.00
18.00	0.00	0.35676E+05	-89.68	0.00000E+00	0.00	17.59	-100.00
19.00	0.00	0.36572E+05	89.16	0.00000E+00	0.00	17.80	-100.00
20.00	0.00	0.62107E+04	-167.19	0.00000E+00	0.00	2.40	-100.00
21.00	0.00	0.30855E+04	177.23	0.00000E+00	0.00	-3.67	-100.00
22.00	0.00	0.37960E+04	-42.25	0.00000E+00	0.00	-1.87	-100.00
23.00	0.00	0.45781E+04	-175.28	0.00000E+00	0.00	-0.25	-100.00
24.00	0.00	0.10406E+05	47.26	0.00000E+00	0.00	6.89	-100.00
25.00	0.00	0.44747E+04	-113.52	0.00000E+00	0.00	-0.44	-100.00
26.00	0.00	0.39829E+04	-21.64	0.00000E+00	0.00	-1.45	-100.00
27.00	0.00	0.21157E+04	-137.05	0.00000E+00	0.00	-6.95	-100.00
28.00	0.00	0.53248E+04	135.37	0.00000E+00	0.00	1.07	-100.00
29.00	0.00	0.68389E+04	67.33	0.00000E+00	0.00	3.24	-100.00
30.00	0.00	0.97330E+04	-151.40	0.00000E+00	0.00	6.31	-100.00
31.00	0.00	0.14635E+05	8.68	0.00000E+00	0.00	9.85	-100.00
32.00	0.00	0.15494E+05	-132.66	0.00000E+00	0.00	10.34	-100.00
33.00	0.00	0.36631E+05	21.11	0.00000E+00	0.00	17.82	-100.00
34.00	0.00	0.27465E+05	135.63	0.00000E+00	0.00	15.32	-100.00
35.00	0.00	0.12657E+05	-47.23	0.00000E+00	0.00	8.59	-100.00
36.00	0.00	0.13970E+05	134.60	0.00000E+00	0.00	9.45	-100.00
37.00	0.00	0.32579E+04	-3.23	0.00000E+00	0.00	-3.20	-100.00
38.00	0.00	0.16052E+05	-108.51	0.00000E+00	0.00	10.65	-100.00
39.00	0.00	0.51112E+05	89.22	0.00000E+00	0.00	20.71	-100.00
40.00	0.00	0.88869E+05	-90.13	0.00000E+00	0.00	25.52	-100.00
41.00	0.00	0.10289E+05	90.46	0.00000E+00	0.00	6.79	-100.00
42.00	0.00	0.31268E+05	-88.70	0.00000E+00	0.00	16.44	-100.00
43.00	0.00	0.23614E+04	136.39	0.00000E+00	0.00	-6.00	-100.00
44.00	0.00	0.36173E+05	89.31	0.00000E+00	0.00	17.71	-100.00
45.00	0.00	0.24351E+05	95.12	0.00000E+00	0.00	14.27	-100.00
46.00	0.00	0.28189E+04	-63.07	0.00000E+00	0.00	-4.46	-100.00
47.00	0.00	0.12137E+05	-92.28	0.00000E+00	0.00	8.22	-100.00
48.00	0.00	0.13485E+05	88.56	0.00000E+00	0.00	9.14	-100.00
49.00	0.00	0.44282E+04	67.50	0.00000E+00	0.00	-0.53	-100.00
50.00	0.00	0.18851E+05	-99.14	0.00000E+00	0.00	12.05	-100.00
51.00	0.00	0.41418E+04	-58.95	0.00000E+00	0.00	-1.12	-100.00
52.00	0.00	0.31927E+04	173.55	0.00000E+00	0.00	-3.38	-100.00
53.00	0.00	0.32784E+04	90.41	0.00000E+00	0.00	-3.15	-100.00
54.00	0.00	0.28499E+04	-73.26	0.00000E+00	0.00	-4.36	-100.00
55.00	0.00	0.72715E+03	100.62	0.00000E+00	0.00	-16.23	-100.00
56.00	0.00	0.26085E+04	81.12	0.00000E+00	0.00	-5.13	-100.00
57.00	0.00	0.96789E+04	71.05	0.00000E+00	0.00	6.26	-100.00
58.00	0.00	0.35023E+04	-101.02	0.00000E+00	0.00	-2.57	-100.00

59.00	0.00	0.45898E+04	-136.39	0.00000E+00	0.00	-0.22	-100.00
60.00	0.00	0.48294E+04	-6.68	0.00000E+00	0.00	0.22	-100.00
61.00	0.00	0.66566E+04	160.73	0.00000E+00	0.00	3.01	-100.00
62.00	0.00	0.63979E+04	164.09	0.00000E+00	0.00	2.66	-100.00
63.00	0.00	0.53955E+04	-21.29	0.00000E+00	0.00	1.18	-100.00
64.00	0.00	0.16464E+04	-157.18	0.00000E+00	0.00	-9.13	-100.00
65.00	0.00	0.38529E+04	-119.42	0.00000E+00	0.00	-1.74	-100.00
66.00	0.00	0.79454E+04	-64.67	0.00000E+00	0.00	4.54	-100.00
67.00	0.00	0.58646E+04	-132.18	0.00000E+00	0.00	1.91	-100.00
68.00	0.00	0.74625E+04	161.26	0.00000E+00	0.00	4.00	-100.00
69.00	0.00	0.55845E+04	71.15	0.00000E+00	0.00	1.48	-100.00
70.00	0.00	0.55821E+04	4.61	0.00000E+00	0.00	1.48	-100.00
71.00	0.00	0.45868E+04	-84.64	0.00000E+00	0.00	-0.23	-100.00
72.00	0.00	0.26808E+04	-152.43	0.00000E+00	0.00	-4.89	-100.00
73.00	0.00	0.59387E+04	86.78	0.00000E+00	0.00	2.02	-100.00
74.00	0.00	0.78101E+04	67.74	0.00000E+00	0.00	4.39	-100.00
75.00	0.00	0.32964E+04	37.23	0.00000E+00	0.00	-3.10	-100.00
76.00	0.00	0.30340E+04	-67.08	0.00000E+00	0.00	-3.82	-100.00
77.00	0.00	0.27265E+04	-77.69	0.00000E+00	0.00	-4.75	-100.00
78.00	0.00	0.11282E+04	42.46	0.00000E+00	0.00	-12.41	-100.00
79.00	0.00	0.38373E+04	72.49	0.00000E+00	0.00	-1.78	-100.00
80.00	0.00	0.42399E+04	73.99	0.00000E+00	0.00	-0.91	-100.00
81.00	0.00	0.26834E+04	68.79	0.00000E+00	0.00	-4.89	-100.00
82.00	0.00	0.84257E+03	26.61	0.00000E+00	0.00	-14.95	-100.00
83.00	0.00	0.13673E+04	-63.95	0.00000E+00	0.00	-10.74	-100.00
84.00	0.00	0.20429E+04	-75.87	0.00000E+00	0.00	-7.25	-100.00
85.00	0.00	0.20793E+04	-78.56	0.00000E+00	0.00	-7.10	-100.00
86.00	0.00	0.17374E+04	-79.26	0.00000E+00	0.00	-8.66	-100.00
87.00	0.00	0.12631E+04	-79.34	0.00000E+00	0.00	-11.43	-100.00
88.00	0.00	0.79525E+03	-79.26	0.00000E+00	0.00	-15.45	-100.00
89.00	0.00	0.37851E+03	-79.18	0.00000E+00	0.00	-21.90	-100.00
90.00	0.00	0.18351E-02	100.85	0.00000E+00	0.00	-100.00	-100.00
0.00	90.00	0.12759E+00	90.00	0.14794E+07	90.00	49.94	-100.00
1.00	90.00	0.15931E-01	-90.00	0.18474E+06	-90.00	31.87	-100.00
2.00	90.00	0.39795E-02	-90.00	0.46169E+05	-90.00	19.83	-100.00
3.00	90.00	0.88529E-04	90.00	0.10279E+04	90.00	-13.22	-100.00
4.00	90.00	0.14843E-02	90.00	0.17252E+05	90.00	11.28	-100.00
5.00	90.00	0.14159E-02	90.00	0.16480E+05	90.00	10.88	-100.00
6.00	90.00	0.65666E-03	90.00	0.76557E+04	90.00	4.22	-100.00
7.00	90.00	0.15957E-03	-90.00	0.18641E+04	-90.00	-8.05	-100.00
8.00	90.00	0.61191E-03	-90.00	0.71646E+04	-90.00	3.65	-100.00
9.00	90.00	0.57165E-03	-90.00	0.67107E+04	-90.00	3.08	-100.00
10.00	90.00	0.18562E-03	-90.00	0.21854E+04	-90.00	-6.67	-100.00
11.00	90.00	0.24565E-03	90.00	0.29015E+04	90.00	-4.21	-100.00
12.00	90.00	0.44246E-03	90.00	0.52448E+04	90.00	0.94	-100.00
13.00	90.00	0.29113E-03	90.00	0.34643E+04	90.00	-2.67	-100.00
14.00	90.00	0.11016E-03	-90.00	0.13164E+04	-90.00	-11.07	-100.00
15.00	90.00	0.53331E-03	-90.00	0.64016E+04	-90.00	2.67	-100.00

16.00	90.00	0.83301E-03	-90.00	0.10048E+05	-90.00	6.58	-100.00
17.00	90.00	0.12494E-02	-90.00	0.15148E+05	-90.00	10.15	-100.00
18.00	90.00	0.14528E-02	-90.00	0.17711E+05	-90.00	11.51	-100.00
19.00	90.00	0.10561E-01	-90.00	0.12950E+06	-90.00	28.79	-100.00
20.00	90.00	0.38578E-02	-90.00	0.47601E+05	-90.00	20.09	-100.00
21.00	90.00	0.21251E-02	90.00	0.26392E+05	90.00	14.97	-100.00
22.00	90.00	0.52266E-03	90.00	0.65360E+04	90.00	2.85	-100.00
23.00	90.00	0.35731E-03	-90.00	0.45007E+04	-90.00	-0.39	-100.00
24.00	90.00	0.17936E-03	89.99	0.22765E+04	89.99	-6.31	-100.00
25.00	90.00	0.17015E-04	90.06	0.21769E+03	90.06	-26.70	-100.00
26.00	90.00	0.16822E-04	90.00	0.21700E+03	90.00	-26.73	-100.00
27.00	90.00	0.45380E-03	90.00	0.59054E+04	90.00	1.97	-100.00
28.00	90.00	0.58358E-03	-90.00	0.76634E+04	-90.00	4.23	-100.00
29.00	90.00	0.29829E-03	90.00	0.39544E+04	90.00	-1.52	-100.00
30.00	90.00	0.22673E-03	90.00	0.30355E+04	90.00	-3.81	-100.00
31.00	90.00	0.70289E-03	90.00	0.95078E+04	90.00	6.10	-100.00
32.00	90.00	0.20615E-04	89.97	0.28186E+03	89.97	-24.46	-100.00
33.00	90.00	0.22024E-03	90.00	0.30448E+04	90.00	-3.79	-100.00
34.00	90.00	0.14095E-02	90.00	0.19712E+05	90.00	12.44	-100.00
35.00	90.00	0.16795E-02	90.00	0.23773E+05	90.00	14.06	-100.00
36.00	90.00	0.27876E-02	90.00	0.39952E+05	90.00	18.57	-100.00
37.00	90.00	0.66891E-02	90.00	0.97113E+05	90.00	26.29	-100.00
38.00	90.00	0.14255E-01	90.00	0.20975E+06	90.00	32.98	-100.00
39.00	90.00	0.16352E-01	90.00	0.24396E+06	90.00	34.29	-100.00
40.00	90.00	0.32969E-01	90.00	0.49901E+06	90.00	40.50	-100.00
41.00	90.00	0.17324E-01	90.00	0.26615E+06	90.00	35.04	-100.00
42.00	90.00	0.44421E-02	90.00	0.69306E+05	90.00	23.36	-100.00
43.00	90.00	0.56410E-02	-90.00	0.89431E+05	-90.00	25.57	-100.00
44.00	90.00	0.21376E-02	-90.00	0.34455E+05	-90.00	17.29	-100.00
45.00	90.00	0.61235E-02	90.00	0.10041E+06	90.00	26.58	-100.00
46.00	90.00	0.42875E-03	-90.00	0.71564E+04	-90.00	3.64	-100.00
47.00	90.00	0.37688E-02	-90.00	0.64073E+05	-90.00	22.67	-100.00
48.00	90.00	0.16523E-03	-90.00	0.28631E+04	-90.00	-4.32	-100.00
49.00	90.00	0.22831E-03	90.00	0.40349E+04	90.00	-1.34	-100.00
50.00	90.00	0.82044E-03	-90.00	0.14799E+05	-90.00	9.95	-100.00
51.00	90.00	0.20755E-03	-90.00	0.38239E+04	-90.00	-1.81	-100.00
52.00	90.00	0.44653E-03	-90.00	0.84094E+04	-90.00	5.04	-100.00
53.00	90.00	0.90580E-03	-90.00	0.17451E+05	-90.00	11.38	-100.00
54.00	90.00	0.18066E-02	90.00	0.35637E+05	90.00	17.58	-100.00
55.00	90.00	0.60709E-03	90.00	0.12272E+05	90.00	8.32	-100.00
56.00	90.00	0.65802E-03	-90.00	0.13644E+05	-90.00	9.24	-100.00
57.00	90.00	0.26972E-03	90.00	0.57420E+04	90.00	1.72	-100.00
58.00	90.00	0.10099E-02	90.00	0.22098E+05	90.00	13.43	-100.00
59.00	90.00	0.49116E-03	-90.00	0.11057E+05	-90.00	7.41	-100.00
60.00	90.00	0.53961E-03	-90.00	0.12513E+05	-90.00	8.49	-100.00
61.00	90.00	0.41154E-03	-90.00	0.98423E+04	-90.00	6.40	-100.00
62.00	90.00	0.39886E-03	-90.00	0.98508E+04	-90.00	6.41	-100.00
63.00	90.00	0.19744E-03	-89.99	0.50425E+04	-89.99	0.59	-100.00
64.00	90.00	0.31008E-03	-90.00	0.82014E+04	-90.00	4.82	-100.00

65.00	90.00	0.58474E-03	-90.00	0.16042E+05	-90.00	10.65	-100.00
66.00	90.00	0.96256E-03	-90.00	0.27439E+05	-90.00	15.31	-100.00
67.00	90.00	0.56859E-03	-90.00	0.16872E+05	-90.00	11.08	-100.00
68.00	90.00	0.11246E-03	-90.00	0.34807E+04	-90.00	-2.63	-100.00
69.00	90.00	0.86532E-03	-90.00	0.27997E+05	-90.00	15.48	-100.00
70.00	90.00	0.16426E-02	-90.00	0.55685E+05	-90.00	21.46	-100.00
71.00	90.00	0.13166E-02	-90.00	0.46888E+05	-90.00	19.96	-100.00
72.00	90.00	0.87485E-03	-90.00	0.32825E+05	-90.00	16.87	-100.00
73.00	90.00	0.12048E-02	-90.00	0.47778E+05	-90.00	20.13	-100.00
74.00	90.00	0.17471E-02	-90.00	0.73493E+05	-90.00	23.87	-100.00
75.00	90.00	0.17663E-02	-90.00	0.79127E+05	-90.00	24.51	-100.00
76.00	90.00	0.13234E-02	-90.00	0.63425E+05	-90.00	22.59	-100.00
77.00	90.00	0.86050E-03	-90.00	0.44353E+05	-90.00	19.48	-100.00
78.00	90.00	0.59644E-03	-90.00	0.33262E+05	-90.00	16.98	-100.00
79.00	90.00	0.47153E-03	-90.00	0.28653E+05	-90.00	15.68	-100.00
80.00	90.00	0.36942E-03	-90.00	0.24666E+05	-90.00	14.38	-100.00
81.00	90.00	0.24624E-03	-90.00	0.18251E+05	-90.00	11.77	-100.00
82.00	90.00	0.11934E-03	-90.00	0.99424E+04	-90.00	6.49	-100.00
83.00	90.00	0.16898E-04	-89.98	0.16077E+04	-89.98	-9.33	-100.00
84.00	90.00	0.48153E-04	89.99	0.53413E+04	89.99	1.09	-100.00
85.00	90.00	0.78296E-04	90.00	0.10416E+05	90.00	6.90	-100.00
86.00	90.00	0.82872E-04	90.00	0.13775E+05	90.00	9.32	-100.00
87.00	90.00	0.71439E-04	90.00	0.15827E+05	90.00	10.53	-100.00
88.00	90.00	0.51123E-04	90.00	0.16985E+05	90.00	11.14	-100.00
89.00	90.00	0.26428E-04	90.00	0.17557E+05	90.00	11.43	-100.00
90.00	90.00	0.13187E-09	-90.00	0.17728E+05	90.00	11.51	-100.00

Análise de Antenas

Prof. Fernando J. S. Moreira

Lista 8 - Entregar dia 11 de dezembro de 2024.

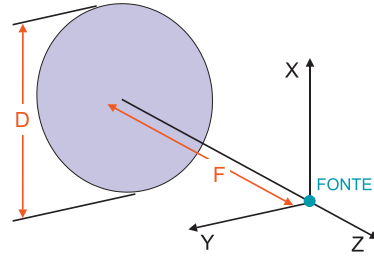
0 - Estudar Balanis, Seções 12.1–12.9.

1 - Balanis, problema 12.48(a) (4a. Edição).

2 - Balanis, problema 12.50 (4a. Edição).

3 - Balanis, problema 12.63 (4a. Edição).

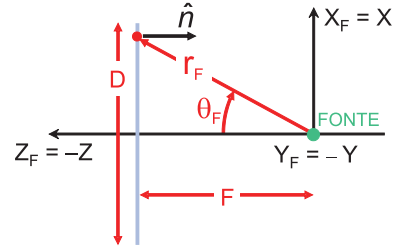
Trabalho (parte 4) - Continuando o trabalho da lista anterior, vamos agora começar a implementar a aproximação da Óptica Física para a análise de antenas refletoras. Para simplificar o problema, vamos assumir a superfície refletora como sendo um disco metálico, conforme ilustrado na figura ao lado.



O campo incidente é produzido por uma fonte pontual TEM, modelada como um cosseno-elevado linearmente polarizado em $\hat{x}_F$:

$$\vec{E}_{in}(\vec{r}_F) = \cos^n \theta_F \left(\cos \phi_F \hat{\theta}_F - \sin \phi_F \hat{\phi}_F \right) \frac{e^{-jkr_F}}{r_F},$$
$$\vec{H}_{in}(\vec{r}_F) = \frac{1}{\eta} \hat{r}_F \times \vec{E}_{in}(\vec{r}_F),$$

para $0 \leq \theta_F \leq \pi/2$ e zero para $\theta_F > \pi/2$, onde as coordenadas esféricas r_F , θ_F e ϕ_F referem-se ao sistema de coordenadas do alimentador, como mostrado na figura ao lado.



Nestas condições, a expressão do campo distante a ser determinado con-

tinua sendo

$$\begin{aligned}\vec{E}(\vec{r}) &\approx -j \frac{\omega\mu}{4\pi} \frac{e^{-jkr}}{r} \int_0^{2\pi} \int_0^{D/2} \left\{ \vec{J}(\vec{r}') - \left[\vec{J}(\vec{r}') \cdot \hat{r} \right] \hat{r} \right\} e^{jk\hat{r} \cdot \vec{r}'} \rho' d\rho' d\phi' \\ &= \left[E_\theta(\theta, \phi) \hat{\theta} + E_\phi(\theta, \phi) \hat{\phi} \right] \exp(-jkr)/r ,\end{aligned}$$

onde agora a corrente elétrica induzida sobre a superfície metálica (contida no plano $z = -F$) é dada pela aproximação da Óptica Física:

$$\vec{J} \approx \vec{J}_{PO} = 2 \hat{n} \times \vec{H}_{in},$$

sendo $\vec{H}_{in}$ o campo magnético incidente (radiado pela fonte) e $\hat{n}$ ($= \hat{z}$ no presente caso) a normal unitária da superfície refletora apontando na direção da fonte.

Basicamente, em relação à etapa passada, você terá que alterar a rotina do integrando. Como sugestão siga o fluxograma apresentado abaixo.

INTEGRANDO:

Entra coordenadas (θ, ϕ) do observador e (ρ', ϕ') sobre o refletor

Sempre em relação ao sistema Cartesiano principal (X,Y,Z):

- Calcula coordenadas x' , y' e z' sobre o refletor
- Calcula componentes Cartesianas da normal em (x', y', z')
- Calcula componentes Cartesianas de H_{in} em (x', y', z')
- Calcula componentes Cartesianas da corrente em (x', y', z')
- Calcula componentes Cartesianas do integrando em (x', y', z')
- Converte as componentes Cartesianas para esféricas

Sai componentes em θ e ϕ do integrando

Nesta etapa, calcule apenas as componentes E_θ e E_ϕ do campo distante radiado pelo refletor (não inclua neste cálculo o campo direto da fonte). Destas componentes E_θ e E_ϕ , determine os ganhos das polarizações principal e cruzada de acordo com a terceira definição de Ludwig. Para tal, defina os ganhos em função da potência total (P_{rad}) radiada pelo alimentador utilizando a expressão já obtida para o modelo cosseno-elevado em uma lista anterior).

Para ajudar a *debugar* o programa, seguem os resultados para um disco com $D = F = 100 \lambda$, com um cosseno-elevado onde $n = 1$. Foi usado $NRADAL = 301$ (como a fase da corrente varia consideravelmente sobre a

superfície do disco, é necessário um número elevado de pontos para a integração). Note que os valores de $|E_\phi|$ para $\phi = 0^\circ$ são desprezíveis (na realidade, nulos). Em particular, lembre-se de que o fator de onda esférica $\exp(-jkr)/r$ foi removido dos resultados abaixo.

Na data indicada pelo professor, para esta parte do trabalho você tem que fornecer o arquivo contendo a listagem do programa e também a listagem impressa, junto gráficos dos ganhos da polarização principal (G_{CO}) e da polarização cruzada (G_{CX}) nos 3 planos principais: $\phi = 0^\circ, 45^\circ$ e 90° . Forneça gráficos para $-45^\circ \leq \theta \leq 45^\circ$ (com ganhos apresentados de -20 dBi a 20 dBi) e outro para $0^\circ \leq \theta \leq 90^\circ$ (com ganhos entre -50 dBi e 20 dBi).

PARTE 4 DO TRABALHO
DISCO METÁLICO (D=F=100 LAMBDA), COM COSSENO-ELEVADO (N=1) E NRADAL=301

THETA (DEG)	PHI (DEG)	ETHETA		EPhi		COPOL (GAIN dB)	CXPOL
		AMPL(VOLTS)	PHASE(DEG)	AMPL(VOLTS)	PHASE(DEG)		
0.00	0.00	0.10769E+01	132.14	0.31219E-07	-142.27	8.42	-100.00
0.01	0.00	0.10766E+01	132.17	0.78969E-07	-164.37	8.42	-100.00
0.02	0.00	0.10756E+01	132.27	0.14589E-06	-161.29	8.41	-100.00
0.03	0.00	0.10741E+01	132.43	0.20370E-06	-159.34	8.40	-100.00
0.04	0.00	0.10719E+01	132.65	0.28874E-06	-164.12	8.38	-100.00
0.05	0.00	0.10692E+01	132.94	0.34552E-06	-164.71	8.36	-100.00
0.06	0.00	0.10659E+01	133.29	0.43834E-06	-167.84	8.34	-100.00
0.07	0.00	0.10620E+01	133.70	0.48722E-06	-165.10	8.30	-100.00
0.08	0.00	0.10577E+01	134.18	0.56104E-06	-165.85	8.27	-100.00
0.09	0.00	0.10529E+01	134.73	0.59700E-06	-165.50	8.23	-100.00
0.10	0.00	0.10476E+01	135.34	0.67022E-06	-167.99	8.19	-100.00
0.11	0.00	0.10420E+01	136.02	0.73826E-06	-166.80	8.14	-100.00
0.12	0.00	0.10361E+01	136.76	0.81811E-06	-165.16	8.09	-100.00
0.13	0.00	0.10299E+01	137.57	0.87007E-06	-165.48	8.04	-100.00
0.14	0.00	0.10235E+01	138.45	0.93826E-06	-167.12	7.98	-100.00
0.15	0.00	0.10170E+01	139.39	0.97759E-06	-167.06	7.93	-100.00
0.16	0.00	0.10103E+01	140.40	0.10224E-05	-165.74	7.87	-100.00
0.17	0.00	0.10037E+01	141.48	0.10917E-05	-166.09	7.81	-100.00
0.18	0.00	0.99709E+00	142.62	0.11170E-05	-166.76	7.76	-100.00
0.19	0.00	0.99062E+00	143.82	0.12050E-05	-167.39	7.70	-100.00
0.20	0.00	0.98436E+00	145.09	0.12412E-05	-167.84	7.64	-100.00
0.21	0.00	0.97836E+00	146.42	0.13016E-05	-166.03	7.59	-100.00
0.22	0.00	0.97269E+00	147.81	0.13211E-05	-166.05	7.54	-100.00
0.23	0.00	0.96745E+00	149.25	0.13727E-05	-166.65	7.49	-100.00
0.24	0.00	0.96269E+00	150.74	0.13947E-05	-167.01	7.45	-100.00
0.25	0.00	0.95846E+00	152.29	0.14734E-05	-167.40	7.41	-100.00
0.26	0.00	0.95484E+00	153.87	0.14740E-05	-167.14	7.38	-100.00

0.27	0.00	0.95186E+00	155.50	0.15185E-05	-167.46	7.35	-100.00
0.28	0.00	0.94960E+00	157.15	0.15655E-05	-167.61	7.33	-100.00
0.29	0.00	0.94806E+00	158.84	0.15826E-05	-167.96	7.32	-100.00
0.30	0.00	0.94731E+00	160.55	0.16126E-05	-167.61	7.31	-100.00
0.31	0.00	0.94736E+00	162.27	0.16614E-05	-168.16	7.31	-100.00
0.32	0.00	0.94822E+00	164.01	0.16816E-05	-168.65	7.32	-100.00
0.33	0.00	0.94989E+00	165.74	0.16763E-05	-168.53	7.34	-100.00
0.34	0.00	0.95240E+00	167.48	0.16991E-05	-169.83	7.36	-100.00
0.35	0.00	0.95570E+00	169.20	0.16861E-05	-168.16	7.39	-100.00
0.36	0.00	0.95978E+00	170.90	0.17081E-05	-169.15	7.42	-100.00
0.37	0.00	0.96463E+00	172.59	0.16992E-05	-168.76	7.47	-100.00
0.38	0.00	0.97019E+00	174.25	0.17102E-05	-170.50	7.52	-100.00
0.39	0.00	0.97643E+00	175.87	0.17173E-05	-169.90	7.57	-100.00
0.40	0.00	0.98328E+00	177.46	0.17454E-05	-169.96	7.64	-100.00
0.41	0.00	0.99072E+00	179.01	0.17515E-05	-170.01	7.70	-100.00
0.42	0.00	0.99868E+00	-179.49	0.17449E-05	-170.85	7.77	-100.00
0.43	0.00	0.10071E+01	-178.04	0.17092E-05	-170.46	7.84	-100.00
0.44	0.00	0.10158E+01	-176.63	0.17413E-05	-172.99	7.92	-100.00
0.45	0.00	0.10249E+01	-175.28	0.17046E-05	-171.06	8.00	-100.00
0.46	0.00	0.10343E+01	-173.98	0.17395E-05	-172.30	8.07	-100.00
0.47	0.00	0.10438E+01	-172.73	0.16962E-05	-173.06	8.15	-100.00
0.48	0.00	0.10534E+01	-171.53	0.16870E-05	-173.09	8.23	-100.00
0.49	0.00	0.10630E+01	-170.40	0.16590E-05	-173.84	8.31	-100.00
0.50	0.00	0.10726E+01	-169.31	0.16101E-05	-173.44	8.39	-100.00
0.51	0.00	0.10821E+01	-168.29	0.16251E-05	-173.68	8.47	-100.00
0.52	0.00	0.10915E+01	-167.31	0.15605E-05	-175.08	8.54	-100.00
0.53	0.00	0.11007E+01	-166.39	0.15549E-05	-175.02	8.61	-100.00
0.54	0.00	0.11095E+01	-165.52	0.15318E-05	-177.01	8.68	-100.00
0.55	0.00	0.11181E+01	-164.71	0.15056E-05	-177.49	8.75	-100.00
0.56	0.00	0.11263E+01	-163.95	0.14619E-05	-177.89	8.81	-100.00
0.57	0.00	0.11340E+01	-163.23	0.14324E-05	-178.62	8.87	-100.00
0.58	0.00	0.11413E+01	-162.56	0.14064E-05	-179.86	8.93	-100.00
0.59	0.00	0.11481E+01	-161.95	0.13490E-05	179.76	8.98	-100.00
0.60	0.00	0.11543E+01	-161.38	0.13349E-05	178.07	9.03	-100.00
0.61	0.00	0.11600E+01	-160.85	0.12862E-05	177.87	9.07	-100.00
0.62	0.00	0.11651E+01	-160.38	0.12283E-05	176.41	9.11	-100.00
0.63	0.00	0.11696E+01	-159.94	0.12261E-05	176.08	9.14	-100.00
0.64	0.00	0.11735E+01	-159.55	0.11757E-05	172.15	9.17	-100.00
0.65	0.00	0.11767E+01	-159.20	0.11419E-05	170.77	9.19	-100.00
0.66	0.00	0.11792E+01	-158.89	0.10679E-05	169.85	9.21	-100.00
0.67	0.00	0.11811E+01	-158.63	0.10352E-05	168.60	9.23	-100.00
0.68	0.00	0.11823E+01	-158.40	0.99561E-06	166.83	9.24	-100.00
0.69	0.00	0.11828E+01	-158.21	0.96580E-06	163.91	9.24	-100.00
0.70	0.00	0.11827E+01	-158.06	0.90599E-06	161.68	9.24	-100.00
0.71	0.00	0.11819E+01	-157.95	0.89548E-06	159.09	9.23	-100.00
0.72	0.00	0.11805E+01	-157.88	0.84570E-06	156.03	9.22	-100.00
0.73	0.00	0.11784E+01	-157.84	0.82418E-06	152.70	9.21	-100.00
0.74	0.00	0.11757E+01	-157.84	0.77624E-06	148.72	9.19	-100.00
0.75	0.00	0.11724E+01	-157.88	0.73652E-06	146.34	9.16	-100.00

0.76	0.00	0.11686E+01	-157.95	0.73363E-06	140.19	9.13	-100.00
0.77	0.00	0.11642E+01	-158.05	0.72169E-06	137.20	9.10	-100.00
0.78	0.00	0.11592E+01	-158.19	0.68779E-06	133.08	9.07	-100.00
0.79	0.00	0.11538E+01	-158.37	0.68250E-06	128.90	9.02	-100.00
0.80	0.00	0.11479E+01	-158.57	0.67318E-06	123.28	8.98	-100.00
0.81	0.00	0.11416E+01	-158.81	0.69528E-06	118.13	8.93	-100.00
0.82	0.00	0.11349E+01	-159.08	0.67030E-06	113.67	8.88	-100.00
0.83	0.00	0.11279E+01	-159.39	0.69107E-06	109.64	8.83	-100.00
0.84	0.00	0.11205E+01	-159.72	0.69954E-06	104.32	8.77	-100.00
0.85	0.00	0.11129E+01	-160.08	0.69270E-06	101.06	8.71	-100.00
0.86	0.00	0.11050E+01	-160.48	0.72053E-06	95.25	8.65	-100.00
0.87	0.00	0.10969E+01	-160.90	0.75355E-06	92.62	8.58	-100.00
0.88	0.00	0.10887E+01	-161.35	0.75382E-06	87.82	8.52	-100.00
0.89	0.00	0.10803E+01	-161.82	0.77511E-06	85.65	8.45	-100.00
0.90	0.00	0.10719E+01	-162.32	0.80649E-06	81.09	8.38	-100.00
0.91	0.00	0.10634E+01	-162.85	0.83521E-06	79.22	8.32	-100.00
0.92	0.00	0.10549E+01	-163.39	0.86517E-06	76.02	8.25	-100.00
0.93	0.00	0.10465E+01	-163.96	0.90318E-06	74.80	8.18	-100.00
0.94	0.00	0.10381E+01	-164.55	0.92913E-06	72.12	8.11	-100.00
0.95	0.00	0.10299E+01	-165.15	0.94561E-06	69.92	8.04	-100.00
0.96	0.00	0.10217E+01	-165.76	0.95141E-06	69.77	7.97	-100.00
0.97	0.00	0.10138E+01	-166.39	0.10259E-05	66.17	7.90	-100.00
0.98	0.00	0.10061E+01	-167.03	0.10192E-05	65.77	7.83	-100.00
0.99	0.00	0.99854E+00	-167.68	0.10610E-05	64.15	7.77	-100.00
1.00	0.00	0.99126E+00	-168.33	0.10803E-05	61.77	7.71	-100.00
1.01	0.00	0.98426E+00	-168.98	0.11267E-05	60.52	7.64	-100.00
1.02	0.00	0.97753E+00	-169.64	0.11552E-05	61.10	7.58	-100.00
1.03	0.00	0.97111E+00	-170.28	0.11446E-05	59.09	7.53	-100.00
1.04	0.00	0.96500E+00	-170.92	0.11796E-05	58.49	7.47	-100.00
1.05	0.00	0.95921E+00	-171.55	0.12165E-05	57.72	7.42	-100.00
1.06	0.00	0.95374E+00	-172.17	0.12286E-05	56.27	7.37	-100.00
1.07	0.00	0.94859E+00	-172.77	0.12455E-05	55.05	7.32	-100.00
1.08	0.00	0.94378E+00	-173.36	0.12285E-05	55.12	7.28	-100.00
1.09	0.00	0.93928E+00	-173.91	0.13080E-05	53.96	7.24	-100.00
1.10	0.00	0.93511E+00	-174.45	0.12813E-05	53.16	7.20	-100.00
1.11	0.00	0.93125E+00	-174.95	0.12942E-05	52.96	7.16	-100.00
1.12	0.00	0.92769E+00	-175.43	0.12913E-05	52.53	7.13	-100.00
1.13	0.00	0.92444E+00	-175.86	0.13148E-05	50.95	7.10	-100.00
1.14	0.00	0.92147E+00	-176.27	0.13265E-05	51.41	7.07	-100.00
1.15	0.00	0.91878E+00	-176.63	0.13280E-05	50.40	7.05	-100.00
1.16	0.00	0.91635E+00	-176.96	0.13234E-05	50.60	7.02	-100.00
1.17	0.00	0.91417E+00	-177.24	0.13402E-05	49.50	7.00	-100.00
1.18	0.00	0.91224E+00	-177.47	0.13117E-05	48.61	6.98	-100.00
1.19	0.00	0.91054E+00	-177.66	0.13282E-05	48.90	6.97	-100.00
1.20	0.00	0.90905E+00	-177.80	0.13293E-05	48.78	6.95	-100.00
1.21	0.00	0.90778E+00	-177.90	0.13013E-05	48.78	6.94	-100.00
1.22	0.00	0.90671E+00	-177.94	0.13171E-05	47.68	6.93	-100.00
1.23	0.00	0.90583E+00	-177.93	0.12979E-05	48.05	6.92	-100.00
1.24	0.00	0.90515E+00	-177.87	0.12873E-05	47.35	6.92	-100.00

1.25	0.00	0.90464E+00	-177.75	0.12718E-05	46.50	6.91	-100.00
1.26	0.00	0.90432E+00	-177.59	0.12611E-05	46.02	6.91	-100.00
1.27	0.00	0.90418E+00	-177.37	0.12527E-05	46.31	6.91	-100.00
1.28	0.00	0.90422E+00	-177.10	0.12374E-05	45.60	6.91	-100.00
1.29	0.00	0.90444E+00	-176.78	0.12142E-05	46.42	6.91	-100.00
1.30	0.00	0.90484E+00	-176.41	0.12163E-05	46.67	6.91	-100.00
1.31	0.00	0.90544E+00	-175.99	0.11835E-05	44.63	6.92	-100.00
1.32	0.00	0.90623E+00	-175.52	0.11475E-05	44.78	6.93	-100.00
1.33	0.00	0.90724E+00	-175.00	0.11460E-05	44.31	6.94	-100.00
1.34	0.00	0.90844E+00	-174.43	0.11241E-05	44.05	6.95	-100.00
1.35	0.00	0.90986E+00	-173.82	0.11149E-05	45.48	6.96	-100.00
1.36	0.00	0.91152E+00	-173.16	0.10586E-05	43.57	6.98	-100.00
1.37	0.00	0.91341E+00	-172.47	0.10444E-05	43.05	6.99	-100.00
1.38	0.00	0.91556E+00	-171.73	0.10047E-05	42.56	7.02	-100.00
1.39	0.00	0.91797E+00	-170.96	0.98508E-06	42.84	7.04	-100.00
1.40	0.00	0.92063E+00	-170.15	0.95918E-06	42.44	7.06	-100.00
1.41	0.00	0.92357E+00	-169.31	0.91789E-06	41.74	7.09	-100.00
1.42	0.00	0.92680E+00	-168.45	0.90551E-06	41.39	7.12	-100.00
1.43	0.00	0.93030E+00	-167.55	0.87820E-06	40.10	7.15	-100.00
1.44	0.00	0.93410E+00	-166.63	0.86719E-06	42.52	7.19	-100.00
1.45	0.00	0.93819E+00	-165.69	0.80873E-06	37.60	7.23	-100.00
1.46	0.00	0.94258E+00	-164.72	0.80301E-06	41.55	7.27	-100.00
1.47	0.00	0.94724E+00	-163.75	0.72951E-06	38.17	7.31	-100.00
1.48	0.00	0.95220E+00	-162.75	0.72287E-06	37.01	7.36	-100.00
1.49	0.00	0.95744E+00	-161.75	0.67345E-06	39.20	7.40	-100.00
1.50	0.00	0.96296E+00	-160.75	0.66292E-06	37.12	7.45	-100.00
1.51	0.00	0.96873E+00	-159.73	0.62252E-06	35.84	7.51	-100.00
1.52	0.00	0.97475E+00	-158.72	0.57983E-06	34.07	7.56	-100.00
1.53	0.00	0.98100E+00	-157.70	0.56769E-06	35.35	7.61	-100.00
1.54	0.00	0.98747E+00	-156.69	0.55581E-06	34.57	7.67	-100.00
1.55	0.00	0.99413E+00	-155.68	0.51012E-06	33.04	7.73	-100.00
1.56	0.00	0.10010E+01	-154.68	0.48112E-06	29.52	7.79	-100.00
1.57	0.00	0.10080E+01	-153.68	0.44230E-06	28.82	7.85	-100.00
1.58	0.00	0.10151E+01	-152.70	0.42417E-06	27.15	7.91	-100.00
1.59	0.00	0.10223E+01	-151.73	0.40393E-06	27.33	7.97	-100.00
1.60	0.00	0.10296E+01	-150.78	0.35855E-06	24.86	8.03	-100.00
1.61	0.00	0.10369E+01	-149.84	0.33893E-06	18.83	8.10	-100.00
1.62	0.00	0.10442E+01	-148.91	0.30233E-06	17.65	8.16	-100.00
1.63	0.00	0.10515E+01	-148.01	0.28735E-06	20.54	8.22	-100.00
1.64	0.00	0.10588E+01	-147.12	0.25104E-06	9.56	8.28	-100.00
1.65	0.00	0.10660E+01	-146.25	0.23449E-06	2.87	8.34	-100.00
1.66	0.00	0.10731E+01	-145.41	0.19960E-06	8.66	8.39	-100.00
1.67	0.00	0.10800E+01	-144.58	0.19869E-06	2.59	8.45	-100.00
1.68	0.00	0.10868E+01	-143.78	0.18774E-06	-4.13	8.50	-100.00
1.69	0.00	0.10934E+01	-142.99	0.19039E-06	-12.85	8.56	-100.00
1.70	0.00	0.10997E+01	-142.23	0.20155E-06	-19.09	8.61	-100.00
1.71	0.00	0.11058E+01	-141.50	0.19878E-06	-34.12	8.66	-100.00
1.72	0.00	0.11116E+01	-140.78	0.14489E-06	-39.83	8.70	-100.00
1.73	0.00	0.11171E+01	-140.09	0.19302E-06	-45.08	8.74	-100.00

1.74	0.00	0.11222E+01	-139.42	0.15099E-06	-43.93	8.78	-100.00
1.75	0.00	0.11270E+01	-138.77	0.17247E-06	-57.03	8.82	-100.00
1.76	0.00	0.11315E+01	-138.14	0.16440E-06	-61.04	8.85	-100.00
1.77	0.00	0.11355E+01	-137.54	0.21043E-06	-65.81	8.89	-100.00
1.78	0.00	0.11391E+01	-136.96	0.19576E-06	-78.33	8.91	-100.00
1.79	0.00	0.11423E+01	-136.41	0.22232E-06	-72.33	8.94	-100.00
1.80	0.00	0.11450E+01	-135.87	0.21775E-06	-67.56	8.96	-100.00
1.81	0.00	0.11473E+01	-135.36	0.23491E-06	-83.19	8.97	-100.00
1.82	0.00	0.11491E+01	-134.86	0.23414E-06	-86.85	8.99	-100.00
1.83	0.00	0.11504E+01	-134.39	0.21854E-06	-86.05	9.00	-100.00
1.84	0.00	0.11513E+01	-133.95	0.25417E-06	-82.71	9.01	-100.00
1.85	0.00	0.11516E+01	-133.52	0.26231E-06	-85.01	9.01	-100.00
1.86	0.00	0.11515E+01	-133.11	0.28312E-06	-88.15	9.01	-100.00
1.87	0.00	0.11509E+01	-132.72	0.29528E-06	-89.15	9.00	-100.00
1.88	0.00	0.11498E+01	-132.36	0.29457E-06	-89.46	8.99	-100.00
1.89	0.00	0.11482E+01	-132.01	0.29265E-06	-91.58	8.98	-100.00
1.90	0.00	0.11461E+01	-131.68	0.28874E-06	-95.88	8.97	-100.00
1.91	0.00	0.11436E+01	-131.37	0.28751E-06	-92.78	8.95	-100.00
1.92	0.00	0.11406E+01	-131.08	0.26064E-06	-88.06	8.92	-100.00
1.93	0.00	0.11371E+01	-130.81	0.32492E-06	-91.30	8.90	-100.00
1.94	0.00	0.11333E+01	-130.56	0.28843E-06	-89.62	8.87	-100.00
1.95	0.00	0.11290E+01	-130.32	0.28098E-06	-86.15	8.84	-100.00
1.96	0.00	0.11242E+01	-130.10	0.32466E-06	-85.66	8.80	-100.00
1.97	0.00	0.11191E+01	-129.90	0.30742E-06	-92.89	8.76	-100.00
1.98	0.00	0.11136E+01	-129.72	0.30371E-06	-95.43	8.72	-100.00
1.99	0.00	0.11078E+01	-129.55	0.32824E-06	-88.82	8.67	-100.00
2.00	0.00	0.11017E+01	-129.39	0.30238E-06	-92.47	8.62	-100.00
2.01	0.00	0.10952E+01	-129.25	0.30907E-06	-91.83	8.57	-100.00
2.02	0.00	0.10884E+01	-129.13	0.27842E-06	-89.34	8.52	-100.00
2.03	0.00	0.10814E+01	-129.02	0.31106E-06	-89.50	8.46	-100.00
2.04	0.00	0.10742E+01	-128.92	0.29402E-06	-86.68	8.40	-100.00
2.05	0.00	0.10667E+01	-128.84	0.28123E-06	-90.69	8.34	-100.00
2.06	0.00	0.10590E+01	-128.77	0.27424E-06	-88.17	8.28	-100.00
2.07	0.00	0.10512E+01	-128.71	0.26548E-06	-88.85	8.22	-100.00
2.08	0.00	0.10433E+01	-128.65	0.24610E-06	-88.28	8.15	-100.00
2.09	0.00	0.10352E+01	-128.61	0.26011E-06	-88.26	8.08	-100.00
2.10	0.00	0.10271E+01	-128.58	0.28007E-06	-84.72	8.01	-100.00
2.11	0.00	0.10189E+01	-128.55	0.25541E-06	-81.96	7.94	-100.00
2.12	0.00	0.10107E+01	-128.54	0.27741E-06	-86.86	7.87	-100.00
2.13	0.00	0.10025E+01	-128.52	0.22809E-06	-91.40	7.80	-100.00
2.14	0.00	0.99433E+00	-128.51	0.22493E-06	-81.34	7.73	-100.00
2.15	0.00	0.98620E+00	-128.50	0.24249E-06	-78.09	7.66	-100.00
2.16	0.00	0.97814E+00	-128.50	0.22681E-06	-82.96	7.59	-100.00
2.17	0.00	0.97019E+00	-128.49	0.17701E-06	-84.78	7.52	-100.00
2.18	0.00	0.96234E+00	-128.49	0.19559E-06	-86.21	7.45	-100.00
2.19	0.00	0.95465E+00	-128.48	0.22321E-06	-83.93	7.38	-100.00
2.20	0.00	0.94713E+00	-128.46	0.21202E-06	-89.63	7.31	-100.00
2.21	0.00	0.93978E+00	-128.44	0.15033E-06	-79.34	7.24	-100.00
2.22	0.00	0.93265E+00	-128.41	0.20319E-06	-72.67	7.18	-100.00

2.23	0.00	0.92573E+00	-128.38	0.16515E-06	-83.51	7.11	-100.00
2.24	0.00	0.91905E+00	-128.33	0.17026E-06	-71.91	7.05	-100.00
2.25	0.00	0.91263E+00	-128.27	0.15855E-06	-79.51	6.99	-100.00
2.26	0.00	0.90649E+00	-128.19	0.16456E-06	-82.16	6.93	-100.00
2.27	0.00	0.90062E+00	-128.10	0.15061E-06	-77.41	6.87	-100.00
2.28	0.00	0.89505E+00	-127.99	0.15552E-06	-79.76	6.82	-100.00
2.29	0.00	0.88980E+00	-127.87	0.14356E-06	-78.15	6.77	-100.00
2.30	0.00	0.88486E+00	-127.72	0.14021E-06	-83.51	6.72	-100.00
2.31	0.00	0.88026E+00	-127.55	0.15859E-06	-73.09	6.67	-100.00
2.32	0.00	0.87600E+00	-127.35	0.14065E-06	-77.01	6.63	-100.00
2.33	0.00	0.87208E+00	-127.13	0.11278E-06	-74.91	6.59	-100.00
2.34	0.00	0.86852E+00	-126.89	0.14495E-06	-63.25	6.56	-100.00
2.35	0.00	0.86532E+00	-126.61	0.10077E-06	-87.05	6.53	-100.00
2.36	0.00	0.86250E+00	-126.31	0.11967E-06	-74.70	6.50	-100.00
2.37	0.00	0.86005E+00	-125.98	0.11605E-06	-73.28	6.47	-100.00
2.38	0.00	0.85798E+00	-125.62	0.14655E-06	-74.49	6.45	-100.00
2.39	0.00	0.85629E+00	-125.23	0.10036E-06	-71.44	6.43	-100.00
2.40	0.00	0.85501E+00	-124.81	0.12898E-06	-67.10	6.42	-100.00
2.41	0.00	0.85411E+00	-124.36	0.10000E-06	-77.07	6.41	-100.00
2.42	0.00	0.85361E+00	-123.87	0.13660E-06	-77.24	6.41	-100.00
2.43	0.00	0.85351E+00	-123.36	0.91960E-07	-85.52	6.41	-100.00
2.44	0.00	0.85381E+00	-122.81	0.94689E-07	-78.10	6.41	-100.00
2.45	0.00	0.85452E+00	-122.24	0.76837E-07	-73.88	6.42	-100.00
2.46	0.00	0.85564E+00	-121.63	0.93198E-07	-91.24	6.43	-100.00
2.47	0.00	0.85716E+00	-121.00	0.91122E-07	-93.70	6.44	-100.00
2.48	0.00	0.85908E+00	-120.34	0.98558E-07	-71.40	6.46	-100.00
2.49	0.00	0.86141E+00	-119.65	0.11062E-06	-83.49	6.49	-100.00
2.50	0.00	0.86413E+00	-118.93	0.78004E-07	-90.64	6.51	-100.00
2.51	0.00	0.86727E+00	-118.19	0.99137E-07	-87.81	6.54	-100.00
2.52	0.00	0.87078E+00	-117.43	0.11661E-06	-104.45	6.58	-100.00
2.53	0.00	0.87469E+00	-116.65	0.10406E-06	-94.77	6.62	-100.00
2.54	0.00	0.87898E+00	-115.85	0.11503E-06	-94.18	6.66	-100.00
2.55	0.00	0.88365E+00	-115.02	0.14026E-06	-97.49	6.71	-100.00
2.56	0.00	0.88869E+00	-114.18	0.13892E-06	-110.61	6.76	-100.00
2.57	0.00	0.89408E+00	-113.33	0.12830E-06	-86.62	6.81	-100.00
2.58	0.00	0.89981E+00	-112.46	0.12713E-06	-116.14	6.86	-100.00
2.59	0.00	0.90589E+00	-111.59	0.15855E-06	-107.99	6.92	-100.00
2.60	0.00	0.91227E+00	-110.70	0.14083E-06	-111.61	6.98	-100.00
2.61	0.00	0.91896E+00	-109.80	0.14338E-06	-95.66	7.05	-100.00
2.62	0.00	0.92593E+00	-108.90	0.16624E-06	-102.41	7.11	-100.00
2.63	0.00	0.93317E+00	-107.99	0.14758E-06	-109.69	7.18	-100.00
2.64	0.00	0.94065E+00	-107.08	0.12929E-06	-114.74	7.25	-100.00
2.65	0.00	0.94837E+00	-106.16	0.16452E-06	-101.08	7.32	-100.00
2.66	0.00	0.95630E+00	-105.25	0.17917E-06	-118.52	7.39	-100.00
2.67	0.00	0.96440E+00	-104.33	0.17558E-06	-95.35	7.47	-100.00
2.68	0.00	0.97266E+00	-103.42	0.19336E-06	-103.58	7.54	-100.00
2.69	0.00	0.98105E+00	-102.51	0.17188E-06	-113.13	7.62	-100.00
2.70	0.00	0.98954E+00	-101.60	0.17936E-06	-126.31	7.69	-100.00
2.71	0.00	0.99813E+00	-100.69	0.18995E-06	-103.81	7.77	-100.00

2.72	0.00	0.10068E+01	-99.80	0.21791E-06	-108.58	7.84	-100.00
2.73	0.00	0.10154E+01	-98.90	0.21121E-06	-107.59	7.91	-100.00
2.74	0.00	0.10241E+01	-98.02	0.21859E-06	-118.47	7.99	-100.00
2.75	0.00	0.10327E+01	-97.14	0.21090E-06	-114.26	8.06	-100.00
2.76	0.00	0.10413E+01	-96.27	0.21690E-06	-102.07	8.13	-100.00
2.77	0.00	0.10498E+01	-95.41	0.20124E-06	-105.90	8.20	-100.00
2.78	0.00	0.10582E+01	-94.56	0.25795E-06	-114.00	8.27	-100.00
2.79	0.00	0.10664E+01	-93.71	0.24242E-06	-107.81	8.34	-100.00
2.80	0.00	0.10745E+01	-92.88	0.24158E-06	-109.44	8.41	-100.00
2.81	0.00	0.10823E+01	-92.05	0.22904E-06	-117.86	8.47	-100.00
2.82	0.00	0.10900E+01	-91.23	0.25326E-06	-113.47	8.53	-100.00
2.83	0.00	0.10974E+01	-90.43	0.24258E-06	-103.93	8.59	-100.00
2.84	0.00	0.11046E+01	-89.63	0.24712E-06	-111.46	8.65	-100.00
2.85	0.00	0.11114E+01	-88.84	0.26973E-06	-112.79	8.70	-100.00
2.86	0.00	0.11179E+01	-88.06	0.24530E-06	-111.52	8.75	-100.00
2.87	0.00	0.11241E+01	-87.29	0.27704E-06	-117.83	8.80	-100.00
2.88	0.00	0.11300E+01	-86.53	0.24928E-06	-114.70	8.84	-100.00
2.89	0.00	0.11354E+01	-85.77	0.26591E-06	-117.23	8.88	-100.00
2.90	0.00	0.11405E+01	-85.03	0.28167E-06	-115.90	8.92	-100.00
2.91	0.00	0.11451E+01	-84.29	0.23463E-06	-114.11	8.96	-100.00
2.92	0.00	0.11493E+01	-83.57	0.28219E-06	-111.51	8.99	-100.00
2.93	0.00	0.11531E+01	-82.85	0.26561E-06	-108.64	9.02	-100.00
2.94	0.00	0.11564E+01	-82.14	0.24533E-06	-105.80	9.04	-100.00
2.95	0.00	0.11593E+01	-81.43	0.21941E-06	-107.23	9.07	-100.00
2.96	0.00	0.11616E+01	-80.74	0.23301E-06	-115.50	9.08	-100.00
2.97	0.00	0.11635E+01	-80.05	0.23037E-06	-110.00	9.10	-100.00
2.98	0.00	0.11649E+01	-79.37	0.21175E-06	-106.73	9.11	-100.00
2.99	0.00	0.11658E+01	-78.69	0.22159E-06	-117.55	9.11	-100.00
3.00	0.00	0.11662E+01	-78.02	0.22822E-06	-120.92	9.12	-100.00
3.01	0.00	0.11661E+01	-77.36	0.24765E-06	-113.42	9.12	-100.00
3.02	0.00	0.11656E+01	-76.70	0.24509E-06	-114.79	9.11	-100.00
3.03	0.00	0.11645E+01	-76.05	0.20443E-06	-124.00	9.10	-100.00
3.04	0.00	0.11629E+01	-75.40	0.18152E-06	-122.91	9.09	-100.00
3.05	0.00	0.11608E+01	-74.76	0.21321E-06	-109.66	9.08	-100.00
3.06	0.00	0.11582E+01	-74.12	0.17190E-06	-106.87	9.06	-100.00
3.07	0.00	0.11552E+01	-73.48	0.18990E-06	-125.19	9.03	-100.00
3.08	0.00	0.11517E+01	-72.85	0.15925E-06	-110.56	9.01	-100.00
3.09	0.00	0.11477E+01	-72.23	0.15658E-06	-129.86	8.98	-100.00
3.10	0.00	0.11433E+01	-71.60	0.15079E-06	-112.72	8.94	-100.00
3.11	0.00	0.11385E+01	-70.98	0.13240E-06	-107.95	8.91	-100.00
3.12	0.00	0.11332E+01	-70.36	0.11748E-06	-127.91	8.87	-100.00
3.13	0.00	0.11276E+01	-69.75	0.15158E-06	-120.86	8.82	-100.00
3.14	0.00	0.11216E+01	-69.13	0.12167E-06	-132.02	8.78	-100.00
3.15	0.00	0.11152E+01	-68.52	0.85917E-07	-159.63	8.73	-100.00
3.16	0.00	0.11084E+01	-67.91	0.85824E-07	-121.90	8.68	-100.00
3.17	0.00	0.11014E+01	-67.29	0.12412E-06	-133.49	8.62	-100.00
3.18	0.00	0.10940E+01	-66.68	0.71983E-07	161.37	8.56	-100.00
3.19	0.00	0.10864E+01	-66.07	0.95033E-07	-158.25	8.50	-100.00
3.20	0.00	0.10785E+01	-65.46	0.10269E-06	-170.91	8.44	-100.00

3.21	0.00	0.10703E+01	-64.85	0.10018E-06	167.02	8.37	-100.00
3.22	0.00	0.10620E+01	-64.24	0.70553E-07	148.03	8.30	-100.00
3.23	0.00	0.10534E+01	-63.63	0.41963E-07	140.65	8.23	-100.00
3.24	0.00	0.10448E+01	-63.01	0.86356E-07	175.10	8.16	-100.00
3.25	0.00	0.10359E+01	-62.40	0.81026E-07	146.40	8.09	-100.00
3.26	0.00	0.10270E+01	-61.78	0.12583E-06	144.99	8.01	-100.00
3.27	0.00	0.10180E+01	-61.16	0.13537E-06	140.09	7.94	-100.00
3.28	0.00	0.10090E+01	-60.53	0.95602E-07	108.67	7.86	-100.00
3.29	0.00	0.99992E+00	-59.90	0.12524E-06	127.74	7.78	-100.00
3.30	0.00	0.99085E+00	-59.27	0.14773E-06	128.04	7.70	-100.00
3.31	0.00	0.98182E+00	-58.64	0.14741E-06	131.54	7.62	-100.00
3.32	0.00	0.97283E+00	-58.00	0.14612E-06	122.60	7.54	-100.00
3.33	0.00	0.96395E+00	-57.36	0.17642E-06	116.57	7.46	-100.00
3.34	0.00	0.95516E+00	-56.71	0.17682E-06	119.94	7.38	-100.00
3.35	0.00	0.94651E+00	-56.06	0.20400E-06	115.16	7.30	-100.00
3.36	0.00	0.93803E+00	-55.40	0.20440E-06	123.42	7.23	-100.00
3.37	0.00	0.92974E+00	-54.73	0.24637E-06	116.97	7.15	-100.00
3.38	0.00	0.92164E+00	-54.07	0.22802E-06	109.03	7.07	-100.00
3.39	0.00	0.91380E+00	-53.39	0.24154E-06	116.87	7.00	-100.00
3.40	0.00	0.90620E+00	-52.71	0.25932E-06	114.44	6.93	-100.00
3.41	0.00	0.89890E+00	-52.02	0.26883E-06	108.83	6.86	-100.00
3.42	0.00	0.89189E+00	-51.33	0.23086E-06	114.64	6.79	-100.00
3.43	0.00	0.88520E+00	-50.63	0.26591E-06	115.61	6.72	-100.00
3.44	0.00	0.87886E+00	-49.93	0.27729E-06	119.25	6.66	-100.00
3.45	0.00	0.87288E+00	-49.22	0.31015E-06	118.34	6.60	-100.00
3.46	0.00	0.86728E+00	-48.50	0.29471E-06	113.89	6.54	-100.00
3.47	0.00	0.86207E+00	-47.77	0.30516E-06	122.20	6.49	-100.00
3.48	0.00	0.85727E+00	-47.04	0.33824E-06	115.52	6.44	-100.00
3.49	0.00	0.85289E+00	-46.31	0.32006E-06	110.67	6.40	-100.00
3.50	0.00	0.84895E+00	-45.57	0.35097E-06	113.90	6.36	-100.00
3.51	0.00	0.84545E+00	-44.82	0.32887E-06	111.31	6.32	-100.00
3.52	0.00	0.84241E+00	-44.07	0.36478E-06	116.80	6.29	-100.00
3.53	0.00	0.83983E+00	-43.31	0.33655E-06	114.42	6.27	-100.00
3.54	0.00	0.83772E+00	-42.55	0.37193E-06	116.75	6.24	-100.00
3.55	0.00	0.83608E+00	-41.79	0.34958E-06	121.93	6.23	-100.00
3.56	0.00	0.83493E+00	-41.02	0.34389E-06	117.32	6.21	-100.00
3.57	0.00	0.83426E+00	-40.25	0.35259E-06	119.58	6.21	-100.00
3.58	0.00	0.83406E+00	-39.47	0.35118E-06	114.47	6.21	-100.00
3.59	0.00	0.83435E+00	-38.70	0.36305E-06	115.40	6.21	-100.00
3.60	0.00	0.83512E+00	-37.92	0.37122E-06	119.56	6.22	-100.00
3.61	0.00	0.83636E+00	-37.14	0.37201E-06	124.27	6.23	-100.00
3.62	0.00	0.83807E+00	-36.35	0.34892E-06	122.07	6.25	-100.00
3.63	0.00	0.84025E+00	-35.57	0.38590E-06	118.80	6.27	-100.00
3.64	0.00	0.84288E+00	-34.79	0.38357E-06	120.43	6.30	-100.00
3.65	0.00	0.84596E+00	-34.00	0.38357E-06	122.08	6.33	-100.00
3.66	0.00	0.84946E+00	-33.22	0.36810E-06	120.37	6.36	-100.00
3.67	0.00	0.85340E+00	-32.44	0.35991E-06	122.47	6.40	-100.00
3.68	0.00	0.85775E+00	-31.66	0.35231E-06	121.43	6.45	-100.00
3.69	0.00	0.86249E+00	-30.87	0.37557E-06	122.24	6.50	-100.00

3.70	0.00	0.86761E+00	-30.09	0.37872E-06	124.82	6.55	-100.00
3.71	0.00	0.87309E+00	-29.32	0.34869E-06	125.83	6.60	-100.00
3.72	0.00	0.87892E+00	-28.54	0.36495E-06	133.43	6.66	-100.00
3.73	0.00	0.88507E+00	-27.76	0.36000E-06	129.46	6.72	-100.00
3.74	0.00	0.89154E+00	-26.99	0.31134E-06	133.71	6.78	-100.00
3.75	0.00	0.89828E+00	-26.22	0.35938E-06	127.85	6.85	-100.00
3.76	0.00	0.90529E+00	-25.44	0.32763E-06	128.23	6.92	-100.00
3.77	0.00	0.91254E+00	-24.68	0.32848E-06	126.52	6.99	-100.00
3.78	0.00	0.92002E+00	-23.91	0.33397E-06	132.25	7.06	-100.00
3.79	0.00	0.92769E+00	-23.14	0.28306E-06	138.12	7.13	-100.00
3.80	0.00	0.93553E+00	-22.38	0.29690E-06	133.14	7.20	-100.00
3.81	0.00	0.94352E+00	-21.61	0.25688E-06	133.54	7.28	-100.00
3.82	0.00	0.95163E+00	-20.85	0.28203E-06	140.39	7.35	-100.00
3.83	0.00	0.95983E+00	-20.08	0.26908E-06	138.22	7.43	-100.00
3.84	0.00	0.96812E+00	-19.32	0.26751E-06	144.64	7.50	-100.00
3.85	0.00	0.97644E+00	-18.56	0.25818E-06	137.28	7.57	-100.00
3.86	0.00	0.98480E+00	-17.80	0.24262E-06	148.90	7.65	-100.00
3.87	0.00	0.99315E+00	-17.04	0.24646E-06	141.37	7.72	-100.00
3.88	0.00	0.10015E+01	-16.27	0.21159E-06	156.30	7.79	-100.00
3.89	0.00	0.10097E+01	-15.51	0.20718E-06	158.61	7.87	-100.00
3.90	0.00	0.10179E+01	-14.74	0.19123E-06	147.40	7.94	-100.00
3.91	0.00	0.10260E+01	-13.97	0.20098E-06	161.46	8.00	-100.00
3.92	0.00	0.10340E+01	-13.20	0.18451E-06	150.81	8.07	-100.00
3.93	0.00	0.10418E+01	-12.43	0.21285E-06	167.83	8.14	-100.00
3.94	0.00	0.10495E+01	-11.66	0.18216E-06	163.94	8.20	-100.00
3.95	0.00	0.10569E+01	-10.88	0.16605E-06	174.34	8.26	-100.00
3.96	0.00	0.10641E+01	-10.10	0.16836E-06	173.95	8.32	-100.00
3.97	0.00	0.10711E+01	-9.32	0.13563E-06	-177.68	8.38	-100.00
3.98	0.00	0.10779E+01	-8.53	0.13189E-06	171.22	8.43	-100.00
3.99	0.00	0.10843E+01	-7.74	0.11746E-06	-179.60	8.48	-100.00
4.00	0.00	0.10905E+01	-6.94	0.13343E-06	-166.15	8.53	-100.00
4.01	0.00	0.10964E+01	-6.14	0.98235E-07	-162.57	8.58	-100.00
4.02	0.00	0.11019E+01	-5.33	0.98903E-07	-161.39	8.62	-100.00
4.03	0.00	0.11071E+01	-4.52	0.15801E-06	-160.08	8.67	-100.00
4.04	0.00	0.11120E+01	-3.70	0.13753E-06	-149.42	8.70	-100.00
4.05	0.00	0.11164E+01	-2.88	0.12415E-06	-117.49	8.74	-100.00
4.06	0.00	0.11205E+01	-2.04	0.14710E-06	-139.27	8.77	-100.00
4.07	0.00	0.11243E+01	-1.20	0.14181E-06	-118.11	8.80	-100.00
4.08	0.00	0.11276E+01	-0.36	0.12973E-06	-124.87	8.82	-100.00
4.09	0.00	0.11305E+01	0.50	0.13263E-06	-116.20	8.85	-100.00
4.10	0.00	0.11330E+01	1.36	0.95597E-07	-120.28	8.87	-100.00
4.11	0.00	0.11351E+01	2.23	0.12558E-06	-103.33	8.88	-100.00
4.12	0.00	0.11367E+01	3.11	0.14024E-06	-101.94	8.89	-100.00
4.13	0.00	0.11380E+01	4.00	0.17029E-06	-98.72	8.90	-100.00
4.14	0.00	0.11388E+01	4.90	0.17356E-06	-96.26	8.91	-100.00
4.15	0.00	0.11392E+01	5.81	0.15264E-06	-111.55	8.91	-100.00
4.16	0.00	0.11392E+01	6.72	0.18672E-06	-96.40	8.91	-100.00
4.17	0.00	0.11387E+01	7.65	0.18614E-06	-92.10	8.91	-100.00
4.18	0.00	0.11379E+01	8.59	0.20628E-06	-91.47	8.90	-100.00

4.19	0.00	0.11366E+01	9.54	0.12672E-06	-86.93	8.89	-100.00
4.20	0.00	0.11350E+01	10.50	0.20280E-06	-81.33	8.88	-100.00
4.21	0.00	0.11330E+01	11.47	0.19033E-06	-82.60	8.87	-100.00
4.22	0.00	0.11306E+01	12.46	0.18169E-06	-74.31	8.85	-100.00
4.23	0.00	0.11278E+01	13.45	0.16305E-06	-73.83	8.83	-100.00
4.24	0.00	0.11247E+01	14.46	0.21050E-06	-69.88	8.80	-100.00
4.25	0.00	0.11212E+01	15.48	0.16816E-06	-86.64	8.78	-100.00
4.26	0.00	0.11174E+01	16.51	0.21357E-06	-81.06	8.75	-100.00
4.27	0.00	0.11134E+01	17.56	0.23729E-06	-67.70	8.71	-100.00
4.28	0.00	0.11090E+01	18.62	0.17592E-06	-67.33	8.68	-100.00
4.29	0.00	0.11043E+01	19.69	0.19009E-06	-75.36	8.64	-100.00
4.30	0.00	0.10994E+01	20.78	0.19931E-06	-69.26	8.60	-100.00
4.31	0.00	0.10943E+01	21.87	0.20281E-06	-68.82	8.56	-100.00
4.32	0.00	0.10889E+01	22.98	0.24003E-06	-61.91	8.52	-100.00
4.33	0.00	0.10833E+01	24.11	0.22764E-06	-55.02	8.48	-100.00
4.34	0.00	0.10776E+01	25.24	0.19755E-06	-59.21	8.43	-100.00
4.35	0.00	0.10717E+01	26.39	0.21149E-06	-59.37	8.38	-100.00
4.36	0.00	0.10657E+01	27.55	0.21560E-06	-57.96	8.33	-100.00
4.37	0.00	0.10596E+01	28.72	0.21427E-06	-52.65	8.28	-100.00
4.38	0.00	0.10534E+01	29.91	0.22675E-06	-64.49	8.23	-100.00
4.39	0.00	0.10472E+01	31.10	0.22403E-06	-52.05	8.18	-100.00
4.40	0.00	0.10409E+01	32.31	0.24871E-06	-53.14	8.13	-100.00
4.41	0.00	0.10345E+01	33.53	0.20109E-06	-54.17	8.08	-100.00
4.42	0.00	0.10282E+01	34.75	0.23131E-06	-48.44	8.02	-100.00
4.43	0.00	0.10219E+01	35.99	0.20190E-06	-48.93	7.97	-100.00
4.44	0.00	0.10157E+01	37.24	0.19026E-06	-49.54	7.92	-100.00
4.45	0.00	0.10095E+01	38.49	0.19920E-06	-46.17	7.86	-100.00
4.46	0.00	0.10034E+01	39.75	0.15493E-06	-45.04	7.81	-100.00
4.47	0.00	0.99741E+00	41.02	0.18838E-06	-47.70	7.76	-100.00
4.48	0.00	0.99154E+00	42.29	0.17340E-06	-53.02	7.71	-100.00
4.49	0.00	0.98580E+00	43.57	0.18776E-06	-55.61	7.66	-100.00
4.50	0.00	0.98022E+00	44.85	0.18431E-06	-52.94	7.61	-100.00
4.51	0.00	0.97481E+00	46.13	0.17216E-06	-53.83	7.56	-100.00
4.52	0.00	0.96959E+00	47.42	0.17088E-06	-32.27	7.51	-100.00
4.53	0.00	0.96455E+00	48.70	0.15158E-06	-45.81	7.47	-100.00
4.54	0.00	0.95974E+00	49.98	0.12446E-06	-38.02	7.42	-100.00
4.55	0.00	0.95513E+00	51.26	0.14323E-06	-43.18	7.38	-100.00
4.56	0.00	0.95075E+00	52.54	0.19358E-06	-25.15	7.34	-100.00
4.57	0.00	0.94660E+00	53.81	0.13025E-06	-41.82	7.30	-100.00
4.58	0.00	0.94270E+00	55.07	0.11945E-06	-35.84	7.27	-100.00
4.59	0.00	0.93904E+00	56.33	0.12377E-06	-41.13	7.24	-100.00
4.60	0.00	0.93564E+00	57.57	0.11193E-06	-31.18	7.20	-100.00
4.61	0.00	0.93248E+00	58.81	0.73840E-07	-27.77	7.17	-100.00
4.62	0.00	0.92959E+00	60.04	0.12944E-06	-39.57	7.15	-100.00
4.63	0.00	0.92694E+00	61.25	0.75711E-07	-2.52	7.12	-100.00
4.64	0.00	0.92455E+00	62.45	0.97592E-07	-20.84	7.10	-100.00
4.65	0.00	0.92242E+00	63.63	0.83065E-07	2.15	7.08	-100.00
4.66	0.00	0.92054E+00	64.80	0.78263E-07	-7.81	7.06	-100.00
4.67	0.00	0.91892E+00	65.95	0.11569E-06	-29.72	7.05	-100.00

4.68	0.00	0.91753E+00	67.09	0.47719E-07	-5.35	7.03	-100.00
4.69	0.00	0.91639E+00	68.21	0.47560E-07	-7.80	7.02	-100.00
4.70	0.00	0.91549E+00	69.30	0.71877E-07	-9.24	7.01	-100.00
4.71	0.00	0.91481E+00	70.38	0.47105E-07	-14.22	7.01	-100.00
4.72	0.00	0.91437E+00	71.44	0.88684E-07	-9.64	7.00	-100.00
4.73	0.00	0.91415E+00	72.48	0.74018E-08	-76.50	7.00	-100.00
4.74	0.00	0.91414E+00	73.50	0.25772E-07	60.85	7.00	-100.00
4.75	0.00	0.91433E+00	74.50	0.63761E-07	25.32	7.00	-100.00
4.76	0.00	0.91474E+00	75.48	0.44865E-07	33.36	7.01	-100.00
4.77	0.00	0.91533E+00	76.43	0.54427E-07	2.30	7.01	-100.00
4.78	0.00	0.91611E+00	77.37	0.57880E-07	76.54	7.02	-100.00
4.79	0.00	0.91707E+00	78.29	0.20459E-07	71.17	7.03	-100.00
4.80	0.00	0.91820E+00	79.19	0.41872E-07	91.55	7.04	-100.00
4.81	0.00	0.91949E+00	80.07	0.76190E-07	34.55	7.05	-100.00
4.82	0.00	0.92094E+00	80.93	0.23581E-07	43.28	7.07	-100.00
4.83	0.00	0.92254E+00	81.77	0.20442E-07	77.30	7.08	-100.00
4.84	0.00	0.92428E+00	82.60	0.21026E-07	128.15	7.10	-100.00
4.85	0.00	0.92616E+00	83.41	0.17120E-07	159.03	7.12	-100.00
4.86	0.00	0.92816E+00	84.20	0.34021E-07	72.24	7.13	-100.00
4.87	0.00	0.93029E+00	84.98	0.46481E-07	156.62	7.15	-100.00
4.88	0.00	0.93253E+00	85.74	0.31233E-07	69.73	7.17	-100.00
4.89	0.00	0.93487E+00	86.50	0.27265E-07	156.29	7.20	-100.00
4.90	0.00	0.93731E+00	87.24	0.50039E-07	140.35	7.22	-100.00
4.91	0.00	0.93983E+00	87.97	0.55629E-07	142.97	7.24	-100.00
4.92	0.00	0.94243E+00	88.69	0.49028E-07	104.90	7.27	-100.00
4.93	0.00	0.94510E+00	89.40	0.59928E-07	141.72	7.29	-100.00
4.94	0.00	0.94784E+00	90.11	0.67391E-07	148.43	7.32	-100.00
4.95	0.00	0.95063E+00	90.81	0.37262E-07	136.65	7.34	-100.00
4.96	0.00	0.95347E+00	91.51	0.26179E-07	126.57	7.37	-100.00
4.97	0.00	0.95634E+00	92.20	0.44325E-07	142.46	7.39	-100.00
4.98	0.00	0.95925E+00	92.89	0.66322E-07	107.62	7.42	-100.00
4.99	0.00	0.96218E+00	93.58	0.22497E-07	124.11	7.45	-100.00
5.00	0.00	0.96512E+00	94.27	0.33504E-07	-162.70	7.47	-100.00

Análise de Antenas

Prof. Fernando J. S. Moreira

Lista 9 - Entregar dia 18 de dezembro de 2024.

0 - Estudar Balanis, Seções 12.1–12.9 e 15.4.

1 - Balanis, problema 15.12 (4a. Edição).

2 - Balanis, problema 15.13 (4a. Edição). Note que o modelo do alimentador não é igual ao cosseno-elevado adotado nas notas de aula e no livro do Balanis.

3 - Balanis, problema 15.23 (4a. Edição).

4 - Balanis, problema 15.24 (4a. Edição).

Trabalho (parte 5) - Continuando o trabalho da parte anterior, note que o campo distante a ser determinado é dado por:

$$\vec{E}(\vec{r}) \approx -j \frac{\omega\mu}{4\pi} \frac{e^{-jkr}}{r} \int_0^{2\pi} \int_0^{D/2} \left\{ \vec{J}(\vec{r}') - \left[\vec{J}(\vec{r}') \cdot \hat{r} \right] \hat{r} \right\} e^{jk\hat{r} \cdot \vec{r}'} \rho' d\rho' d\phi'.$$

Ou seja, para cada par (θ, ϕ) uma nova integral tem que ser avaliada. Porém, independentemente da direção do observador, a distribuição da corrente $\vec{J}(\vec{r}')$ permanece a mesma. Logo, pode-se economizar um grande tempo de computação se esta corrente for calculada uma única vez, armazenada adequadamente numa matriz e reutilizada para novos pares (θ, ϕ) , desde que a grade do domínio de integração (ρ', ϕ') não seja alterada.

Logo, modifique o seu programa para incorporar este procedimento. Compare os tempos de processamento antes e após esta modificação.

Na data indicada pelo professor, para esta parte do trabalho você tem que fornecer o arquivo com a listagem do programa e a listagem impressa, junto com os gráficos dos diagramas de radiação, da mesma maneira exigida na quarta parte do trabalho.

Além disso, você deve fornecer porcentualmente o tempo economizado com as alterações pedidas.

Se o problema envolve-se dois ou mais refletores (aqui temos apenas um), a diferença de tempo seria absurda...

Análise de Antenas

Prof. Fernando J. S. Moreira

Lista 10 (última) - Entregar dia 08 de janeiro de 2025.

0 - Estudar Balanis, Seções 12.1–12.9 e 15.4.

1 - Projete um refletor parabólico *offset* (ou seja, ache o expoente n do modelo de alimentador RCF) com $D = 150 \lambda$, $F = 120 \lambda$ e $d_o = 80 \lambda$.

2 - Na solução dos itens abaixo, utilize resultados já obtidos em aula.

- a) Proponha um modelo *cosseno-elevado* para um alimentador com polarização RHCP, de tal forma que este não possua polarização cruzada de acordo com a terceira definição de Ludwig. Repita o problema para uma polarização LHCP.
- b) Assumindo que o alimentador seja utilizado para excitar um parabolóide simétrico, determine o campo elétrico na abertura da antena através dos princípios da Ótica Geométrica.
- c) Determine a polarização, em $\theta = 0$, do campo radiado pela abertura. Como esta se compara com a do alimentador? Por quê?

3 - Um modelo alternativo de cosseno-elevado para o alimentador de uma antena refletora é o seguinte:

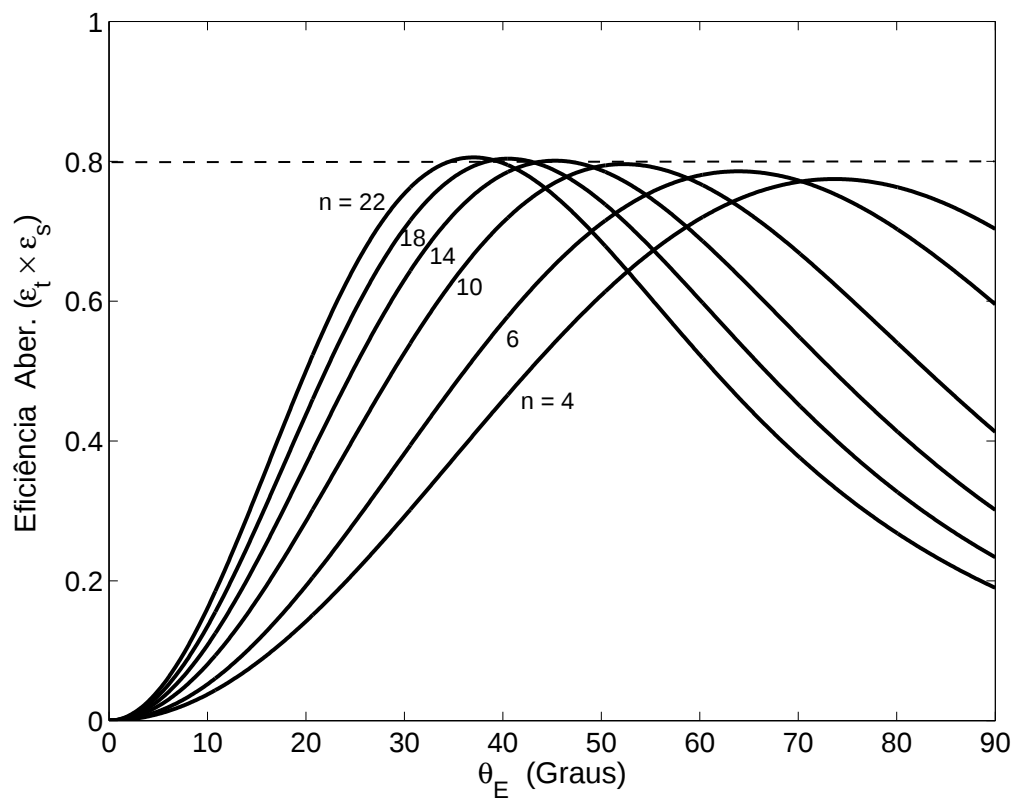
$$f(\theta_F) = \cos^n\left(\frac{\theta_F}{2}\right), \quad 0 \leq \theta_F \leq \pi,$$

e $\vec{E}(\vec{r}_F) = f(\theta_F) \exp(-jkr_F)/r_F \hat{e}_F$ é o campo elétrico radiado.

- a) Determine a diretividade deste modelo de alimentador.
- b) Assumindo que o alimentador acima ilumine um refletor parabólico *front-fed* com ângulo de borda θ_E , determine em função de n e θ_E a eficiência de iluminação ϵ_t e a eficiência de transbordamento ϵ_s .
- c) Mostre que a eficiência $\epsilon_{ap} = \epsilon_t \times \epsilon_s$ da antena refletora é dada por

$$\epsilon_{ap} = \frac{4(n+1)}{n^2} \cot^2\left(\frac{\theta_E}{2}\right) \left[1 - \cos^n\left(\frac{\theta_E}{2}\right)\right]^2$$

Para este modelo de alimentador obtém-se os resultados da próxima página (compare-os aos resultados do modelo RCF das notas de aula).



Eficiência da antena refletora em função de n e θ_E .

n	θ_E	F/D_P	AB(dB)	ϵ_{ap}
4	73,7°	0,334	−11,62	0,775
6	63,9°	0,401	−11,41	0,786
10	52,3°	0,509	−11,26	0,796
14	45,3°	0,599	−11,15	0,801
18	40,6°	0,677	−11,11	0,804
22	37°	0,747	−11,06	0,806

Atenuação na borda do refletor nos pontos de máxima eficiência.

Trabalho (parte 6) - Agora vamos incluir a superfície parabólica para ser analisada via Óptica Física. O campo distante radiado pela antena refletora é dado por:

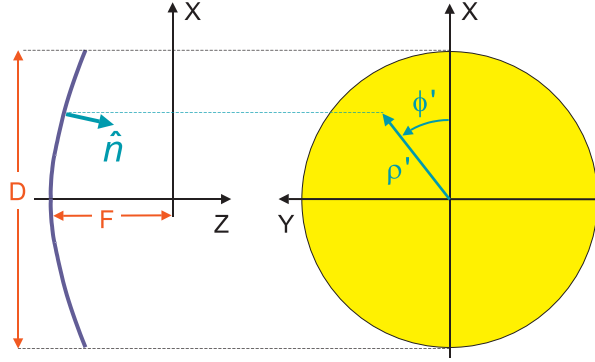
$$\vec{E}(\vec{r}) \approx -j \frac{\omega\mu}{4\pi} \frac{e^{-jkr}}{r} \iint_S \left\{ \vec{J}(\vec{r}') - \left[\vec{J}(\vec{r}') \cdot \hat{r} \right] \hat{r} \right\} e^{jk\hat{r} \cdot \vec{r}'} ds' ,$$

onde

$$\vec{J} \approx \vec{J}_{PO} = 2 \hat{n} \times \vec{H}_{in}$$

é a corrente na superfície do refletor parabólico dada pela aproximação da Óptica Física e a integral dupla tem que ser avaliada sobre tal superfície (S).

Felizmente, esta integral não é tão complicada de ser avaliada, dado que a projeção do refletor parabólico descreve um círculo no plano da abertura (veja a figura abaixo). Logo, podemos continuar utilizando as coordenadas



cilíndricas ρ' e ϕ' para avaliar as integrais, só que através de um Jacobiano apropriado, dado pela razão entre a área infinitesimal sobre o parabolóide e aquela projetada na abertura. Ou seja:

$$ds' = \frac{\rho' d\rho' d\phi'}{|\hat{n} \cdot \hat{z}|} ,$$

onde $\hat{n}$ é a normal à superfície no ponto correspondente à projeção (ρ', ϕ') na abertura (veja a figura). Consequentemente:

$$\vec{E}(\vec{r}) \approx -j \frac{\omega\mu}{4\pi} \frac{e^{-jkr}}{r} \int_0^{2\pi} \int_0^{D/2} \frac{\left\{ \vec{J}(\vec{r}') - \left[\vec{J}(\vec{r}') \cdot \hat{r} \right] \hat{r} \right\}}{|\hat{n} \cdot \hat{z}|} e^{jk\hat{r} \cdot \vec{r}'} \rho' d\rho' d\phi' .$$

Note que este Jacobiano pode ser calculado uma única vez e armazenado numa matriz, incorporado às componentes da corrente $\vec{J}$.

Para conferir os resultados é apresentada a tabela abaixo, onde $D = 100 \lambda$, $F = 40 \lambda$ e o expoente $n = 1,40$ para um modelo cosseno-elevado correspondendo a uma atenuação de borda de aproximadamente 11 dB. Note que os valores de ganho foram “truncados” em -100 dBi e que os valores de $|E_\phi|$ para $\phi = 0^\circ$ e de $|E_\theta|$ para $\phi = 90^\circ$ são desprezíveis (na realidade, nulos). Foram utilizados NRADAL = 61 anéis, suficiente apenas para assegurar convergência em torno do eixo z . Os resultados apresentam o campo com fator de onda esférica removido.

Na data indicada pelo professor, para esta última parte do trabalho você tem que fornecer o arquivo com a listagem do programa e a listagem impressa, junto com os gráficos dos ganhos das polarizações principal (G_{CO}) e cruzada (G_{CX}) nos 3 planos principais: $\phi = 0^\circ$, 45° e 90° . Apresente tanto gráficos para $-10^\circ \leq \theta \leq 10^\circ$ como também para $0^\circ \leq \theta \leq 90^\circ$, com os valores dos ganhos em decibéis entre -50 dBi e 50 dBi.

PARTE 6 DO TRABALHO

PARABOLÓIDE SIMÉTRICO (D=100 E F=40 LAMBDA), COM COSENO-ELEVADO (N=1,40) E NRADAL=61

THETA (DEG)	PHI (DEG)	ETHETA		E PHI		COPOL	CXPOL
		AMPL (VOLTS)	PHASE (DEG)	AMPL (VOLTS)	PHASE (DEG)	(GAIN dB)	
0.00	0.00	0.10285E+03	-90.00	0.72579E-06	-90.01	49.05	-100.00
0.25	0.00	0.85626E+02	-89.92	0.17888E-05	-162.61	47.46	-100.00
0.50	0.00	0.46501E+02	-89.69	0.22278E-05	-177.40	42.16	-100.00
0.75	0.00	0.11273E+02	-89.26	0.14572E-05	168.80	29.85	-100.00
1.00	0.00	0.38053E+01	90.81	0.46831E-06	116.77	20.42	-100.00
1.25	0.00	0.23089E+01	91.08	0.58105E-06	31.77	16.08	-100.00
1.50	0.00	0.22179E+01	-86.81	0.50740E-06	10.37	15.73	-100.00
1.75	0.00	0.19233E+01	-86.59	0.25365E-06	-16.78	14.49	-100.00
2.00	0.00	0.93619E+00	96.19	0.17614E-06	-46.38	8.24	-100.00
2.25	0.00	0.15668E+01	96.25	0.17255E-06	-39.57	12.71	-100.00
2.50	0.00	0.20527E+00	-76.69	0.13232E-06	-41.92	-4.95	-100.00
2.75	0.00	0.12182E+01	-80.14	0.87043E-07	-93.20	10.52	-100.00
3.00	0.00	0.23626E+00	-82.35	0.92826E-07	-121.57	-3.72	-100.00
3.25	0.00	0.86800E+00	104.27	0.47274E-07	-68.41	7.58	-100.00
3.50	0.00	0.47949E+00	104.49	0.91106E-07	-2.90	2.42	-100.00
3.75	0.00	0.53451E+00	-70.28	0.75820E-07	1.81	3.37	-100.00
4.00	0.00	0.57843E+00	-69.70	0.21773E-07	-66.57	4.05	-100.00
4.25	0.00	0.23775E+00	117.10	0.35025E-07	-112.40	-3.67	-100.00
4.50	0.00	0.56905E+00	116.50	0.34504E-07	-22.29	3.91	-100.00
4.75	0.00	0.15018E-01	50.87	0.90065E-07	10.57	-27.66	-100.00
5.00	0.00	0.48351E+00	-56.52	0.12342E-06	12.56	2.50	-100.00
5.25	0.00	0.18374E+00	-57.17	0.14892E-06	6.31	-5.91	-100.00
5.50	0.00	0.35032E+00	131.30	0.18770E-06	-0.64	-0.30	-100.00

5.75	0.00	0.29133E+00	132.12	0.21265E-06	-8.11	-1.90	-100.00
6.00	0.00	0.19737E+00	-39.02	0.19659E-06	-21.47	-5.29	-100.00
6.25	0.00	0.33188E+00	-38.76	0.15864E-06	-42.54	-0.77	-100.00
6.50	0.00	0.48625E-01	159.62	0.11681E-06	-63.04	-17.45	-100.00
6.75	0.00	0.31365E+00	150.60	0.66257E-07	-79.71	-1.26	-100.00
7.00	0.00	0.80438E-01	146.81	0.33884E-07	-114.61	-13.08	-100.00
7.25	0.00	0.25042E+00	-18.78	0.41268E-07	-141.73	-3.22	-100.00
7.50	0.00	0.17025E+00	-17.88	0.46750E-07	-146.64	-6.57	-100.00
7.75	0.00	0.15942E+00	172.72	0.33653E-07	176.52	-7.14	-100.00
8.00	0.00	0.21802E+00	173.66	0.54536E-07	117.04	-4.42	-100.00
8.25	0.00	0.58271E-01	11.54	0.77650E-07	103.41	-15.88	-100.00
8.50	0.00	0.22137E+00	6.22	0.71762E-07	98.99	-4.29	-100.00
8.75	0.00	0.37920E-01	-2.51	0.62271E-07	95.37	-19.61	-100.00
9.00	0.00	0.18889E+00	-161.31	0.72143E-07	96.17	-5.67	-100.00
9.25	0.00	0.11256E+00	-160.87	0.89648E-07	99.63	-10.16	-100.00
9.50	0.00	0.12689E+00	33.81	0.91965E-07	101.39	-9.12	-100.00
9.75	0.00	0.15478E+00	34.93	0.79433E-07	103.03	-7.40	-100.00
10.00	0.00	0.54850E-01	-128.04	0.69226E-07	112.64	-16.41	-100.00
10.25	0.00	0.16798E+00	-130.81	0.67658E-07	131.56	-6.69	-100.00
10.50	0.00	0.24815E-01	-147.96	0.57916E-07	151.32	-23.30	-100.00
10.75	0.00	0.14459E+00	65.31	0.27617E-07	-171.98	-7.99	-100.00
11.00	0.00	0.80670E-01	65.70	0.33928E-07	-71.25	-13.06	-100.00
11.25	0.00	0.10328E+00	-98.18	0.61735E-07	-56.59	-10.91	-100.00
11.50	0.00	0.12265E+00	-96.52	0.74297E-07	-63.25	-9.42	-100.00
11.75	0.00	0.41177E-01	106.17	0.80032E-07	-71.47	-18.90	-100.00
12.00	0.00	0.12923E+00	101.08	0.75478E-07	-74.12	-8.96	-100.00
12.25	0.00	0.18276E-01	78.57	0.59296E-07	-78.99	-25.95	-100.00
12.50	0.00	0.11831E+00	-60.42	0.47836E-07	-98.87	-9.73	-100.00
12.75	0.00	0.71568E-01	-59.25	0.52495E-07	-114.05	-14.10	-100.00
13.00	0.00	0.75851E-01	138.84	0.52445E-07	-106.48	-13.59	-100.00
13.25	0.00	0.97604E-01	139.93	0.42035E-07	-79.14	-11.40	-100.00
13.50	0.00	0.32918E-01	-9.31	0.36755E-07	-37.80	-20.84	-100.00
13.75	0.00	0.11042E+00	-17.83	0.38887E-07	-7.53	-10.33	-100.00
14.00	0.00	0.25809E-01	-23.64	0.40171E-07	8.40	-22.96	-100.00
14.25	0.00	0.89501E-01	-179.61	0.39480E-07	18.27	-12.16	-100.00
14.50	0.00	0.62883E-01	-179.98	0.34998E-07	25.33	-15.22	-100.00
14.75	0.00	0.59951E-01	29.21	0.24115E-07	30.74	-15.64	-100.00
15.00	0.00	0.89596E-01	29.06	0.89436E-08	51.57	-12.15	-100.00
15.25	0.00	0.12312E-01	-119.44	0.11279E-07	157.22	-29.38	-100.00
15.50	0.00	0.89348E-01	-133.42	0.21667E-07	160.29	-12.17	-100.00
15.75	0.00	0.33812E-01	-143.65	0.25094E-07	137.10	-20.61	-100.00
16.00	0.00	0.71109E-01	77.75	0.36185E-07	103.51	-14.15	-100.00
16.25	0.00	0.63645E-01	79.53	0.58493E-07	94.83	-15.12	-100.00
16.50	0.00	0.37603E-01	-84.37	0.77731E-07	101.94	-19.69	-100.00
16.75	0.00	0.82149E-01	-82.77	0.87827E-07	112.13	-12.90	-100.00
17.00	0.00	0.16234E-01	-126.70	0.88998E-07	118.77	-26.98	-100.00
17.25	0.00	0.70630E-01	130.56	0.83472E-07	122.85	-14.21	-100.00
17.50	0.00	0.38298E-01	130.87	0.68880E-07	132.63	-19.53	-100.00
17.75	0.00	0.54343E-01	-29.46	0.43690E-07	160.64	-16.49	-100.00

18.00	0.00	0.72102E-01	-26.92	0.27569E-07	-128.41	-14.03	-100.00
18.25	0.00	0.14097E-01	-129.65	0.35400E-07	-56.76	-28.21	-100.00
18.50	0.00	0.64155E-01	-174.32	0.43691E-07	-7.33	-15.05	-100.00
18.75	0.00	0.18805E-01	171.02	0.46606E-07	28.30	-25.71	-100.00
19.00	0.00	0.63188E-01	32.50	0.38392E-07	44.36	-15.18	-100.00
19.25	0.00	0.60881E-01	34.99	0.28023E-07	29.28	-15.50	-100.00
19.50	0.00	0.19227E-01	-103.78	0.34509E-07	9.77	-25.51	-100.00
19.75	0.00	0.57596E-01	-118.10	0.45468E-07	17.29	-15.98	-100.00
20.00	0.00	0.14410E-01	-177.41	0.54709E-07	31.86	-28.02	-100.00
20.25	0.00	0.64952E-01	100.31	0.63059E-07	43.35	-14.94	-100.00
20.50	0.00	0.48622E-01	102.97	0.67899E-07	53.40	-17.46	-100.00
20.75	0.00	0.26732E-01	-56.47	0.65221E-07	67.29	-22.65	-100.00
21.00	0.00	0.55580E-01	-58.89	0.57389E-07	87.84	-16.29	-100.00
21.25	0.00	0.20169E-01	-128.39	0.52572E-07	110.63	-25.10	-100.00
21.50	0.00	0.60516E-01	172.65	0.51799E-07	126.14	-15.55	-100.00
21.75	0.00	0.35499E-01	174.81	0.48707E-07	135.23	-20.19	-100.00
22.00	0.00	0.36144E-01	7.24	0.37036E-07	146.75	-20.03	-100.00
22.25	0.00	0.58696E-01	8.30	0.18752E-07	-179.35	-15.82	-100.00
22.50	0.00	0.22964E-01	-50.08	0.19922E-07	-96.74	-23.97	-100.00
22.75	0.00	0.51614E-01	-113.28	0.35496E-07	-73.76	-16.94	-100.00
23.00	0.00	0.23337E-01	-119.00	0.47933E-07	-70.82	-23.83	-100.00
23.25	0.00	0.45291E-01	85.30	0.57332E-07	-69.95	-18.07	-100.00
23.50	0.00	0.63578E-01	86.14	0.60494E-07	-68.02	-15.13	-100.00
23.75	0.00	0.21153E-01	42.66	0.55531E-07	-69.51	-24.68	-100.00
24.00	0.00	0.42512E-01	-42.88	0.48694E-07	-79.79	-18.62	-100.00
24.25	0.00	0.20792E-01	-73.43	0.47696E-07	-92.79	-24.83	-100.00
24.50	0.00	0.51102E-01	175.22	0.48155E-07	-96.62	-17.02	-100.00
24.75	0.00	0.65930E-01	173.01	0.44619E-07	-90.14	-14.81	-100.00
25.00	0.00	0.16081E-01	143.78	0.39641E-07	-74.01	-27.07	-100.00
25.25	0.00	0.42063E-01	23.03	0.36555E-07	-50.59	-18.71	-100.00
25.50	0.00	0.35001E-01	-6.77	0.31920E-07	-26.12	-20.31	-100.00
25.75	0.00	0.51634E-01	-84.03	0.19311E-07	-1.49	-16.93	-100.00
26.00	0.00	0.62634E-01	-94.67	0.27720E-08	111.00	-15.26	-100.00
26.25	0.00	0.94824E-02	-127.96	0.17593E-07	-160.32	-31.65	-100.00
26.50	0.00	0.54600E-01	102.17	0.23165E-07	-142.54	-16.45	-100.00
26.75	0.00	0.57147E-01	87.56	0.20512E-07	-138.96	-16.05	-100.00
27.00	0.00	0.47426E-01	27.66	0.24077E-07	-146.65	-17.67	-100.00
27.25	0.00	0.53527E-01	-3.33	0.39709E-07	-135.18	-16.62	-100.00
27.50	0.00	0.15314E-01	-89.40	0.61057E-07	-113.56	-27.49	-100.00
27.75	0.00	0.73104E-01	-157.75	0.80098E-07	-93.09	-13.91	-100.00
28.00	0.00	0.81369E-01	-166.64	0.90867E-07	-77.10	-12.98	-100.00
28.25	0.00	0.43341E-01	147.90	0.93864E-07	-66.62	-18.45	-100.00
28.50	0.00	0.49955E-01	77.03	0.93329E-07	-60.53	-17.22	-100.00
28.75	0.00	0.47689E-01	11.35	0.89933E-07	-55.76	-17.62	-100.00
29.00	0.00	0.94298E-01	-40.42	0.79898E-07	-50.11	-11.70	-100.00
29.25	0.00	0.10600E+00	-55.49	0.61951E-07	-42.69	-10.69	-100.00
29.50	0.00	0.49756E-01	-97.62	0.40539E-07	-30.11	-17.25	-100.00
29.75	0.00	0.79029E-01	167.96	0.23701E-07	0.63	-13.24	-100.00
30.00	0.00	0.11384E+00	132.63	0.20363E-07	52.85	-10.07	-100.00

30.25	0.00	0.13766E+00	91.79	0.21059E-07	90.87	-8.42	-100.00
30.50	0.00	0.15132E+00	60.77	0.14592E-07	143.19	-7.59	-100.00
30.75	0.00	0.11055E+00	13.10	0.23023E-07	-130.63	-10.32	-100.00
31.00	0.00	0.16788E+00	-57.83	0.42591E-07	-99.30	-6.69	-100.00
31.25	0.00	0.26178E+00	-87.89	0.47147E-07	-84.35	-2.83	-100.00
31.50	0.00	0.29400E+00	-117.39	0.28715E-07	-82.02	-1.82	-100.00
31.75	0.00	0.32039E+00	-153.52	0.15799E-07	-166.67	-1.08	-100.00
32.00	0.00	0.34945E+00	169.21	0.38020E-07	172.25	-0.32	-100.00
32.25	0.00	0.41742E+00	127.75	0.35575E-07	-171.64	1.22	-100.00
32.50	0.00	0.57622E+00	96.07	0.14051E-07	-78.87	4.02	-100.00
32.75	0.00	0.71057E+00	75.15	0.54549E-07	-0.92	5.84	-100.00
33.00	0.00	0.76084E+00	54.94	0.91045E-07	17.66	6.43	-100.00
33.25	0.00	0.78491E+00	32.89	0.98702E-07	28.48	6.70	-100.00
33.50	0.00	0.80774E+00	12.29	0.81631E-07	32.03	6.95	-100.00
33.75	0.00	0.82072E+00	-6.27	0.58090E-07	25.46	7.09	-100.00
34.00	0.00	0.85497E+00	-21.00	0.41222E-07	8.97	7.45	-100.00
34.25	0.00	0.89573E+00	-27.16	0.33781E-07	-16.38	7.85	-100.00
34.50	0.00	0.89257E+00	-24.12	0.41405E-07	-36.70	7.82	-100.00
34.75	0.00	0.85468E+00	-14.77	0.57878E-07	-32.82	7.44	-100.00
35.00	0.00	0.82667E+00	-2.52	0.70149E-07	-14.39	7.15	-100.00
35.25	0.00	0.81553E+00	10.25	0.69124E-07	11.05	7.04	-100.00
35.50	0.00	0.77922E+00	23.12	0.52328E-07	45.03	6.64	-100.00
35.75	0.00	0.67816E+00	36.48	0.33381E-07	105.71	5.43	-100.00
36.00	0.00	0.52535E+00	50.65	0.41738E-07	178.17	3.22	-100.00
36.25	0.00	0.38044E+00	65.90	0.56253E-07	-146.57	0.41	-100.00
36.50	0.00	0.29660E+00	81.54	0.56553E-07	-129.35	-1.75	-100.00
36.75	0.00	0.27935E+00	94.15	0.48490E-07	-126.76	-2.27	-100.00
37.00	0.00	0.30139E+00	101.58	0.48193E-07	-132.33	-1.61	-100.00
37.25	0.00	0.34353E+00	107.18	0.56511E-07	-124.92	-0.47	-100.00
37.50	0.00	0.39565E+00	117.95	0.62865E-07	-103.22	0.75	-100.00
37.75	0.00	0.44408E+00	138.98	0.62679E-07	-75.83	1.76	-100.00
38.00	0.00	0.49724E+00	169.80	0.53680E-07	-50.02	2.74	-100.00
38.25	0.00	0.57389E+00	-155.96	0.36148E-07	-33.19	3.98	-100.00
38.50	0.00	0.64709E+00	-123.91	0.19758E-07	-45.61	5.03	-100.00
38.75	0.00	0.66771E+00	-93.70	0.21313E-07	-76.41	5.30	-100.00
39.00	0.00	0.62355E+00	-61.92	0.24016E-07	-70.45	4.71	-100.00
39.25	0.00	0.54951E+00	-25.32	0.16376E-07	-50.74	3.61	-100.00
39.50	0.00	0.48664E+00	15.69	0.25327E-08	-11.45	2.55	-100.00
39.75	0.00	0.42230E+00	57.07	0.11398E-07	165.98	1.32	-100.00
40.00	0.00	0.31060E+00	99.86	0.21919E-07	-172.38	-1.35	-100.00
40.25	0.00	0.16878E+00	162.60	0.31297E-07	-156.23	-6.65	-100.00
40.50	0.00	0.17375E+00	-95.02	0.43556E-07	-141.59	-6.39	-100.00
40.75	0.00	0.27257E+00	-34.22	0.59381E-07	-124.40	-2.48	-100.00
41.00	0.00	0.31162E+00	16.33	0.74386E-07	-104.12	-1.32	-100.00
41.25	0.00	0.32303E+00	72.84	0.82448E-07	-81.82	-1.01	-100.00
41.50	0.00	0.36330E+00	129.56	0.79676E-07	-58.54	0.01	-100.00
41.75	0.00	0.39941E+00	179.79	0.66397E-07	-35.62	0.84	-100.00
42.00	0.00	0.39037E+00	-130.78	0.46950E-07	-16.95	0.64	-100.00
42.25	0.00	0.36524E+00	-76.35	0.30356E-07	-15.32	0.06	-100.00

42.50	0.00	0.36135E+00	-21.64	0.32550E-07	-29.98	-0.03	-100.00
42.75	0.00	0.33295E+00	26.45	0.49235E-07	-18.20	-0.74	-100.00
43.00	0.00	0.22268E+00	72.86	0.65127E-07	10.21	-4.24	-100.00
43.25	0.00	0.72867E-01	163.31	0.73570E-07	44.93	-13.94	-100.00
43.50	0.00	0.18019E+00	-71.16	0.71870E-07	82.75	-6.08	-100.00
43.75	0.00	0.29595E+00	-18.84	0.59903E-07	122.09	-1.77	-100.00
44.00	0.00	0.33293E+00	34.42	0.39094E-07	160.95	-0.74	-100.00
44.25	0.00	0.33891E+00	94.98	0.12414E-07	-170.92	-0.59	-100.00
44.50	0.00	0.34987E+00	157.82	0.17390E-07	81.50	-0.31	-100.00
44.75	0.00	0.35135E+00	-138.62	0.41099E-07	115.04	-0.28	-100.00
45.00	0.00	0.36673E+00	-71.95	0.55455E-07	156.70	0.10	-100.00
45.25	0.00	0.42094E+00	-10.99	0.60753E-07	-156.90	1.29	-100.00
45.50	0.00	0.44047E+00	38.62	0.62863E-07	-106.98	1.69	-100.00
45.75	0.00	0.34834E+00	81.38	0.66327E-07	-59.02	-0.35	-100.00
46.00	0.00	0.14859E+00	124.19	0.68971E-07	-18.10	-7.75	-100.00
46.25	0.00	0.88080E-01	-35.38	0.67216E-07	15.35	-12.29	-100.00
46.50	0.00	0.26356E+00	12.91	0.61110E-07	43.26	-2.77	-100.00
46.75	0.00	0.33445E+00	59.32	0.52710E-07	68.77	-0.71	-100.00
47.00	0.00	0.31896E+00	113.13	0.42745E-07	96.21	-1.12	-100.00
47.25	0.00	0.27462E+00	177.24	0.30517E-07	131.17	-2.42	-100.00
47.50	0.00	0.24698E+00	-108.31	0.17692E-07	-171.19	-3.34	-100.00
47.75	0.00	0.27969E+00	-29.63	0.18441E-07	-72.47	-2.26	-100.00
48.00	0.00	0.37921E+00	35.27	0.34210E-07	-10.96	0.39	-100.00
48.25	0.00	0.46247E+00	84.59	0.48818E-07	31.71	2.11	-100.00
48.50	0.00	0.45063E+00	124.95	0.55313E-07	70.73	1.88	-100.00
48.75	0.00	0.32782E+00	158.79	0.50506E-07	111.02	-0.88	-100.00
49.00	0.00	0.15064E+00	177.15	0.35919E-07	159.16	-7.63	-100.00
49.25	0.00	0.99936E-01	126.71	0.21991E-07	-124.45	-11.20	-100.00
49.50	0.00	0.18443E+00	138.86	0.27059E-07	-33.08	-5.88	-100.00
49.75	0.00	0.22141E+00	-177.75	0.36489E-07	26.58	-4.29	-100.00
50.00	0.00	0.23237E+00	-126.79	0.36358E-07	79.67	-3.87	-100.00
50.25	0.00	0.22495E+00	-80.90	0.28507E-07	143.60	-4.15	-100.00
50.50	0.00	0.17566E+00	-49.23	0.26228E-07	-130.51	-6.30	-100.00
50.75	0.00	0.11619E+00	-51.13	0.36467E-07	-55.27	-9.89	-100.00
51.00	0.00	0.16231E+00	-66.14	0.47440E-07	1.87	-6.99	-100.00
51.25	0.00	0.23846E+00	-43.40	0.52507E-07	51.68	-3.64	-100.00
51.50	0.00	0.26638E+00	-5.43	0.49838E-07	96.86	-2.68	-100.00
51.75	0.00	0.24901E+00	39.93	0.39377E-07	136.05	-3.27	-100.00
52.00	0.00	0.20546E+00	86.50	0.24061E-07	162.69	-4.94	-100.00
52.25	0.00	0.13240E+00	122.74	0.13826E-07	154.18	-8.75	-100.00
52.50	0.00	0.65422E-01	96.01	0.16069E-07	148.16	-14.88	-100.00
52.75	0.00	0.17031E+00	76.06	0.13839E-07	-176.63	-6.57	-100.00
53.00	0.00	0.28116E+00	104.60	0.93491E-08	-68.98	-2.21	-100.00
53.25	0.00	0.31386E+00	141.01	0.25849E-07	12.86	-1.26	-100.00
53.50	0.00	0.25648E+00	-174.30	0.42364E-07	54.52	-3.01	-100.00
53.75	0.00	0.17503E+00	-106.67	0.46723E-07	88.28	-6.33	-100.00
54.00	0.00	0.20246E+00	-24.97	0.36010E-07	112.49	-5.07	-100.00
54.25	0.00	0.27453E+00	25.70	0.22721E-07	100.51	-2.42	-100.00
54.50	0.00	0.28987E+00	59.22	0.38293E-07	82.33	-1.95	-100.00

54.75	0.00	0.24834E+00	81.38	0.62138E-07	107.70	-3.29	-100.00
55.00	0.00	0.20241E+00	91.21	0.77248E-07	146.39	-5.07	-100.00
55.25	0.00	0.19551E+00	98.89	0.81922E-07	-168.44	-5.37	-100.00
55.50	0.00	0.20381E+00	119.59	0.79729E-07	-119.28	-5.01	-100.00
55.75	0.00	0.19850E+00	151.84	0.73635E-07	-69.19	-5.24	-100.00
56.00	0.00	0.17937E+00	-171.81	0.63305E-07	-21.32	-6.12	-100.00
56.25	0.00	0.14861E+00	-141.03	0.47946E-07	21.67	-7.75	-100.00
56.50	0.00	0.11294E+00	-129.12	0.30205E-07	53.82	-10.13	-100.00
56.75	0.00	0.11461E+00	-140.77	0.19868E-07	56.50	-10.01	-100.00
57.00	0.00	0.16147E+00	-140.92	0.27956E-07	60.26	-7.03	-100.00
57.25	0.00	0.19785E+00	-130.10	0.42307E-07	93.78	-5.27	-100.00
57.50	0.00	0.20413E+00	-122.12	0.55261E-07	136.01	-4.99	-100.00
57.75	0.00	0.21097E+00	-122.93	0.63528E-07	179.33	-4.71	-100.00
58.00	0.00	0.25738E+00	-122.33	0.64379E-07	-137.99	-2.98	-100.00
58.25	0.00	0.31882E+00	-110.06	0.57134E-07	-95.35	-1.12	-100.00
58.50	0.00	0.34794E+00	-88.80	0.44535E-07	-50.16	-0.36	-100.00
58.75	0.00	0.32391E+00	-61.45	0.32765E-07	3.00	-0.98	-100.00
59.00	0.00	0.25849E+00	-27.30	0.29497E-07	64.15	-2.94	-100.00
59.25	0.00	0.19157E+00	18.34	0.35471E-07	115.77	-5.55	-100.00
59.50	0.00	0.17421E+00	73.55	0.44492E-07	154.93	-6.37	-100.00
59.75	0.00	0.20479E+00	117.34	0.51532E-07	-170.13	-4.97	-100.00
60.00	0.00	0.24104E+00	146.23	0.52328E-07	-134.08	-3.55	-100.00
60.25	0.00	0.26252E+00	167.35	0.44117E-07	-92.83	-2.81	-100.00
60.50	0.00	0.26088E+00	-175.25	0.29203E-07	-35.76	-2.86	-100.00
60.75	0.00	0.23125E+00	-161.03	0.24949E-07	59.26	-3.91	-100.00
61.00	0.00	0.17945E+00	-153.46	0.42788E-07	132.83	-6.11	-100.00
61.25	0.00	0.13420E+00	-160.97	0.60633E-07	-177.87	-8.64	-100.00
61.50	0.00	0.13609E+00	-177.43	0.68244E-07	-134.42	-8.52	-100.00
61.75	0.00	0.16137E+00	-178.85	0.63505E-07	-92.06	-7.04	-100.00
62.00	0.00	0.16019E+00	-170.27	0.49162E-07	-49.12	-7.10	-100.00
62.25	0.00	0.11561E+00	-164.93	0.30788E-07	-5.53	-9.93	-100.00
62.50	0.00	0.67090E-01	155.33	0.14084E-07	30.48	-14.66	-100.00
62.75	0.00	0.15308E+00	116.22	0.90924E-08	3.19	-7.49	-100.00
63.00	0.00	0.29001E+00	124.92	0.23494E-07	21.18	-1.94	-100.00
63.25	0.00	0.42077E+00	142.21	0.43143E-07	64.30	1.29	-100.00
63.50	0.00	0.52031E+00	161.82	0.62801E-07	107.85	3.13	-100.00
63.75	0.00	0.57065E+00	-177.96	0.76323E-07	149.93	3.94	-100.00
64.00	0.00	0.56144E+00	-158.26	0.78336E-07	-169.11	3.79	-100.00
64.25	0.00	0.49355E+00	-140.72	0.66538E-07	-128.67	2.67	-100.00
64.50	0.00	0.38528E+00	-129.05	0.42737E-07	-87.73	0.52	-100.00
64.75	0.00	0.28666E+00	-131.28	0.12659E-07	-38.42	-2.04	-100.00
65.00	0.00	0.28459E+00	-146.74	0.17224E-07	155.33	-2.11	-100.00
65.25	0.00	0.37869E+00	-149.83	0.37349E-07	-160.10	0.37	-100.00
65.50	0.00	0.48513E+00	-139.91	0.43081E-07	-120.52	2.53	-100.00
65.75	0.00	0.56339E+00	-125.33	0.32257E-07	-82.49	3.82	-100.00
66.00	0.00	0.60933E+00	-109.96	0.70324E-08	-56.90	4.51	-100.00
66.25	0.00	0.63593E+00	-95.07	0.28059E-07	-176.55	4.88	-100.00
66.50	0.00	0.65771E+00	-80.27	0.64579E-07	-139.57	5.17	-100.00
66.75	0.00	0.67762E+00	-64.49	0.95414E-07	-100.41	5.43	-100.00

67.00	0.00	0.68573E+00	-47.15	0.11452E-06	-60.28	5.53	-100.00
67.25	0.00	0.66962E+00	-28.65	0.11870E-06	-19.02	5.32	-100.00
67.50	0.00	0.62539E+00	-10.20	0.10810E-06	24.09	4.73	-100.00
67.75	0.00	0.56288E+00	6.57	0.86303E-07	70.91	3.82	-100.00
68.00	0.00	0.50458E+00	20.30	0.60536E-07	126.55	2.87	-100.00
68.25	0.00	0.47591E+00	31.56	0.44148E-07	-159.19	2.36	-100.00
68.50	0.00	0.48628E+00	43.77	0.50095E-07	-80.75	2.55	-100.00
68.75	0.00	0.52156E+00	60.03	0.66320E-07	-22.32	3.15	-100.00
69.00	0.00	0.56110E+00	80.61	0.79680E-07	24.10	3.79	-100.00
69.25	0.00	0.59289E+00	104.42	0.86829E-07	64.69	4.27	-100.00
69.50	0.00	0.61485E+00	130.47	0.88721E-07	101.47	4.58	-100.00
69.75	0.00	0.63061E+00	158.24	0.88144E-07	135.23	4.80	-100.00
70.00	0.00	0.64496E+00	-172.42	0.88233E-07	166.99	5.00	-100.00
70.25	0.00	0.66088E+00	-141.51	0.91014E-07	-161.55	5.21	-100.00
70.50	0.00	0.67846E+00	-109.10	0.96589E-07	-128.70	5.44	-100.00
70.75	0.00	0.69526E+00	-75.44	0.10360E-06	-93.71	5.65	-100.00
71.00	0.00	0.70717E+00	-40.97	0.11029E-06	-56.78	5.80	-100.00
71.25	0.00	0.70973E+00	-6.20	0.11518E-06	-18.55	5.83	-100.00
71.50	0.00	0.69945E+00	28.34	0.11728E-06	20.28	5.70	-100.00
71.75	0.00	0.67531E+00	62.11	0.11617E-06	59.09	5.40	-100.00
72.00	0.00	0.63994E+00	94.58	0.11196E-06	97.36	4.93	-100.00
72.25	0.00	0.60020E+00	125.35	0.10534E-06	134.63	4.37	-100.00
72.50	0.00	0.56600E+00	154.34	0.97454E-07	170.54	3.86	-100.00
72.75	0.00	0.54688E+00	-177.79	0.89684E-07	-155.08	3.57	-100.00
73.00	0.00	0.54704E+00	-149.60	0.83326E-07	-122.01	3.57	-100.00
73.25	0.00	0.56272E+00	-119.59	0.79147E-07	-89.49	3.81	-100.00
73.50	0.00	0.58506E+00	-86.90	0.77136E-07	-56.53	4.15	-100.00
73.75	0.00	0.60528E+00	-51.42	0.76653E-07	-22.30	4.45	-100.00
74.00	0.00	0.61792E+00	-13.41	0.76885E-07	13.49	4.63	-100.00
74.25	0.00	0.62148E+00	26.75	0.77229E-07	50.68	4.68	-100.00
74.50	0.00	0.61747E+00	68.69	0.77435E-07	88.89	4.62	-100.00
74.75	0.00	0.60893E+00	111.98	0.77557E-07	127.73	4.50	-100.00
75.00	0.00	0.59890E+00	156.15	0.77835E-07	166.90	4.36	-100.00
75.25	0.00	0.58926E+00	-159.28	0.78567E-07	-153.75	4.21	-100.00
75.50	0.00	0.58043E+00	-114.75	0.79986E-07	-114.16	4.08	-100.00
75.75	0.00	0.57174E+00	-70.56	0.82171E-07	-74.14	3.95	-100.00
76.00	0.00	0.56209E+00	-26.85	0.84996E-07	-33.42	3.80	-100.00
76.25	0.00	0.55064E+00	16.42	0.88153E-07	8.23	3.63	-100.00
76.50	0.00	0.53708E+00	59.41	0.91237E-07	50.95	3.41	-100.00
76.75	0.00	0.52166E+00	102.40	0.93840E-07	94.82	3.16	-100.00
77.00	0.00	0.50504E+00	145.69	0.95647E-07	139.85	2.87	-100.00
77.25	0.00	0.48815E+00	-170.38	0.96486E-07	-174.00	2.58	-100.00
77.50	0.00	0.47222E+00	-125.53	0.96346E-07	-126.78	2.29	-100.00
77.75	0.00	0.45866E+00	-79.56	0.95343E-07	-78.59	2.04	-100.00
78.00	0.00	0.44902E+00	-32.44	0.93677E-07	-29.53	1.85	-100.00
78.25	0.00	0.44462E+00	15.70	0.91560E-07	20.23	1.77	-100.00
78.50	0.00	0.44604E+00	64.54	0.89152E-07	70.52	1.80	-100.00
78.75	0.00	0.45279E+00	113.69	0.86540E-07	121.17	1.93	-100.00
79.00	0.00	0.46324E+00	162.83	0.83731E-07	172.03	2.12	-100.00

79.25	0.00	0.47494E+00	-148.25	0.80682E-07	-137.00	2.34	-100.00
79.50	0.00	0.48523E+00	-99.61	0.77351E-07	-85.93	2.53	-100.00
79.75	0.00	0.49170E+00	-51.19	0.73736E-07	-34.69	2.64	-100.00
80.00	0.00	0.49263E+00	-2.84	0.69907E-07	16.82	2.66	-100.00
80.25	0.00	0.48711E+00	45.61	0.66010E-07	68.78	2.56	-100.00
80.50	0.00	0.47513E+00	94.37	0.62260E-07	121.34	2.34	-100.00
80.75	0.00	0.45754E+00	143.68	0.58923E-07	174.63	2.02	-100.00
81.00	0.00	0.43598E+00	-166.26	0.56257E-07	-131.36	1.60	-100.00
81.25	0.00	0.41273E+00	-115.22	0.54461E-07	-76.78	1.12	-100.00
81.50	0.00	0.39048E+00	-63.06	0.53604E-07	-21.96	0.64	-100.00
81.75	0.00	0.37205E+00	-9.77	0.53582E-07	32.73	0.22	-100.00
82.00	0.00	0.35980E+00	44.44	0.54131E-07	86.97	-0.07	-100.00
82.25	0.00	0.35511E+00	99.14	0.54878E-07	140.60	-0.18	-100.00
82.50	0.00	0.35793E+00	153.76	0.55410E-07	-166.40	-0.12	-100.00
82.75	0.00	0.36686E+00	-152.15	0.55335E-07	-113.93	0.10	-100.00
83.00	0.00	0.37961E+00	-98.84	0.54316E-07	-61.82	0.39	-100.00
83.25	0.00	0.39367E+00	-46.36	0.52095E-07	-9.88	0.71	-100.00
83.50	0.00	0.40669E+00	5.42	0.48504E-07	42.08	0.99	-100.00
83.75	0.00	0.41676E+00	56.67	0.43476E-07	94.35	1.21	-100.00
84.00	0.00	0.42244E+00	107.58	0.37041E-07	147.32	1.32	-100.00
84.25	0.00	0.42274E+00	158.33	0.29350E-07	-158.22	1.33	-100.00
84.50	0.00	0.41708E+00	-150.90	0.20734E-07	-100.11	1.21	-100.00
84.75	0.00	0.40528E+00	-99.95	0.12111E-07	-29.95	0.96	-100.00
85.00	0.00	0.38745E+00	-48.67	0.82554E-08	81.59	0.57	-100.00
85.25	0.00	0.36406E+00	3.12	0.15119E-07	178.95	0.03	-100.00
85.50	0.00	0.33585E+00	55.63	0.25181E-07	-115.65	-0.67	-100.00
85.75	0.00	0.30390E+00	109.12	0.35508E-07	-58.03	-1.54	-100.00
86.00	0.00	0.26962E+00	163.97	0.45360E-07	-2.81	-2.58	-100.00
86.25	0.00	0.23489E+00	-139.27	0.54328E-07	51.52	-3.77	-100.00
86.50	0.00	0.20224E+00	-79.84	0.62117E-07	105.54	-5.07	-100.00
86.75	0.00	0.17514E+00	-16.95	0.68498E-07	159.56	-6.32	-100.00
87.00	0.00	0.15779E+00	49.63	0.73311E-07	-146.27	-7.23	-100.00
87.25	0.00	0.15364E+00	118.37	0.76463E-07	-91.81	-7.46	-100.00
87.50	0.00	0.16275E+00	-173.77	0.77929E-07	-36.95	-6.96	-100.00
87.75	0.00	0.18154E+00	-108.90	0.77757E-07	18.44	-6.01	-100.00
88.00	0.00	0.20546E+00	-47.18	0.76069E-07	74.49	-4.94	-100.00
88.25	0.00	0.23101E+00	12.12	0.73067E-07	131.39	-3.92	-100.00
88.50	0.00	0.25585E+00	69.77	0.69039E-07	-170.65	-3.03	-100.00
88.75	0.00	0.27856E+00	126.35	0.64368E-07	-111.34	-2.29	-100.00
89.00	0.00	0.29821E+00	-177.78	0.59543E-07	-50.37	-1.70	-100.00
89.25	0.00	0.31425E+00	-122.37	0.55158E-07	12.52	-1.25	-100.00
89.50	0.00	0.32629E+00	-67.24	0.51866E-07	77.36	-0.92	-100.00
89.75	0.00	0.33408E+00	-12.30	0.50254E-07	143.73	-0.71	-100.00
90.00	0.00	0.33742E+00	42.54	0.50637E-07	-149.35	-0.63	-100.00

PHI = 90 GRAUS

0.00	90.00	0.37700E-05	90.00	0.10285E+03	90.00	49.05	-100.00
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0.25	90.00	0.31354E-05	86.19	0.85626E+02	90.12	47.46	-100.00
0.50	90.00	0.17013E-05	78.85	0.46503E+02	90.51	42.16	-100.00
0.75	90.00	0.49976E-06	52.64	0.11274E+02	91.54	29.85	-100.00
1.00	90.00	0.20633E-06	-43.07	0.38077E+01	-89.76	20.42	-100.00
1.25	90.00	0.43045E-07	154.79	0.23098E+01	-87.63	16.08	-100.00
1.50	90.00	0.30575E-06	123.91	0.22189E+01	92.43	15.73	-100.00
1.75	90.00	0.30320E-06	127.95	0.19243E+01	94.45	14.49	-100.00
2.00	90.00	0.21884E-06	100.19	0.93729E+00	-86.01	8.25	-100.00
2.25	90.00	0.13911E-06	72.46	0.15684E+01	-83.09	12.72	-100.00
2.50	90.00	0.95028E-07	-12.79	0.20596E+00	92.70	-4.92	-100.00
2.75	90.00	0.13032E-06	-43.79	0.12204E+01	99.97	10.54	-100.00
3.00	90.00	0.31541E-06	-74.77	0.23671E+00	106.20	-3.71	-100.00
3.25	90.00	0.43292E-06	-65.38	0.87003E+00	-76.45	7.60	-100.00
3.50	90.00	0.46624E-06	-76.89	0.48069E+00	-72.11	2.45	-100.00
3.75	90.00	0.48154E-06	-76.88	0.53610E+00	107.48	3.39	-100.00
4.00	90.00	0.61886E-06	-59.97	0.58027E+00	112.12	4.08	-100.00
4.25	90.00	0.72412E-06	-61.20	0.23884E+00	-69.29	-3.63	-100.00
4.50	90.00	0.89177E-06	-50.25	0.57146E+00	-62.77	3.95	-100.00
4.75	90.00	0.11371E-05	-31.72	0.14978E-01	9.68	-27.68	-100.00
5.00	90.00	0.11623E-05	-33.69	0.48623E+00	122.96	2.55	-100.00
5.25	90.00	0.12243E-05	-28.22	0.18489E+00	130.53	-5.85	-100.00
5.50	90.00	0.11017E-05	-33.77	0.35247E+00	-50.93	-0.25	-100.00
5.75	90.00	0.12017E-05	-11.02	0.29312E+00	-44.25	-1.85	-100.00
6.00	90.00	0.14553E-05	-0.53	0.19911E+00	134.96	-5.21	-100.00
6.25	90.00	0.18698E-05	2.20	0.33478E+00	142.79	-0.70	-100.00
6.50	90.00	0.19978E-05	8.83	0.49124E-01	-47.80	-17.37	-100.00
6.75	90.00	0.24432E-05	6.12	0.31651E+00	-29.43	-1.18	-100.00
7.00	90.00	0.27396E-05	14.30	0.80809E-01	-16.93	-13.04	-100.00
7.25	90.00	0.26245E-05	19.71	0.25358E+00	158.94	-3.11	-100.00
7.50	90.00	0.26510E-05	28.98	0.17267E+00	167.93	-6.45	-100.00
7.75	90.00	0.32569E-05	33.89	0.16111E+00	-13.11	-7.05	-100.00
8.00	90.00	0.36863E-05	44.15	0.22038E+00	-3.56	-4.33	-99.88
8.25	90.00	0.39879E-05	54.66	0.59534E-01	171.24	-15.70	-99.17
8.50	90.00	0.46384E-05	67.88	0.22546E+00	-173.49	-4.13	-97.86
8.75	90.00	0.52224E-05	82.54	0.39427E-01	-152.37	-19.28	-96.83
9.00	90.00	0.54927E-05	89.53	0.19142E+00	16.63	-5.55	-96.40
9.25	90.00	0.61500E-05	98.97	0.11354E+00	27.87	-10.09	-95.42
9.50	90.00	0.66198E-05	108.44	0.13031E+00	-152.67	-8.89	-94.77
9.75	90.00	0.68865E-05	118.20	0.15908E+00	-141.36	-7.16	-94.43
10.00	90.00	0.72972E-05	128.48	0.55077E-01	32.94	-16.37	-93.93
10.25	90.00	0.72521E-05	139.39	0.17043E+00	49.97	-6.56	-93.98
10.50	90.00	0.80829E-05	151.59	0.23170E-01	78.24	-23.89	-93.04
10.75	90.00	0.86913E-05	164.09	0.14970E+00	-117.01	-7.69	-92.41
11.00	90.00	0.94897E-05	177.74	0.84373E-01	-103.12	-12.67	-91.65
11.25	90.00	0.10643E-04	-168.63	0.10453E+00	74.50	-10.81	-90.65
11.50	90.00	0.11271E-04	-157.39	0.12430E+00	87.79	-9.30	-90.15
11.75	90.00	0.11545E-04	-144.65	0.43938E-01	-96.06	-18.34	-89.95
12.00	90.00	0.13110E-04	-133.11	0.13515E+00	-77.69	-8.58	-88.84
12.25	90.00	0.13846E-04	-120.18	0.20249E-01	-43.17	-25.06	-88.37

12.50	90.00	0.14440E-04	-106.16	0.12041E+00	116.06	-9.58	-88.00
12.75	90.00	0.15786E-04	-92.92	0.72104E-01	131.15	-14.03	-87.23
13.00	90.00	0.16985E-04	-77.52	0.80448E-01	-49.11	-13.08	-86.59
13.25	90.00	0.18040E-04	-63.47	0.10292E+00	-34.02	-10.94	-86.07
13.50	90.00	0.19346E-04	-49.17	0.31986E-01	137.32	-21.09	-85.46
13.75	90.00	0.20784E-04	-35.61	0.11342E+00	161.24	-10.10	-84.84
14.00	90.00	0.21836E-04	-20.82	0.25785E-01	-172.79	-22.96	-84.41
14.25	90.00	0.23228E-04	-6.40	0.94608E-01	-2.12	-11.67	-83.87
14.50	90.00	0.24178E-04	9.39	0.65977E-01	14.47	-14.80	-83.52
14.75	90.00	0.24701E-04	25.50	0.61535E-01	-166.52	-15.41	-83.34
15.00	90.00	0.27112E-04	41.84	0.93740E-01	-149.25	-11.75	-82.53
15.25	90.00	0.28322E-04	58.30	0.14170E-01	5.74	-28.16	-82.15
15.50	90.00	0.30319E-04	73.17	0.93258E-01	48.12	-11.80	-81.56
15.75	90.00	0.32082E-04	91.75	0.32208E-01	69.88	-21.03	-81.07
16.00	90.00	0.33777E-04	109.27	0.75967E-01	-112.55	-13.58	-80.62
16.25	90.00	0.36254E-04	125.08	0.69557E-01	-94.93	-14.35	-80.00
16.50	90.00	0.38800E-04	142.48	0.37820E-01	79.78	-19.64	-79.42
16.75	90.00	0.42685E-04	159.88	0.83560E-01	102.01	-12.75	-78.59
17.00	90.00	0.44713E-04	178.77	0.70109E-02	158.90	-34.28	-78.18
17.25	90.00	0.48231E-04	-164.09	0.78925E-01	-55.80	-13.25	-77.53
17.50	90.00	0.50175E-04	-144.06	0.45888E-01	-35.26	-17.96	-77.18
17.75	90.00	0.53787E-04	-124.44	0.53073E-01	140.52	-16.69	-76.58
18.00	90.00	0.56821E-04	-105.35	0.70831E-01	160.02	-14.19	-76.10
18.25	90.00	0.61245E-04	-86.57	0.14503E-01	-25.28	-27.96	-75.45
18.50	90.00	0.64906E-04	-67.39	0.75161E-01	4.17	-13.67	-74.95
18.75	90.00	0.69069E-04	-47.45	0.25957E-01	31.05	-22.91	-74.41
19.00	90.00	0.74510E-04	-27.69	0.61091E-01	-156.62	-15.47	-73.75
19.25	90.00	0.78795E-04	-6.10	0.58396E-01	-137.60	-15.86	-73.26
19.50	90.00	0.83748E-04	15.17	0.26188E-01	44.73	-22.83	-72.73
19.75	90.00	0.90605E-04	36.56	0.68635E-01	67.08	-14.46	-72.05
20.00	90.00	0.97127E-04	58.22	0.11259E-01	107.75	-30.16	-71.45
20.25	90.00	0.10395E-03	79.25	0.63921E-01	-90.10	-15.08	-70.86
20.50	90.00	0.11225E-03	102.23	0.47618E-01	-70.65	-17.64	-70.19
20.75	90.00	0.12038E-03	123.91	0.33574E-01	112.16	-20.67	-69.58
21.00	90.00	0.12860E-03	146.04	0.62698E-01	132.99	-15.25	-69.01
21.25	90.00	0.13761E-03	168.66	0.32147E-02	-133.78	-41.05	-68.42
21.50	90.00	0.14689E-03	-168.80	0.63183E-01	-20.02	-15.18	-67.85
21.75	90.00	0.15741E-03	-145.98	0.38942E-01	0.04	-19.38	-67.25
22.00	90.00	0.16975E-03	-122.79	0.38224E-01	-177.20	-19.55	-66.60
22.25	90.00	0.18260E-03	-99.06	0.59107E-01	-157.45	-15.76	-65.96
22.50	90.00	0.19627E-03	-75.53	0.37118E-02	18.54	-39.80	-65.33
22.75	90.00	0.21054E-03	-50.97	0.60796E-01	52.86	-15.51	-64.73
23.00	90.00	0.22712E-03	-26.72	0.33134E-01	71.88	-20.79	-64.07
23.25	90.00	0.24471E-03	-1.86	0.40456E-01	-101.11	-19.05	-63.42
23.50	90.00	0.26395E-03	22.91	0.57713E-01	-83.20	-15.97	-62.76
23.75	90.00	0.28533E-03	47.76	0.40665E-02	110.56	-39.01	-62.08
24.00	90.00	0.30733E-03	73.06	0.59072E-01	128.17	-15.76	-61.44
24.25	90.00	0.33205E-03	98.59	0.32017E-01	143.24	-21.08	-60.77
24.50	90.00	0.35923E-03	124.21	0.39384E-01	-19.46	-19.29	-60.08

24.75	90.00	0.38843E-03	150.57	0.57320E-01	-4.77	-16.03	-59.41
25.00	90.00	0.42173E-03	176.73	0.31407E-02	-143.54	-41.25	-58.69
25.25	90.00	0.45667E-03	-156.81	0.59805E-01	-152.40	-15.66	-58.00
25.50	90.00	0.49397E-03	-130.27	0.37162E-01	-141.24	-19.79	-57.32
25.75	90.00	0.53303E-03	-103.40	0.34628E-01	66.49	-20.40	-56.66
26.00	90.00	0.57828E-03	-76.18	0.57931E-01	75.45	-15.93	-55.95
26.25	90.00	0.62543E-03	-48.80	0.69139E-02	9.82	-34.40	-55.27
26.50	90.00	0.67830E-03	-21.18	0.62139E-01	-65.12	-15.32	-54.56
26.75	90.00	0.73690E-03	6.66	0.46843E-01	-56.35	-17.78	-53.84
27.00	90.00	0.80012E-03	34.53	0.28069E-01	154.62	-22.23	-53.13
27.25	90.00	0.86980E-03	62.71	0.64071E-01	156.35	-15.06	-52.40
27.50	90.00	0.94532E-03	91.04	0.23298E-01	123.46	-23.85	-51.68
27.75	90.00	0.10291E-02	119.51	0.61479E-01	33.09	-15.42	-50.94
28.00	90.00	0.11235E-02	148.18	0.56037E-01	34.81	-16.22	-50.18
28.25	90.00	0.12259E-02	176.86	0.25917E-01	-107.49	-22.92	-49.42
28.50	90.00	0.13410E-02	-154.27	0.83815E-01	-114.68	-12.73	-48.64
28.75	90.00	0.14675E-02	-125.35	0.56773E-01	-127.97	-16.11	-47.86
29.00	90.00	0.16066E-02	-96.36	0.54583E-01	145.55	-16.45	-47.07
29.25	90.00	0.17608E-02	-67.25	0.64588E-01	123.47	-14.99	-46.28
29.50	90.00	0.19338E-02	-38.09	0.42317E-01	23.97	-18.66	-45.46
29.75	90.00	0.21238E-02	-8.94	0.12272E+00	-6.78	-9.41	-44.65
30.00	90.00	0.23365E-02	20.20	0.11500E+00	-14.69	-9.98	-43.82
30.25	90.00	0.25748E-02	49.31	0.57204E-01	-80.12	-16.04	-42.98
30.50	90.00	0.28402E-02	78.47	0.10473E+00	-144.32	-10.79	-42.12
30.75	90.00	0.31396E-02	107.54	0.12719E+00	169.35	-9.10	-41.25
31.00	90.00	0.34763E-02	136.58	0.20758E+00	129.23	-4.85	-40.37
31.25	90.00	0.38559E-02	165.56	0.24207E+00	111.85	-3.51	-39.47
31.50	90.00	0.42868E-02	-165.48	0.16339E+00	74.27	-6.93	-38.55
31.75	90.00	0.47803E-02	-136.52	0.22902E+00	2.63	-3.99	-37.60
32.00	90.00	0.53481E-02	-107.56	0.37348E+00	-26.91	0.25	-36.63
32.25	90.00	0.60043E-02	-78.52	0.47616E+00	-52.40	2.36	-35.62
32.50	90.00	0.67726E-02	-49.39	0.57697E+00	-74.91	4.03	-34.58
32.75	90.00	0.76725E-02	-20.10	0.59163E+00	-93.96	4.25	-33.49
33.00	90.00	0.87378E-02	9.35	0.52874E+00	-124.01	3.27	-32.36
33.25	90.00	0.10005E-01	39.00	0.62424E+00	-161.33	4.72	-31.19
33.50	90.00	0.11515E-01	68.88	0.82604E+00	178.87	7.15	-29.97
33.75	90.00	0.13318E-01	98.98	0.95397E+00	168.76	8.40	-28.70
34.00	90.00	0.15469E-01	129.28	0.10111E+01	162.97	8.90	-27.40
34.25	90.00	0.18022E-01	159.77	0.10133E+01	163.57	8.92	-26.08
34.50	90.00	0.21022E-01	-169.59	0.93381E+00	171.14	8.21	-24.74
34.75	90.00	0.24504E-01	-138.84	0.79387E+00	-177.92	6.80	-23.41
35.00	90.00	0.28475E-01	-107.98	0.66244E+00	-169.37	5.23	-22.10
35.25	90.00	0.32898E-01	-77.01	0.59256E+00	-165.99	4.26	-20.85
35.50	90.00	0.37693E-01	-45.88	0.57026E+00	-163.87	3.93	-19.67
35.75	90.00	0.42710E-01	-14.53	0.54214E+00	-160.61	3.49	-18.58
36.00	90.00	0.47751E-01	17.16	0.51099E+00	-156.85	2.98	-17.61
36.25	90.00	0.52566E-01	49.37	0.52214E+00	-148.11	3.16	-16.78
36.50	90.00	0.56918E-01	82.31	0.58501E+00	-128.78	4.15	-16.09
36.75	90.00	0.60630E-01	116.29	0.68095E+00	-102.23	5.47	-15.54

37.00	90.00	0.63715E-01	151.65	0.77175E+00	-74.69	6.56	-15.11
37.25	90.00	0.66503E-01	-171.28	0.81925E+00	-47.98	7.08	-14.74
37.50	90.00	0.69750E-01	-132.37	0.83085E+00	-20.24	7.20	-14.32
37.75	90.00	0.74567E-01	-91.95	0.85516E+00	11.07	7.45	-13.74
38.00	90.00	0.82046E-01	-50.92	0.93384E+00	45.69	8.21	-12.91
38.25	90.00	0.92658E-01	-10.45	0.10504E+01	81.06	9.24	-11.85
38.50	90.00	0.10591E+00	28.66	0.11440E+01	116.53	9.98	-10.69
38.75	90.00	0.12042E+00	66.23	0.11847E+01	153.47	10.28	-9.58
39.00	90.00	0.13428E+00	102.50	0.12094E+01	-167.35	10.46	-8.63
39.25	90.00	0.14548E+00	137.92	0.12690E+01	-127.41	10.88	-7.94
39.50	90.00	0.15218E+00	172.96	0.13581E+01	-88.46	11.47	-7.54
39.75	90.00	0.15303E+00	-151.86	0.14310E+01	-49.73	11.92	-7.50
40.00	90.00	0.14750E+00	-115.97	0.14672E+01	-9.05	12.14	-7.82
40.25	90.00	0.13606E+00	-78.70	0.14897E+01	34.29	12.27	-8.52
40.50	90.00	0.12031E+00	-39.15	0.15105E+01	78.66	12.39	-9.59
40.75	90.00	0.10300E+00	3.79	0.14877E+01	122.54	12.26	-10.94
41.00	90.00	0.87532E-01	51.05	0.13802E+01	166.67	11.61	-12.35
41.25	90.00	0.76812E-01	102.38	0.12146E+01	-147.03	10.50	-13.48
41.50	90.00	0.71308E-01	155.63	0.10583E+01	-98.19	9.30	-14.13
41.75	90.00	0.68769E-01	-151.26	0.93060E+00	-49.16	8.18	-14.44
42.00	90.00	0.66885E-01	-98.08	0.79087E+00	-1.35	6.77	-14.69
42.25	90.00	0.65790E-01	-43.30	0.62143E+00	47.36	4.68	-14.83
42.50	90.00	0.67954E-01	13.12	0.45363E+00	98.96	1.94	-14.55
42.75	90.00	0.75260E-01	68.46	0.29731E+00	149.11	-1.73	-13.66
43.00	90.00	0.86315E-01	120.12	0.11247E+00	177.02	-10.17	-12.47
43.25	90.00	0.97601E-01	168.16	0.17593E+00	98.29	-6.29	-11.40
43.50	90.00	0.10601E+00	-145.94	0.42940E+00	130.75	1.47	-10.68
43.75	90.00	0.11008E+00	-100.72	0.61935E+00	176.12	4.65	-10.36
44.00	90.00	0.10996E+00	-55.17	0.72791E+00	-131.39	6.05	-10.37
44.25	90.00	0.10670E+00	-8.88	0.80108E+00	-73.77	6.88	-10.63
44.50	90.00	0.10104E+00	38.06	0.85855E+00	-14.49	7.48	-11.10
44.75	90.00	0.92713E-01	85.55	0.88165E+00	46.26	7.71	-11.85
45.00	90.00	0.80870E-01	134.34	0.90173E+00	109.99	7.91	-13.04
45.25	90.00	0.66069E-01	-172.71	0.96916E+00	173.36	8.54	-14.79
45.50	90.00	0.53541E-01	-109.81	0.10330E+01	-127.73	9.09	-16.62
45.75	90.00	0.54277E-01	-38.24	0.10069E+01	-71.09	8.87	-16.50
46.00	90.00	0.69949E-01	23.80	0.90047E+00	-11.74	7.90	-14.30
46.25	90.00	0.88807E-01	73.18	0.80694E+00	52.16	6.94	-12.22
46.50	90.00	0.10129E+00	116.02	0.76398E+00	115.72	6.47	-11.08
46.75	90.00	0.10243E+00	156.21	0.71116E+00	175.66	5.85	-10.98
47.00	90.00	0.90981E-01	-163.67	0.62197E+00	-125.60	4.68	-12.01
47.25	90.00	0.69371E-01	-120.20	0.52856E+00	-67.81	3.27	-14.37
47.50	90.00	0.44916E-01	-64.58	0.43276E+00	-16.99	1.53	-18.14
47.75	90.00	0.35119E-01	17.37	0.31306E+00	17.91	-1.28	-20.28
48.00	90.00	0.48582E-01	88.44	0.24404E+00	25.74	-3.44	-17.46
48.25	90.00	0.63804E-01	136.83	0.32070E+00	38.65	-1.07	-15.09
48.50	90.00	0.69868E-01	177.77	0.43611E+00	80.04	1.60	-14.31
48.75	90.00	0.64858E-01	-142.54	0.55550E+00	135.49	3.70	-14.95
49.00	90.00	0.51218E-01	-99.77	0.69087E+00	-165.85	5.60	-17.00

49.25	90.00	0.35280E-01	-46.07	0.79865E+00	-107.43	6.86	-20.24
49.50	90.00	0.28424E-01	26.82	0.84605E+00	-46.26	7.36	-22.12
49.75	90.00	0.34646E-01	92.32	0.88938E+00	19.83	7.79	-20.40
50.00	90.00	0.41331E-01	139.03	0.99670E+00	86.19	8.78	-18.87
50.25	90.00	0.40947E-01	177.80	0.11171E+01	148.18	9.77	-18.95
50.50	90.00	0.31987E-01	-145.12	0.11636E+01	-152.16	10.12	-21.09
50.75	90.00	0.16158E-01	-100.29	0.11331E+01	-91.37	9.89	-27.02
51.00	90.00	0.93653E-02	40.66	0.10807E+01	-28.92	9.48	-31.76
51.25	90.00	0.29523E-01	104.64	0.10165E+01	32.97	8.95	-21.79
51.50	90.00	0.48711E-01	141.47	0.90234E+00	94.26	7.92	-17.44
51.75	90.00	0.62110E-01	175.81	0.75326E+00	158.63	6.35	-15.33
52.00	90.00	0.67364E-01	-149.17	0.65722E+00	-132.71	5.16	-14.62
52.25	90.00	0.63926E-01	-111.45	0.63470E+00	-68.55	4.86	-15.08
52.50	90.00	0.53751E-01	-67.86	0.59290E+00	-14.91	4.27	-16.58
52.75	90.00	0.42677E-01	-12.68	0.48722E+00	30.37	2.56	-18.59
53.00	90.00	0.40415E-01	54.34	0.36585E+00	70.71	0.07	-19.06
53.25	90.00	0.48661E-01	115.02	0.30345E+00	112.00	-1.55	-17.45
53.50	90.00	0.57327E-01	164.07	0.33871E+00	160.41	-0.60	-16.02
53.75	90.00	0.58626E-01	-152.36	0.45580E+00	-147.87	1.98	-15.83
54.00	90.00	0.49600E-01	-109.60	0.59371E+00	-95.20	4.28	-17.28
54.25	90.00	0.31154E-01	-61.47	0.70363E+00	-39.19	5.76	-21.32
54.50	90.00	0.12563E-01	34.71	0.79741E+00	21.21	6.84	-29.21
54.75	90.00	0.29706E-01	148.53	0.90880E+00	82.88	7.98	-21.73
55.00	90.00	0.54767E-01	-159.74	0.10060E+01	142.38	8.86	-16.42
55.25	90.00	0.73796E-01	-114.72	0.10153E+01	-159.08	8.94	-13.83
55.50	90.00	0.83662E-01	-69.85	0.92484E+00	-96.77	8.13	-12.74
55.75	90.00	0.84107E-01	-23.07	0.83728E+00	-26.51	7.27	-12.70
56.00	90.00	0.77221E-01	27.15	0.86396E+00	46.20	7.54	-13.44
56.25	90.00	0.66716E-01	82.42	0.93576E+00	112.43	8.23	-14.71
56.50	90.00	0.56929E-01	144.14	0.92807E+00	174.81	8.16	-16.09
56.75	90.00	0.51544E-01	-148.25	0.84008E+00	-119.89	7.29	-16.95
57.00	90.00	0.52121E-01	-78.70	0.77923E+00	-48.99	6.64	-16.85
57.25	90.00	0.57585E-01	-11.90	0.79544E+00	20.52	6.82	-15.99
57.50	90.00	0.65286E-01	50.40	0.79536E+00	84.19	6.82	-14.90
57.75	90.00	0.72181E-01	109.00	0.71171E+00	147.33	5.85	-14.02
58.00	90.00	0.75685E-01	165.70	0.60911E+00	-142.50	4.50	-13.61
58.25	90.00	0.74631E-01	-137.37	0.60947E+00	-68.53	4.51	-13.73
58.50	90.00	0.70178E-01	-77.93	0.67524E+00	-4.62	5.40	-14.27
58.75	90.00	0.65813E-01	-14.57	0.67404E+00	49.64	5.38	-14.83
59.00	90.00	0.65100E-01	51.17	0.56221E+00	101.00	3.81	-14.92
59.25	90.00	0.67845E-01	115.51	0.39306E+00	157.09	0.70	-14.56
59.50	90.00	0.70364E-01	177.28	0.27630E+00	-133.95	-2.36	-14.24
59.75	90.00	0.70024E-01	-121.22	0.26468E+00	-67.67	-2.74	-14.29
60.00	90.00	0.68373E-01	-56.90	0.26795E+00	-23.35	-2.63	-14.49
60.25	90.00	0.70619E-01	10.30	0.23955E+00	4.93	-3.60	-14.21
60.50	90.00	0.79710E-01	75.29	0.18653E+00	25.26	-5.78	-13.16
60.75	90.00	0.91469E-01	134.32	0.96458E-01	43.18	-11.51	-11.97
61.00	90.00	0.98610E-01	-171.48	0.57336E-01	-88.40	-16.02	-11.31
61.25	90.00	0.95781E-01	-119.25	0.25432E+00	-68.91	-3.08	-11.57

61.50	90.00	0.81626E-01	-65.44	0.44138E+00	-36.84	1.70	-12.96
61.75	90.00	0.60574E-01	-3.29	0.54093E+00	-1.03	3.47	-15.55
62.00	90.00	0.47695E-01	78.51	0.49681E+00	39.11	2.73	-17.62
62.25	90.00	0.59776E-01	161.49	0.31336E+00	91.52	-1.27	-15.66
62.50	90.00	0.81772E-01	-136.11	0.20033E+00	-156.76	-5.16	-12.94
62.75	90.00	0.96324E-01	-83.35	0.44790E+00	-73.10	1.83	-11.52
63.00	90.00	0.96442E-01	-32.85	0.67535E+00	-24.08	5.40	-11.51
63.25	90.00	0.81698E-01	20.43	0.73404E+00	20.80	6.12	-12.95
63.50	90.00	0.59541E-01	85.62	0.59253E+00	69.30	4.26	-15.70
63.75	90.00	0.53071E-01	173.39	0.34027E+00	139.88	-0.56	-16.69
64.00	90.00	0.77258E-01	-109.70	0.39059E+00	-108.11	0.64	-13.43
64.25	90.00	0.10855E+00	-53.44	0.71187E+00	-43.26	5.86	-10.48
64.50	90.00	0.13026E+00	-5.21	0.92584E+00	4.30	8.14	-8.90
64.75	90.00	0.13528E+00	39.99	0.91486E+00	48.91	8.04	-8.57
65.00	90.00	0.12163E+00	84.15	0.66464E+00	96.53	5.26	-9.49
65.25	90.00	0.91373E-01	128.67	0.28968E+00	172.33	-1.95	-11.98
65.50	90.00	0.50076E-01	177.01	0.45962E+00	-56.64	2.06	-17.20
65.75	90.00	0.11766E-01	-77.14	0.92644E+00	-0.41	8.14	-29.78
66.00	90.00	0.41255E-01	52.37	0.12540E+01	43.20	10.77	-18.88
66.25	90.00	0.72084E-01	102.38	0.13394E+01	83.79	11.35	-14.04
66.50	90.00	0.87861E-01	148.26	0.11573E+01	122.79	10.08	-12.32
66.75	90.00	0.86559E-01	-165.18	0.74786E+00	159.34	6.28	-12.45
67.00	90.00	0.70363E-01	-114.42	0.21683E+00	176.59	-4.47	-14.25
67.25	90.00	0.47423E-01	-50.04	0.40904E+00	82.82	1.04	-17.67
67.50	90.00	0.40216E-01	42.78	0.89323E+00	113.85	7.83	-19.10
67.75	90.00	0.61367E-01	120.71	0.12088E+01	151.64	10.46	-15.43
68.00	90.00	0.86026E-01	175.66	0.13040E+01	-169.22	11.11	-12.50
68.25	90.00	0.10059E+00	-137.18	0.11781E+01	-129.74	10.23	-11.14
68.50	90.00	0.10021E+00	-93.11	0.87255E+00	-90.91	7.62	-11.17
68.75	90.00	0.84036E-01	-50.78	0.46013E+00	-56.77	2.07	-12.70
69.00	90.00	0.54270E-01	-10.50	0.12876E+00	-94.26	-9.00	-16.50
69.25	90.00	0.15867E-01	17.40	0.45236E+00	-117.95	1.92	-27.18
69.50	90.00	0.28002E-01	-90.34	0.77556E+00	-80.39	6.60	-22.25
69.75	90.00	0.67288E-01	-55.35	0.98840E+00	-36.94	8.71	-14.63
70.00	90.00	0.98359E-01	-15.61	0.10833E+01	8.91	9.50	-11.34
70.25	90.00	0.11687E+00	24.74	0.10727E+01	56.36	9.42	-9.84
70.50	90.00	0.12068E+00	64.94	0.97630E+00	104.95	8.60	-9.56
70.75	90.00	0.10990E+00	104.41	0.81270E+00	154.25	7.01	-10.37
71.00	90.00	0.86892E-01	141.96	0.59517E+00	-156.12	4.30	-12.41
71.25	90.00	0.56321E-01	173.62	0.33353E+00	-106.24	-0.73	-16.18
71.50	90.00	0.28660E-01	179.54	0.39656E-01	-46.27	-19.23	-22.05
71.75	90.00	0.34390E-01	151.76	0.27298E+00	167.48	-2.47	-20.46
72.00	90.00	0.59744E-01	171.10	0.57942E+00	-143.80	4.07	-15.67
72.25	90.00	0.80210E-01	-153.82	0.85619E+00	-96.17	7.46	-13.11
72.50	90.00	0.90677E-01	-114.49	0.10800E+01	-49.00	9.48	-12.04
72.75	90.00	0.90044E-01	-73.48	0.12335E+01	-2.08	10.63	-12.10
73.00	90.00	0.79127E-01	-31.74	0.13075E+01	44.68	11.14	-13.23
73.25	90.00	0.60102E-01	9.98	0.13025E+01	91.28	11.10	-15.61
73.50	90.00	0.36062E-01	49.81	0.12271E+01	137.58	10.59	-20.05

73.75	90.00	0.11359E-01	70.27	0.10961E+01	-176.79	9.61	-30.09
74.00	90.00	0.16783E-01	-7.06	0.92787E+00	-132.66	8.16	-26.69
74.25	90.00	0.37140E-01	26.87	0.74464E+00	-91.77	6.25	-19.80
74.50	90.00	0.52732E-01	71.58	0.57828E+00	-57.51	4.05	-16.75
74.75	90.00	0.62695E-01	119.63	0.48460E+00	-33.71	2.52	-15.25
75.00	90.00	0.67680E-01	170.13	0.52425E+00	-13.88	3.20	-14.58
75.25	90.00	0.69287E-01	-137.13	0.67756E+00	14.95	5.43	-14.38
75.50	90.00	0.69485E-01	-82.70	0.88045E+00	52.63	7.70	-14.35
75.75	90.00	0.69763E-01	-27.79	0.10911E+01	95.08	9.57	-14.32
76.00	90.00	0.70413E-01	25.94	0.12855E+01	139.89	10.99	-14.24
76.25	90.00	0.70580E-01	77.06	0.14479E+01	-174.05	12.02	-14.22
76.50	90.00	0.69093E-01	124.63	0.15675E+01	-127.28	12.71	-14.40
76.75	90.00	0.65435E-01	167.82	0.16382E+01	-80.08	13.10	-14.88
77.00	90.00	0.60501E-01	-154.51	0.16582E+01	-32.59	13.20	-15.56
77.25	90.00	0.57135E-01	-123.26	0.16298E+01	15.09	13.05	-16.05
77.50	90.00	0.59359E-01	-96.29	0.15586E+01	62.87	12.66	-15.72
77.75	90.00	0.69025E-01	-67.72	0.14527E+01	110.64	12.05	-14.41
78.00	90.00	0.83980E-01	-33.96	0.13217E+01	158.23	11.23	-12.71
78.25	90.00	0.10063E+00	4.53	0.11756E+01	-154.59	10.21	-11.14
78.50	90.00	0.11595E+00	46.29	0.10246E+01	-108.19	9.02	-9.91
78.75	90.00	0.12782E+00	90.28	0.87856E+00	-63.04	7.68	-9.06
79.00	90.00	0.13492E+00	135.92	0.74799E+00	-19.77	6.29	-8.59
79.25	90.00	0.13668E+00	-177.04	0.64379E+00	21.13	4.98	-8.48
79.50	90.00	0.13317E+00	-128.67	0.57618E+00	59.79	4.02	-8.70
79.75	90.00	0.12506E+00	-78.82	0.55029E+00	97.68	3.62	-9.25
80.00	90.00	0.11358E+00	-27.24	0.56173E+00	137.10	3.80	-10.09
80.25	90.00	0.10037E+00	26.52	0.59865E+00	179.60	4.35	-11.16
80.50	90.00	0.87364E-01	82.90	0.64893E+00	-134.58	5.05	-12.37
80.75	90.00	0.76467E-01	142.05	0.70462E+00	-85.89	5.77	-13.52
81.00	90.00	0.68994E-01	-156.80	0.76227E+00	-34.96	6.45	-14.42
81.25	90.00	0.64908E-01	-95.51	0.82163E+00	17.62	7.10	-14.95
81.50	90.00	0.62733E-01	-35.97	0.88386E+00	71.33	7.74	-15.24
81.75	90.00	0.60416E-01	20.89	0.95020E+00	125.72	8.36	-15.57
82.00	90.00	0.56261E-01	75.01	0.10208E+01	-179.61	8.99	-16.19
82.25	90.00	0.49303E-01	126.46	0.10941E+01	-124.95	9.59	-17.33
82.50	90.00	0.39308E-01	174.63	0.11672E+01	-70.48	10.15	-19.30
82.75	90.00	0.26870E-01	-143.70	0.12362E+01	-16.26	10.65	-22.61
83.00	90.00	0.15048E-01	-125.08	0.12971E+01	37.70	11.07	-27.64
83.25	90.00	0.17435E-01	-142.32	0.13460E+01	91.47	11.39	-26.36
83.50	90.00	0.33468E-01	-117.92	0.13802E+01	145.13	11.61	-20.70
83.75	90.00	0.52185E-01	-75.89	0.13979E+01	-161.20	11.72	-16.84
84.00	90.00	0.70973E-01	-29.12	0.13987E+01	-107.43	11.72	-14.17
84.25	90.00	0.88767E-01	19.55	0.13834E+01	-53.44	11.63	-12.23
84.50	90.00	0.10488E+00	69.23	0.13539E+01	0.89	11.44	-10.78
84.75	90.00	0.11883E+00	119.59	0.13133E+01	55.64	11.18	-9.69
85.00	90.00	0.13035E+00	170.47	0.12650E+01	110.90	10.85	-8.89
85.25	90.00	0.13932E+00	-138.19	0.12129E+01	166.74	10.48	-8.31
85.50	90.00	0.14575E+00	-86.44	0.11610E+01	-136.83	10.10	-7.92
85.75	90.00	0.14979E+00	-34.29	0.11125E+01	-79.84	9.73	-7.68

86.00	90.00	0.15164E+00	18.22	0.10700E+01	-22.38	9.40	-7.58
86.25	90.00	0.15158E+00	71.08	0.10349E+01	35.44	9.11	-7.58
86.50	90.00	0.14989E+00	124.27	0.10073E+01	93.45	8.87	-7.68
86.75	90.00	0.14681E+00	177.73	0.98646E+00	151.51	8.69	-7.86
87.00	90.00	0.14259E+00	-128.55	0.97052E+00	-150.50	8.55	-8.11
87.25	90.00	0.13740E+00	-74.63	0.95750E+00	-92.65	8.43	-8.43
87.50	90.00	0.13139E+00	-20.54	0.94541E+00	-34.95	8.32	-8.82
87.75	90.00	0.12463E+00	33.70	0.93258E+00	22.63	8.20	-9.28
88.00	90.00	0.11720E+00	88.08	0.91779E+00	80.16	8.06	-9.81
88.25	90.00	0.10916E+00	142.61	0.90037E+00	137.70	7.90	-10.43
88.50	90.00	0.10056E+00	-162.66	0.88015E+00	-164.66	7.70	-11.14
88.75	90.00	0.91492E-01	-107.65	0.85731E+00	-106.84	7.47	-11.96
89.00	90.00	0.82087E-01	-52.24	0.83241E+00	-48.76	7.21	-12.91
89.25	90.00	0.72515E-01	3.78	0.80618E+00	9.63	6.94	-13.98
89.50	90.00	0.63005E-01	60.71	0.77952E+00	68.39	6.64	-15.20
89.75	90.00	0.53856E-01	118.96	0.75330E+00	127.53	6.35	-16.57
90.00	90.00	0.45444E-01	179.12	0.72840E+00	-172.92	6.06	-18.04