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3相単相変換スコット変圧器

Scott Tranceformer to transpose from Three phase to Single phase

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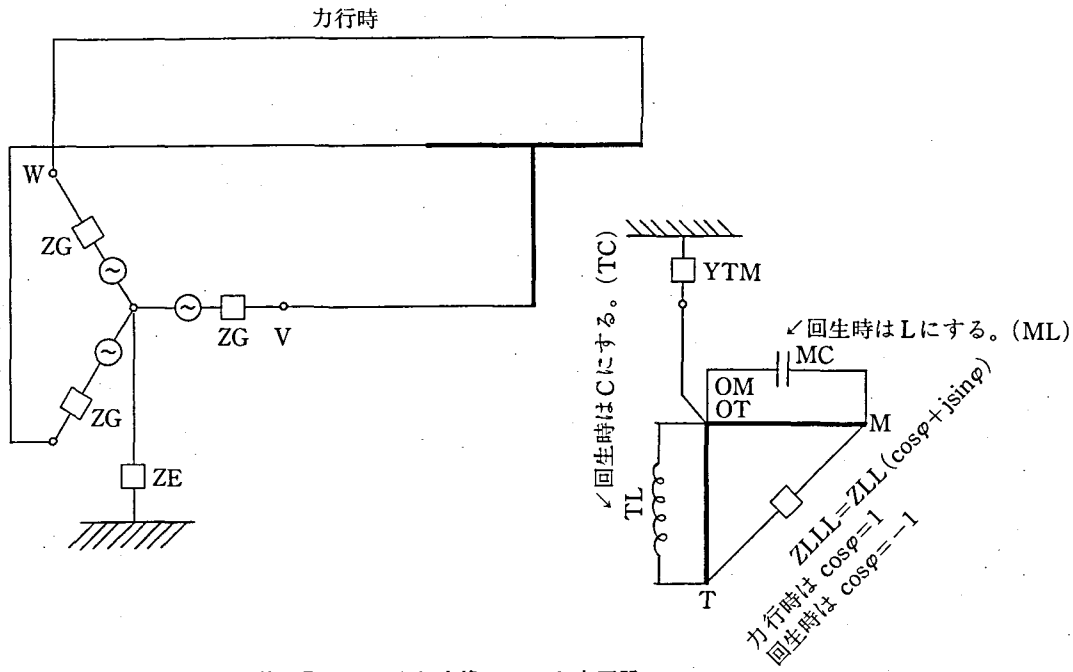
1．はじめに

前に述べた3相2相変換スコット変圧器[1]は2つの負荷が同じインピーダンスでなければ3相側の電圧電流が不平衡となり、電源側としては好ましくない。

力率1の単相負荷の場合ならば単相負荷の変動に応じて、3相電流の大きさは増減するが、平衡は保つようにオーム数を単相負荷のオーム数に合わせたインダクタンスL、コンデンサCを附け加えることで第1図のような3相単相変換スコット変圧器を作ることが出来る。

このとき元々単相負荷が一定なら3相合計電力は時間にかかわらず一定であるが単相電力は電源周波数の2倍の余弦変化をする。

このL、Cは3相電力と単相電力との差を埋めるダンパーの役目をし、3相側から見れば、L、Cおよび単相負荷の合成装置が常に一定電力を消費することになるのである。

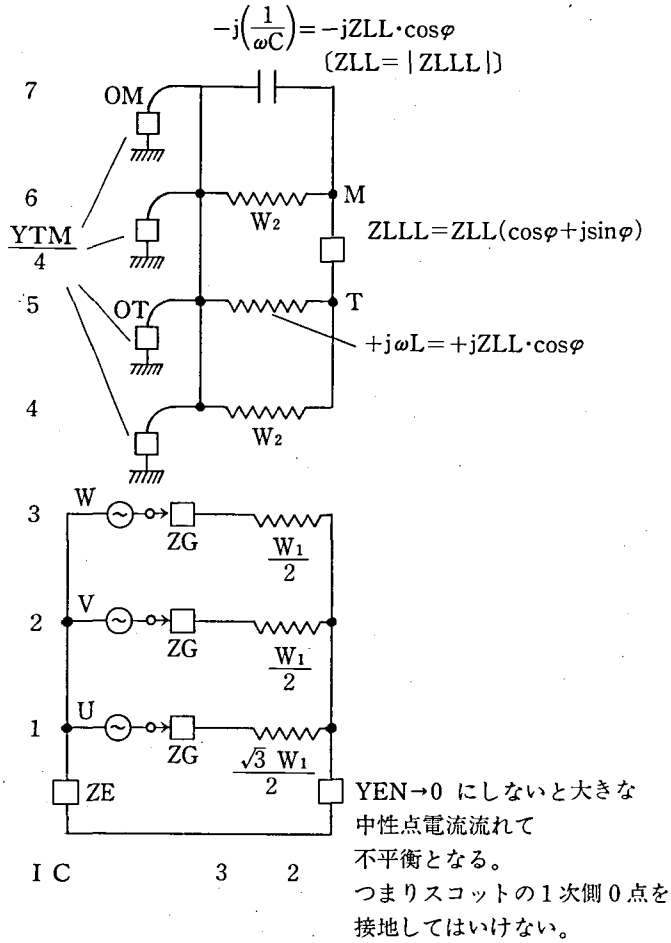


第1図　3相単相変換スコット変圧器

2．変換器結線および多導体はしご形回路[2]に画きなおした図

第1図の力行時とは、電車が電源から電力をもらって動いている時（つまり電車がモータになっている時）、回生時とは電車が電力ブレーキをかけて電源側に電力を送り返している時（つまり電車が発電機になっている時）のことを言う。

ＺＬＬは電車インピーダンスの大きさ、cosφは、その力率で、従って力行時は最大力率は1、



第2図　はしご形にした図

回生時は－1であり、本論文で電車の負荷の力率cosφ＝1とcosφ＝－1の時が3相側が平衡することを示すのである。すなわち、計算結果を図示した第3図、第4図で明らかに3相側が平衡している。また、T座、M座、L、Cの電流電圧の様子がよく分かる。

第2図は第1図を多導体はしご形回路に画きなおした図で$w_1/2$はスコット変圧器のM座1次巻数、$\sqrt{3}w_1/2$はT座1次巻線、w_2は2次側T、M座巻数である。

なお、詳細な吟味をする必要がある場合に備えて数値のケタ数を多く載せた。

第3図、第4図に記入した負荷的と起電力的とは次のことを言う。

直流Iが抵抗Rに流れているとき

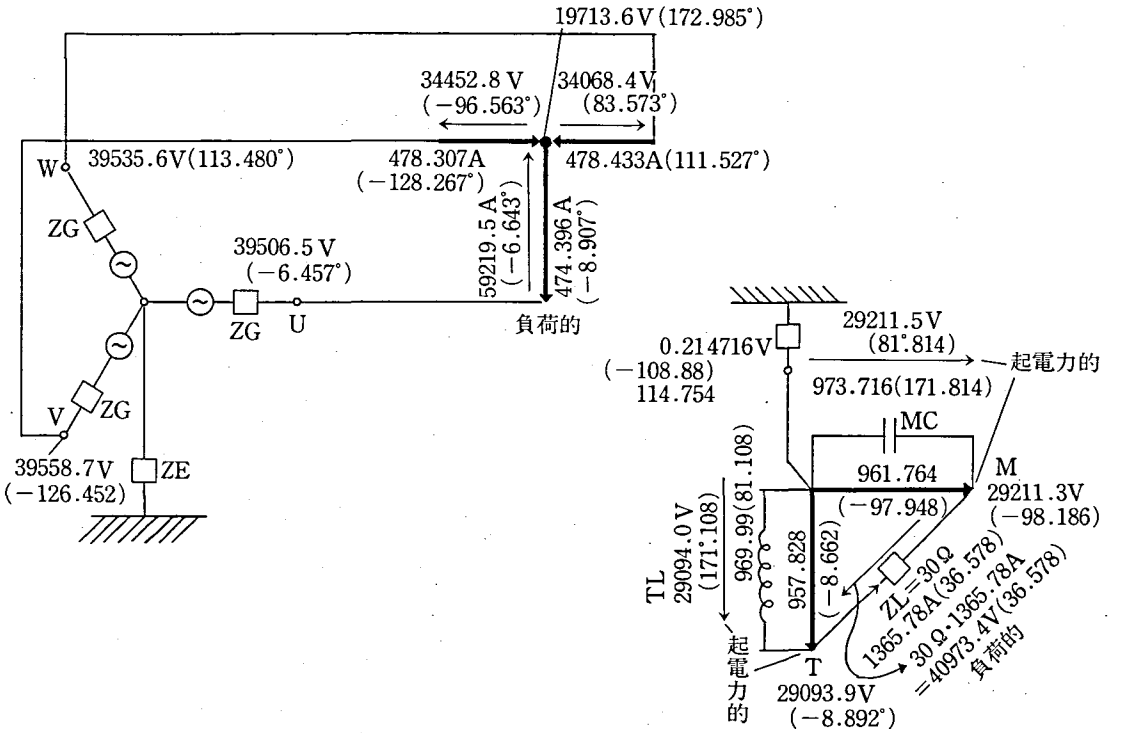
$$RI=E$$

なるオーム則で電圧Eが在る。

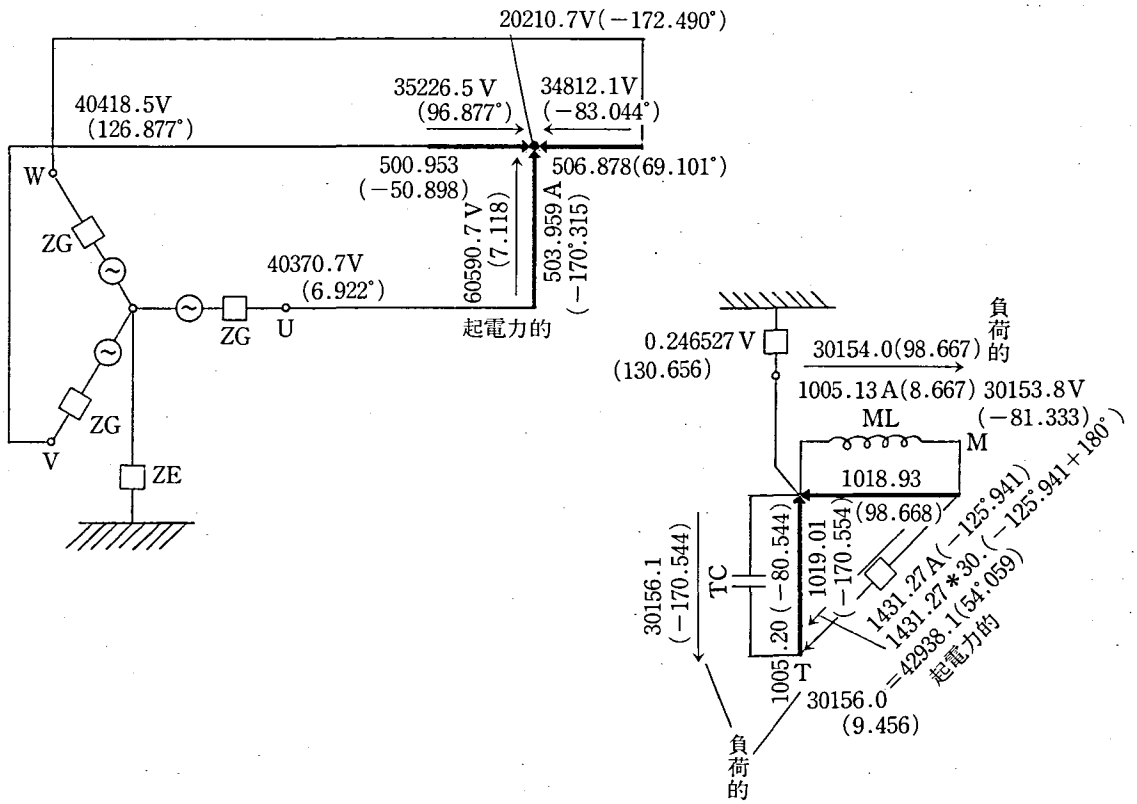
つまり、Rが正の値のときは、IとEとは符号が同じで、このとき第5図のように図示する。

ここでEの矢印の頭はRの両端子中で電位の高い方に付ける。このような場合を負荷的という。抵抗Rなる負荷には電位の高い方から低い方へ電流が正常に流れて電力を消費しているからである。Rが負のときはEとIとは符号が異るので第5図の抵抗R中に流れる電流を基にすればEが逆向きになり第6図となる。この場合Eの方向へIが流れる、つまり電池内部のIと起電力Eとの関係なので、この場合を起電力的という。

Rが電車であるとき第5図は力行時（正常運転時)、第6図は回生時(電力ブレーキをかけて電車



第3図　力行時cosφ=1 の電圧電流分布



第4図　回生時cosφ=−1 の電圧電流分布

のエネルギーを発電機側に返しているとき）に当る。

次に交流になれば上のRはインピーダンスZとなり、Z、I、Eとも複素数となり

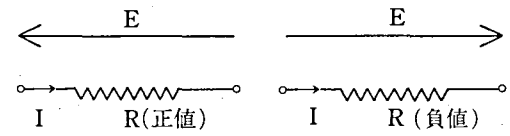
$$ZI=E$$

である。それらの関係をベクトル図で画けば第7図、第8図となる。

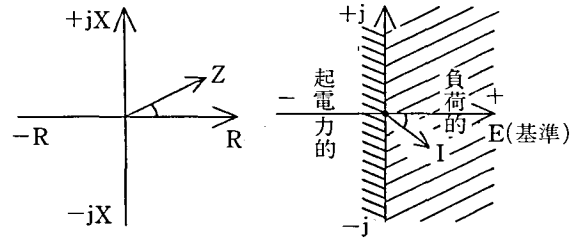
第7図でZの実部Rが正の範囲は第4象限、第1象限で、このZベクトルに対応するIベクトルは、それぞれ第1象限、第4象限にある。

つまりE（基準）とIとの位相差角は＋270°（－90°）から左廻りに＋90°までである。このような場合が、直流抵抗が正値の場合に該当するので負荷的と名づけ第9図のように図示し、EとIとの位相差角が＋90°から左廻りに＋270°（－90°）までの場合を起電力的と名づけ第10図のように図示する。

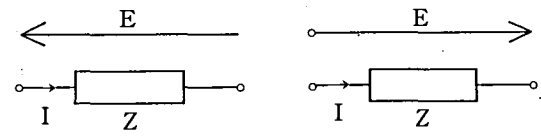
例えば第3図のM座のEは29211.5^{V}（81.814°）、Iは961,764^{A}（－97.947°）であるが第8図に合わせるべくEを基準0°とするので　－97.948°－81.814°＝－179.762°　つまりIは第3象限に入るので起電力的となるのである。



第5図　負荷的　　第6図　起電力的



第7図　　第8図



第9図　負荷的　　第10図　起電力的

3．インピーダンス行列、アドミタンス行列

第1表、第2表、第3表にインピーダンス行列とアドミタンス行列とを示す。

第1表

$[Y_2]_{7,7}$

	1	2	3	4	5	6	7
1	2G+YEN/3	−G	−G	YEN→0でないと3相中性点電流大になり、3相不平衡となる。			
2	−G	2G+YEN/3	−G				
3	−G	−G	2G+YEN/3				
4				G	−G		
5				−G	G+1/ZLLL	−1/ZLLL	
6					−1/ZLLL	G+1/ZLLL	−G
7						−G	G

第2表

$[Z_2]_{7,7}$

	1	2	3	4	5	6	7
1	ZU			ZUT			
2		ZV	ZVW			ZVM	
3		ZVW	ZW			ZWM	
4	ZUT			ZT			
5				jZLL×cosφ			
6		ZVM	ZWM			ZM	
7							−jZLL×cosφ

ZUT、ZVW、ZVMは負数値、
他は正数値を入れること。

第3表

$[Y_3]_{7,7}$

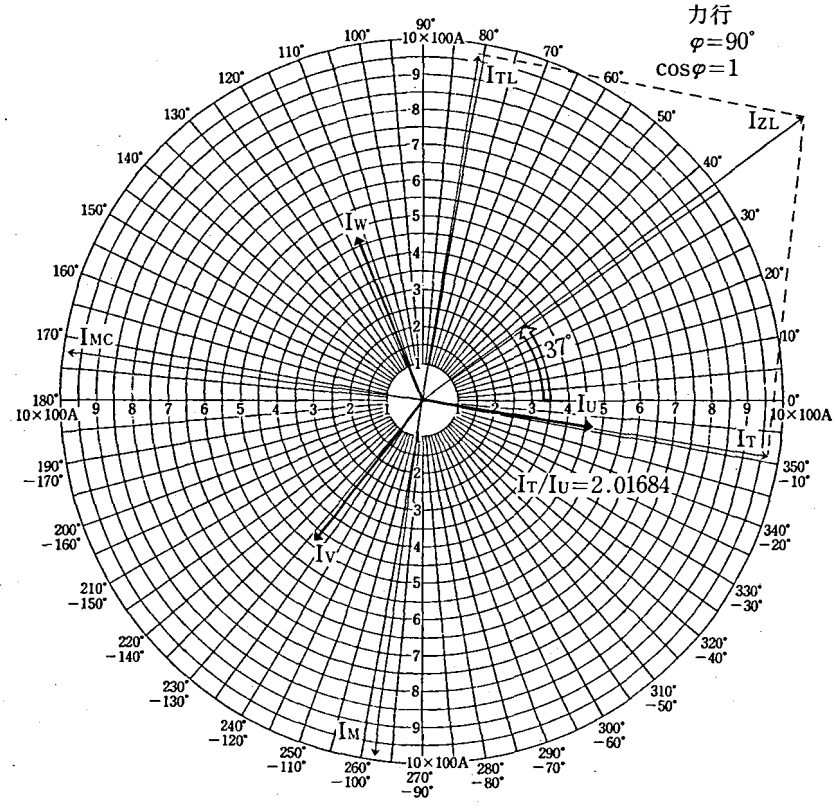
	1	2	3	4	5	6	7
1							
2							
3							
4				3G+ YTM/4	−G	−G	−G
5				−G	3G+ YTM/4	−G	−G
6				−G	−G	3G+ YTM/4	−G
7				−G	−G	−G	3G+ YTM/4

$[Z_3]_{7,7}=[0]_{7,7}$

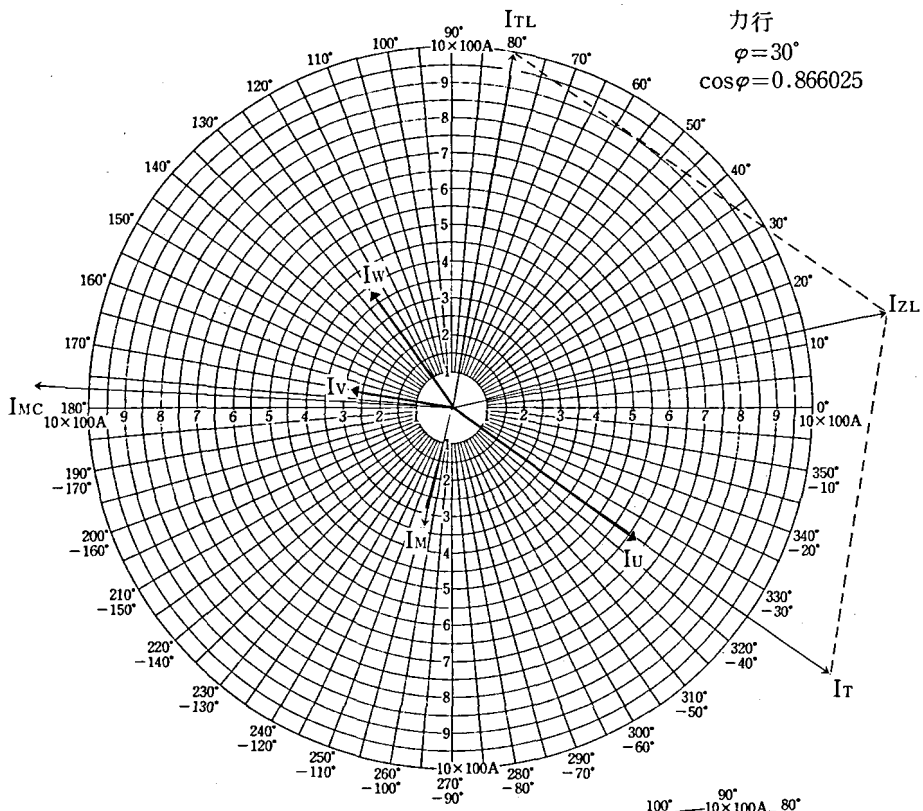
4．多導体はしご形回路理論[(2)]によるプログラムＳＣ３Ｐ１Ｐおよび計算例

巻末に、多導体はしご形回路理論[(2)]によるプログラムＳＣ３Ｐ１Ｐおよびそれによる計算結果を載せる。この例は負荷の位相角 φ を0°から360°まで10°間隔で計算したもので、その際 ω Ｌ、$1/\omega$ Ｃ（$\omega=2\pi\times$周波数）は負荷の大きさの $\cos\varphi$ 倍、つまり負荷（複素数）の実数部の大きさに合わせた装置としたものである。

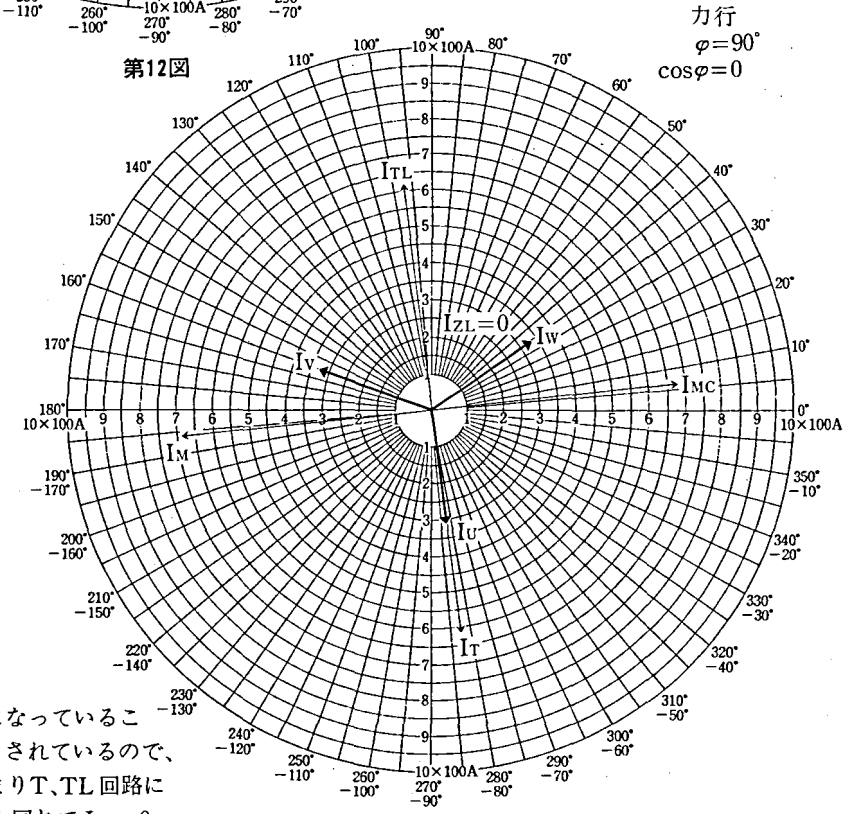
第11図から第15図はこの各例の各電流ベクトル図を画いたもので、3相各電流 I_U、I_V、I_W、とＴ座、Ｍ座の各電流 I_M、I_T、I_{ML}、I_{TL}、負荷電流 I_{ZL} などの位相関係が明白になっている。



第11図　第3図の電流ベクトル図

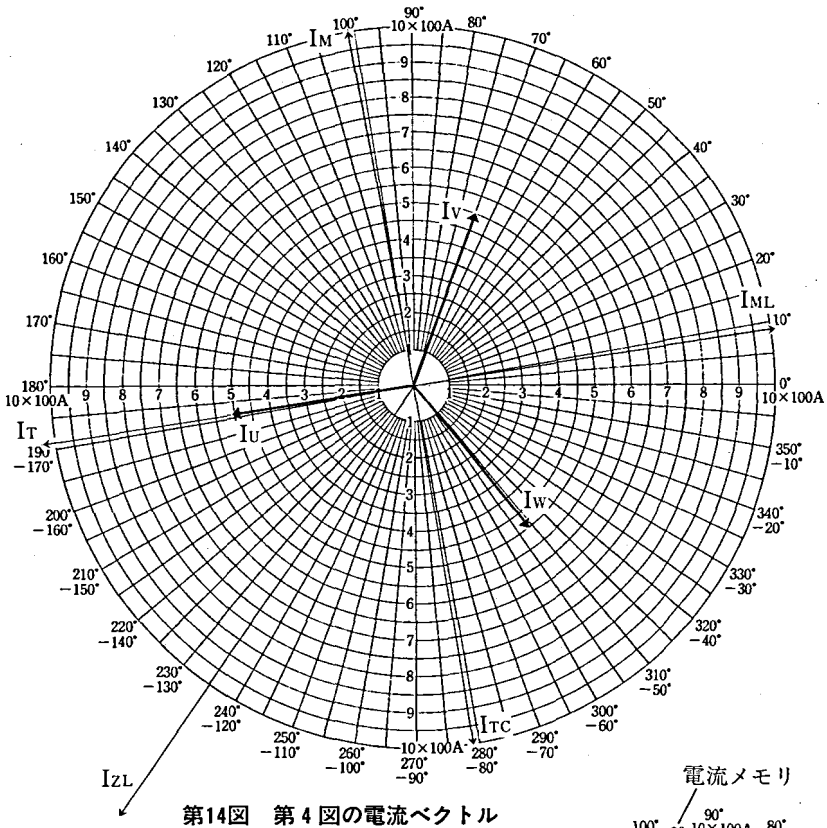


第12図

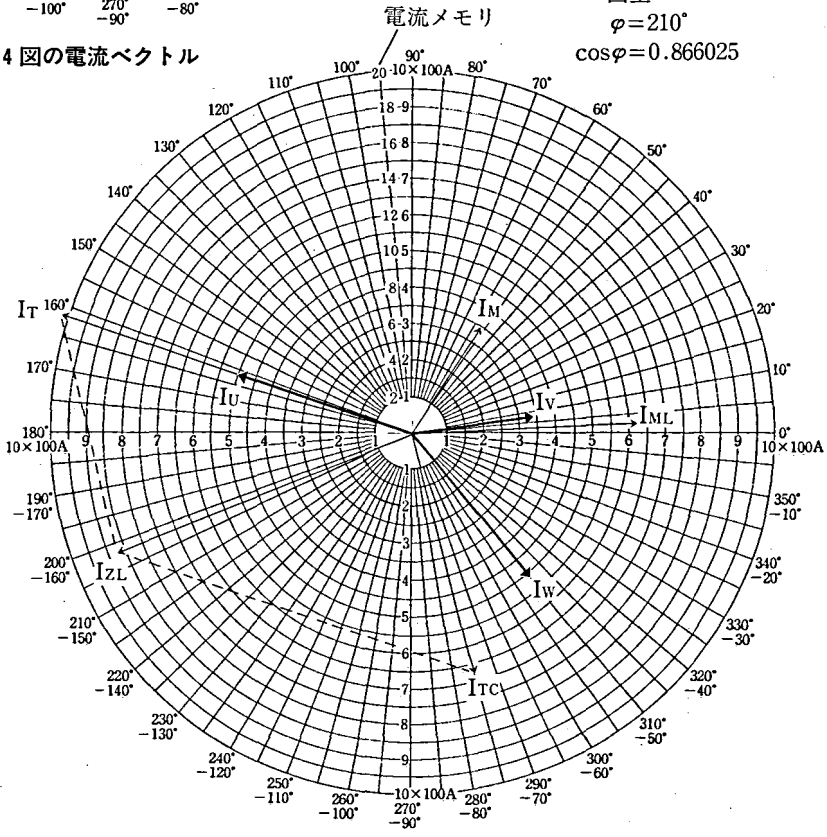


第13図

電流目盛、他に比べて10倍になっていることに注意。L、C共ショートされているので、$I_T+I_{TL}=0$、$I_M+I_{MC}=0$ つまりT、TL回路に循環電流流れ、M、MC回路も同じで $I_{ZL}=0$ つまり負荷には電流流れない。



第14図　第4図の電流ベクトル



第15図

4. SC3P1P.FOR プログラム

プログラムの文字などは文献(2)を参照して推察できる。

プログラムの歴史など記入されていて、ここでは不要の文字もそのままにしてある。

```
C   61.3.14 , 61.3.24  SCOTT L,C IRI  1 PHASE LOAD  3-PHASE  BALANSE
C   S 61.3.26
C       S 62.10.21
CCC     SC31---> SC3P1P
      CALL MOTOSC
      STOP
      END
CCC.....................................................................
      SUBROUTINE MOTOSC
C   60 CON. (TN IRI )
      PARAMETER(L1=7, L2=L1+1, K2=3)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER PERM
      COMPLEX*16  Z(L1,L2),Y(L1,L1),Y1(L1,L2)
     1     ,ZL,          EG(L1),E0(L1),D1(L1),D2(L1),E1(L1),E2(L1)
     2,   XX(L2),TZ,ZG,S1(L1),                YH( K2,L1,L1)      ,ZLLL
     3 ,ZM
      DIMENSION             E0A(L1),E0P(L1),D1A( K2,L1),D1P( K2,L1),D2A(
     1  K2,L1),D2P( K2,L1),E1A( K2,L1),E1P( K2,L1),E2A( K2,L1),E2P( K2,
     2 L1),S1A( K2,L1),S1P( K2,L1)
     3,PERM(L1)            ,ICOUNT( K2)
                    PI=3.1415926535897932D0
                                              P1180=180.D0/PI
      ICNYH=99
      DS3=DSQRT(3.D0)
 1000    READ(5,1005)NCASE,N ,ZE ,YEN,YTM
 1005 FORMAT(2I10,3D10.3)
      WRITE (6, 1007)
 1007 FORMAT ('1H ,'NCASE,N,ZE,YEN,YTM')
      WRITE(6,1010)NCASE,N  ,ZE ,YEN,YTM
 1010 FORMAT('1H ,  2I5, 3D10.3)
      IF(NCASE.EQ.0) STOP
      READ(5,1015) ZG, ZL,ZLL ,PHI
 1015 FORMAT(8F10.5)
       WRITE(6,1016)ZG,ZL,ZLL,PHI
 1150 READ(5,1030)NZYM,(ICOUNT(I),I=1,NZYM)
 1030 FORMAT(2014)
      WRITE (6, 1032)
 1032 FORMAT ('1H ,'NZYM,ICOUNT(I)')
      WRITE(6,1031)NZYM,(ICOUNT(I),I=1,NZYM)
 1031 FORMAT('1H ,2014)
    1 PHI= PHI+10.D0
      WRITE(6,1016)ZG,ZL,ZLL,PHI
 1016 FORMAT('1H0,'ZG=', 2F10.5,'   ZL=',2F10.5,'   ZLL=' F10.5,'
     1PHI=',  F10.5)
      IF(PHI.GE.360.05)STOP
      P=PHI*PI/180.D0
      ZLLL= ZLL * DCMPLX(DCOS(P), DSIN(P))
      COSPHI=DCOS(P)
      WRITE(6,1017)ZLLL,COSPHI
 1017 FORMAT('1H ,'ZLLL=',2D13.6,'   COSPHI=',D13.6)
      NN=NZYM+1
                 K1=N
 2000 CONTINUE
                       DO 1050 J=1,L2
                                          DO 1050 I=1,L1
 1050 Y1(I,J)=(0.D0,0.D0)
 1130 NN=NN-1
      IC=ICOUNT(NN)
 1002                 IF(IC.GT.ICNYH) GO TO 1001
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P)
      CALL YZGOSE (Y1,Y,Z,PERM,XX, K1,IZM,L1,L2)
 1001 CONTINUE
      DO 1003 J=1,L1
                       DO 1003 I=1,L1
 1003 YH(NN, I,J)= Y1(I,J)
 1111  IF(NN.NE.1) GO TO 1130
 1120 DO   35 J=1,K1
                      DO 35  I=1,K1
   35 Z(I,J)= Y1 (I,J)
      CALL DCINV( Z,K1,0,L1,L2,1.D-14,XX,PERM, NSTOP)
      EG(1)=  70.D0/DS3
      EG(2)= DCMPLX(-0.5D0,-DS3*0.5D0) *EG(1)
      EG(3)= DCMPLX(-0.5D0, DS3*0.5D0) *EG(1)
      DO 39 I=1,L1
      D1(I)=(0.D0,0.D0)
      DO 39 J=1,L1
   39 Y(I,J)=(0.D0,0.D0)
      DO 38 I=1,3
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```
   38 Y(I,4 ) =EG(I)
      Y(1,1)=ZG+ZE+Z(1,1)
      Y(1,2)=   ZE+Z(1,2)
      Y(1,3)=   ZE+Z(1,3)
      Y(2,1)=   ZE+Z(2,1)
      Y(2,2)=ZG+ZE+Z(2,2)
      Y(2,3)=   ZE+Z(2,3)
      Y(3,1)=   ZE+Z(3,1)
      Y(3,2)=   ZE+Z(3,2)
      Y(3,3)=ZG+ZE+Z(3,3)
      CALL DCINV(Y ,3 ,1,L1,L2,1.D-14,XX,PERM, NSTOP)
      D1(1)=Y (1,4)
      D1(2)=Y (2,4)
      D1(3)=Y (3,4)
      DO 50 I=1,K1
   50 E0(I)= (0.D0,0.D0)
C       DO  36  I=1,N
C       DO  36  J=1,N
C    36 WRITE(6,37 ) I,J,Z(I,J)
C    37 FORMAT(1H  ,2I5,'Z=' 2D15.7)
      DO 55 I=1,K1
                        DO 55 J=1,K1
   55 E0(I)=E0(I)+ Z(I,J)*D1(J)
      DO 80 I=1,3
      D1A(1,I)=CDABS(D1(I))
      IF(D1A(1,1).EQ.0.D0) GO TO 81
          D1P(1,I)=PI180*DATAN2(DIMAG(D1( I)),DREAL(D1( I)))
      GO TO 80
   81 D1P(1,I)=0.D0
   80 CONTINUE
C       DO 84 I=1,K1
C                       WRITE(6,85) I,D1(I),D1A(1,I), D1P(1,I)
C   85 FORMAT(1H ,I5,3X,3HIR=,1P4E15.7)
C   84 CONTINUE
      DO  87 I=1,K1
       E0A(I)=CDABS(E0(I))
      IF( E0(I).EQ. 0.D0) GO TO 88
      E0P(1)= PI180*DATAN2( DIMAG(E0(I)), DREAL(E0(I)))
      GO TO 87
   88  E0P(I)=0.D0
   87 CONTINUE
      DO   90 I=1,K1
      WRITE(6,   95) I, E0(I), E0A(I), E0P(I)
   95 FORMAT(1H ,I5,3X,3HE0=,1P4E15.7)
   90 CONTINUE
      TZ =EG( 1)/D1(1)
   92 TZ A=CDABS(TZ )
                          TZ P  =PI180*DATAN2(DIMAG(TZ    ),DREAL(TZ    ))
      WRITE(6,9182)TZ,TZA,TZP
 9182 FORMAT(1H ,3HTZ=,1P2E13.6,5X,4HTZA=,E13.6,5X,4HTZP=,E13.6)
      NN=0
      DO 619 I=1,L1
  619 D1(I)=(0.D0,0.D0)
  620 NN=NN+1
      IC=ICOUNT(NN)
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P)
      DO 502  I=1,K1
      D1(I)=(0.D0,0.D0)
                          DO 502 J=1,K1
  502 D1(1)=D1(I)+YH(NN,1,J)*E0(J)
      DO  506 I=1,K1
      E1(1)=(0.D0,0.D0)
                          DO 506 J=1,K1
  506 E1(I)=E1(I)+Z(I,J)*D1(J)
      DO  550 I=1,K1
  550 E2(I)=E0(I)-E1(I)
 8560 DO 508 I=1,K1
                   D2(I)=(0.D0,0.D0)
                                        DO 508 J=1,K1
  508 D2(I)=D2(I)+ Y(I,J)*E2(J)
      DO 4301 I=1,K1
 4301 S1(I)=(0.D0,0.D0)
      DO 10 I=1,N
   10 S1(1) =S1(1)-D1(I)
      S1(2)=(E2(5)-E2(6)) / ZLLL
      S1 (3) = (E2(15)- E2(14)) / ZLLL
      S1(4) = EG(1)/ D1(1)
      S1(5) = EG(2)/ D1(2)
      S1(6) = EG(3)/ D1(3)
      S1(7)= D1(1)+D1(2)+D1(3)
 2325 DO 1200 I=1,K1
      D1A(NN,I)=CDABS(D1(I))
      D2A(NN,I)=CDABS(D2(I))
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      E1A(NN,I)=CDABS(E1(I))
      E2A(NN,I)=CDABS(E2(I))
      IF(D1A(NN,I).EQ.0.D0)  GO TO 415
      D1P(NN,I)=PI180*DATAN2(DIMAG(D1(I) ),DREAL(D1(I)))
      GO TO 1506
  415 D1P(NN,I)=0.D0
 1506 IF(E1A(NN,I).EQ.0.D0)  GO TO 420
      E1P(NN,I)=PI180*DATAN2(DIMAG(E1(I) ),DREAL(E1(I)))
      GO TO  507
  420 E1P(NN,I)=0.0D0
  507 E2P(NN,I)=PI180*DATAN2(DIMAG(E2(I) ),DREAL(E2(I)))
      IF(D2A(NN,I).EQ.0.D0)  GO TO 425
      D2P(NN,I)=PI180*DATAN2(DIMAG(D2(I) ),DREAL(D2(I)))
      GO TO  607
  425 D2P(NN,I)=0.0D0
  607 E0(I)=E2(I)
 1200 CONTINUE
      DO 1201 I=1,K1
      S1A(NN,I)= CDABS(S1(I))
      IF(S1A(NN,I).EQ.0.D0) GO TO 552
      S1P(NN,I)=PI180*DATAN2(DIMAG(S1(I))  , DREAL(S1(I)))
      GO TO 1201
  552 S1P(NN,I)=0.D0
1201  CONTINUE
    9 IF(NN.NE.NZYM) GO TO 620
      DO 1253 I=1,N
                      WRITE(6,1251)
 1251 FORMAT(1H ,2H  )
      DO 1253 NN=1,NZYM
                          NP=2*NN-1
 1253 WRITE(6,1254)ICOUNT(NN), NP,I,D1A(NN,I),D1P(NN,I),S1A(NN,I),S1P(NN
     1,I), E1A(NN,I),E1P(NN,I)          ,D2A(NN,I),D2P(NN,I)
     2 ,ICOUNT(NN), E2A(NN,I), E2P(NN,I)
 1254 FORMAT(1H ,I3,2H I,I4,I3,  E13.6,F8.3,1X,2HSI,  E13.6,F8.3, 1X,1HE
     1,  E13.6,F8.3       ,3H II,  E13.6,F8.3,I4,1X,2HEE,  E13.6,F8.3)
      GO TO 1
CCC    GOTO 1000
      END
CCC.....................................................................
      SUBROUTINE ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMPLEX*16 Z(L1,L2),Y(L1,L1) ,ZL
     1,ZU,ZT,ZUT,ZV,ZW,ZM,ZVM,ZWM,ZVW
     2       ,ZO,ZMORE ,ZLLL
     3,ZUM,ZUW,ZVT
      COMPLEX*16 ZU1,ZV1,ZW1,ZU2,ZV2,ZW2, ZU1U2,ZV1V2,ZW1W2
      DO 9000 J=1,N+1
      DO 9000 I=1,N
 9000 Z(I,J)=(0.D0,0.0D0)
      DO 9003 J=1,N
      DO 9003 I=1,N
 9003 Y(I,J)=(0.D0,0.0D0)
      IZM=1
      G=1.D9
       GO TO (100,200,300),IC
  100 RETURN
  200  ZMORE=(0.1D0,0.6D0)
      PI =3.14159265358979320
      THETA= PI/180.D0*80.D0
      ZO=       7000.D0*DCMPLX (DCOS(THETA), DSIN(THETA))
      A12= 30.D0/35.D0
      ZM=ZMORE+ZO
      ZV= ZM/( A12**2)
      ZW=ZV
      ZT=ZM
      ZU=3.D0*ZV
CC    ZWM  NO MI  +  NO SUUCHI
      ZWM= ZO/A12
      ZVM=-ZO/A12
      ZVW=-ZO/(A12*A12)
      ZUT=-ZO/A12 * DSQRT(3.D0)
      WRITE(6, 197) ZU,ZT,ZUT,ZV
  197  FORMAT(1H ,'ZU=',2D13.6,'   ZT=',2D13.6, '   ZUT=',2D13.6,'   ZV=
     1',2D13.6)
      WRITE(6, 198)    ZW,ZM,ZVW,ZWM
  198  FORMAT(1H ,'ZW=',2D13.6,'   ZM=',2D13.6, '   ZVW=',2D13.6,'  ZWM=
     1',2D13.6)
      WRITE(6, 199)ZVM, ZL,ZO, A12
  199  FORMAT(1H ,'ZVM=' 2D13.6,'   ZL=', 2D13.6,'   ZO=',2D13.6,'   A12
     1='D13.6)
      Y(1,2)=-G
      Y(1,3)=-G
      Y(2,3)=-G
```

```
CCC YEN=0.DO  DENAITO  3-PHASE CURRENT DAI NI NARI  UNBALANCE TO NARU
      Y(1,1)=G*2.DO +  YEN/3.DO
      Y(2,2)=G*2.DO +  YEN/3.DO
      Y(3,3)=G*2.DO +  YEN/3.DO
       Y(4,5)= -G
       Y(5,6)=-1.DO/ZLLL
       Y(6,7)= -G
       Y(4,4)= G
       Y(5,5)= G+1.DO/ZLLL
       Y(6,6)= Y(5,5)
       Y(7,7)= G
CC    KAISEIJI WA SC31.DAT NO DATA COSPHI 0 -1 NI SURU TO NEXT 2GYOO L,C
CC     MO IREKAETA KOTONINARU
CCC   ZLLL(FUKUSOSUU) DEWA DAME -R O IRERUKOTO NIMO NARU.
       Z(5,5)=ZLL *DCOS(P)*( 0.DO, 1.DO)
       Z(7,7)=ZLL *DCOS(P)*( 0.DO,-1.DO)
      Z(1,4)=ZUT
      Z(2,6)=ZVM
      Z(3,6)=ZWM
      Z(2,3)=ZVW
      Z(1,1)=ZU
      Z(2,2)=ZV
      Z(3,3)=ZW
      Z(4,4)=ZT
      Z(6,6)=ZM
      DO 220 I=1,N
      DO 220 J=1,N
      Y(J,I)=Y(I,J)
  220 Z(J,I)=Z(I,J)
      DO  207  I=1,N
  207 Y(I,I)=Y(I,I)     +1.D-7  *FLOAT(I)
      RETURN
  300 IZM=0
      Y(4,5)=-G
      Y(4,6)=-G
      Y(4,7)=-G
      Y(5,6)=-G
      Y(5,7)=-G
      Y(6,7)=-G
      Y(4,4)=G*3.DO+YTM/4.DO
      Y(6,6)=Y(4,4)
      Y(5,5)=Y(4,4)
      Y(7,7)=Y(4,4)
      DO 321 I=4,N
      DO 321 J=4,N
  321 Y(J,I)=Y(I,J)
      RETURN
      END
CCC.....................................................................
      SUBROUTINE   YZGOSE (Y1,Y,Z,PERM,XX,K1,IZM,L1,L2)
      COMPLEX*16 Y1(L1,L2),Y(L1,L1),Z(L1,L2),XX(L2)
      INTEGER PERM(L1)
      DO 1070 I=1,K1
                        Y1(I,K1+1)=(1.DO,0.DO)
                                                DO 1070 J=1,K1
 1070 Y1(I,J)=Y(I,J)+Y1(I,J)
      IF(IZM.EQ.0) RETURN
       CALL       DCINV(Y1,K1,0,L1,L2,1.D-14,     XX,PERM,NSTOP)
      DO 1080 I=1,K1
                        Y1(I,K1+1)=(1.DO,0.DO)
                                                DO 1080 J=1,K1
 1080 Y1(I,J)=Z(I,J)+Y1(I,J)
       CALL       DCINV(Y1,K1,0,L1,L2,1.D-14,     XX,PERM,NSTOP)
      RETURN
      END
CCC.....................................................................
      SUBROUTINE DCINV(A,N,M,N1,M1,EPS,     W,IP,NSTOP)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 A,     PIVOT,W,AWK, PIVI
      REAL*8 MAX
      DIMENSION A(N1,M1), IP(N1), W(M1)
      NM = N+M
      IF ( N ) 1000,1000,100
  100 CONTINUE
      IF ( N-N1 ) 110,110,1000
  110 CONTINUE
      IF ( M ) 1000,120,120
  120 CONTINUE
      IF ( NM-M1 ) 130,130,1000
  130 CONTINUE
      IF ( EPS ) 140,150,150
  140 CONTINUE
      EPS = 1.0D-14
```

```
  150 CONTINUE
      EPSS = 1.0D-2*EPS
      DO 160 I=1,N
      IP(I) = 0
  160 CONTINUE
      DO 270 K=1,N
      MAX = -1.0D0
      DO 190 I=1,N
      IF ( IP(I) ) 170,170,190
  170 CONTINUE
      ABSS = CDABS(A(I,K))
      IF ( MAX-ABSS) 180,190,190
  180 CONTINUE
      MAX = ABSS
      L = I
  190 CONTINUE
      IF ( MAX-EPS ) 1010,1010,200
  200 CONTINUE
      PIVOT = A(L,K)
      IP(L) = K
      PIVI = -1.0D+0/PIVOT
      DO 250 J=1,NM
      IF ( J-K ) 210,250,210
  210 CONTINUE
      AWK = A(L,J) * PIVI
      IF ( CDABS(AWK)-EPSS ) 240,240,220
  220 CONTINUE
      DO 230 I=1,N
      A(I,J) = A(I,J) + A(I,K)*AWK
  230 CONTINUE
  240 CONTINUE
      A(L,J) = -AWK
  250 CONTINUE
      DO 260 I=1,N
      A(I,K) = A(I,K) * PIVI
  260 CONTINUE
      A(L,K) = -PIVI
  270 CONTINUE
      DO 290 J=1,NM
      DO 280 I=1,N
      W(I) = A(I,J)
  280 CONTINUE
      DO 290 I=1,N
      A( IP(I), J) = W(I)
  290 CONTINUE
      IF ( N-1 ) 350,350,300
  300 CONTINUE
      DO 320 I=1,N
      DO 310 J=1,N
      W(J) = A(I,J)
  310 CONTINUE
      DO 320 J=1,N
      A(I,J) = W( IP(J) )
  320 CONTINUE
  350 CONTINUE
      NSTOP = 0
      RETURN
 1000 CONTINUE
      NSTOP = 3
      WRITE(6,10) N,M,N1,M1
      RETURN
 1010 CONTINUE
      IF ( MAX ) 1011,1020,1011
 1011 CONTINUE
      NSTOP = 2
      WRITE(6,20) K
      RETURN
 1020 CONTINUE
      NSTOP = 1
      WRITE(6,30)
   10 FORMAT(1H0,'(SUBR.DCINV) INVALID ARGUMENT. N,M,N1,M1 =',4I5)
   20 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR AT STEP #',I5)
   30 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR.')
      RETURN
      END
```

SC3P2P.DAT データ

```
        2          7     0.2D0     0.D0     0.2D0
0.963       9.63         24.       18.      30.       -10.
2    3    2
```

5．計算結果の一部

```
NCASE,N,ZE,YEN,YTM
    2    7  .200D+00  .000D+00  .200D+00

ZG=    .96300   9.63000   ZL=  24.00000  18.00000   ZLL=  30.00000        PHI= -10.00000
NZYM,ICOUNT(I)
   2   3   2

ZG=    .96300   9.63000   ZL=  24.00000  18.00000   ZLL=  30.00000        PHI=    .00000
ZLLL=  .300000D+02  .000000D+00   COSPHI=  .100000D+01
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00
    1   EO=  3.9255896E+01 -4.4425936E+00  3.9506481E+01 -6.4566977E+00
    2   EO= -2.3503605E+01 -3.1819328E+01  3.9558679E+01 -1.2645173E+02
    3   EO= -1.5752266E+01  3.6262009E+01  3.9535645E+01  1.1348019E+02
    4   EO= -8.9908509E-05  1.9498571E-04  2.1471602E-04  1.1475457E+02
    5   EO= -8.9908309E-05  1.9498544E-04  2.1471568E-04  1.1475455E+02
    6   EO= -8.9908239E-05  1.9498591E-04  2.1471609E-04  1.1475448E+02
    7   EO= -8.9908031E-05  1.9498564E-04  2.1471575E-04  1.1475446E+02
TZ= 8.416480E+01 1.318964E+01     TZA= 8.519202E+01     TZP= 8.906499E+00
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00

  3 I   1  1  .474396E+00  -8.907 SI  .940023E-05  -7.016 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395065E+02  -6.457
  2 I   3  1  .474396E+00  -8.907 SI  .388253E-04 102.876 E  .592195E+02  -6.643 II  .280760E+00  31.219   2 EE  .197136E+02 172.985

  3 I   1  2  .473307E+00-128.267 SI  .160962E-10 -98.422 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395587E+02-126.452
  2 I   3  2  .473307E+00-128.267 SI  .136578E+01  36.578 E  .344528E+02 -96.563 II  .522629E+00-129.563   2 EE  .197136E+02 172.985

  3 I   1  3  .478433E+00 111.527 SI  .000000E+00    .000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395356E+02 113.480
  2 I   3  3  .478433E+00 111.527 SI  .101218E-04 135.000 E  .340684E+02  83.573 II  .273594E+00  70.180   2 EE  .197136E+02 172.985

  3 I   1  4  .940087E-05 -54.975 SI  .851914E+02   8.907 E  .000000E+00    .000 II  .957822E+00 171.338   3 EE  .214716E-03 114.755
  2 I   3  4  .957828E+00  -8.662 SI  .851914E+02   8.907 E  .290940E+02 171.108 II  .889152E+00 -11.316   2 EE  .290939E+02  -8.892

  3 I   1  5  .368044E-05 100.749 SI  .853875E+02   8.267 E  .000000E+00    .000 II  .969796E+00 -98.892   3 EE  .214716E-03 114.755
  2 I   3  5  .969799E+00  81.108 SI  .853875E+02   8.267 E  .290940E+02 171.108 II  .101362E+01  77.178   2 EE  .290939E+02  -8.892

  3 I   1  6  .993858E-05 162.493 SI  .844727E+02   8.473 E  .000000E+00    .000 II  .961808E+00  82.053   3 EE  .214716E-03 114.754
  2 I   3  6  .961806E+00 -97.948 SI  .844727E+02   8.473 E  .292115E+02  81.814 II  .956916E+00 -99.131   2 EE  .292113E+02 -98.186

  3 I   1  7  .489281E-05  12.907 SI  .940019E-05 172.985 E  .000000E+00    .000 II  .973721E+00  -8.186   3 EE  .214716E-03 114.754
  2 I   3  7  .973716E+00 171.814 SI  .940019E-05 172.985 E  .292115E+02  81.814 II  .953952E+00 172.115   2 EE  .292113E+02 -98.186

ZG=    .96300   9.63000   ZL=  24.00000  18.00000   ZLL=  30.00000        PHI=  10.00000
ZLLL=  .295442D+02  .520945D+01   COSPHI=  .984808D+00
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00
    1   EO=  3.8359921E+01 -4.6004584E+00  3.8634800E+01 -6.8387505E+00
    2   EO= -2.2076316E+01 -3.1643189E+01  3.8583094E+01 -1.2490210E+02
    3   EO= -1.6283579E+01  3.6243733E+01  3.9733652E+01  1.1419342E+02
    4   EO= -9.3810137E-05  1.9414322E-04  2.1561987E-04  1.1578987E+02
    5   EO= -9.3809927E-05  1.9414290E-04  2.1561950E-04  1.1578985E+02
    6   EO= -9.3809843E-05  1.9414331E-04  2.1561983E-04  1.1578978E+02
    7   EO= -9.3809644E-05  1.9414311E-04  2.1561956E-04  1.1578976E+02
TZ= 7.368053E+01 2.444644E+01     TZA= 7.763020E+01     TZP= 1.835531E+01
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00
```

```
  3 I   1  1  .520603E+00 -18.356 SI  .917485E-05  -7.438 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .386348E+02  -6.839
  2 I   3  1  .520603E+00 -18.356 SI  .388619E-04 104.400 E  .578754E+02  -7.038 II  .249825E+00  13.581   2 EE  .192413E+02 172.562

  3 I   1  2  .396987E+00-145.181 SI  .141303E-10-111.461 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .385831E+02-124.902
  2 I   3  2  .396987E+00-145.181 SI  .130879E+01  28.016 E  .342654E+02 -95.018 II  .441957E+00-145.820   2 EE  .192413E+02 172.562

  3 I   1  3  .425301E+00 113.298 SI  .969788E+00-100.000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .397337E+02 114.193
  2 I   3  3  .425301E+00 113.298 SI  .969788E+00-100.000 E  .338684E+02  85.265 II  .225908E+00  57.078   2 EE  .192413E+02 172.562

  3 I   1  4  .615802E-05-115.967 SI  .776303E+02  18.356 E  .000000E+00    .000 II  .105061E+01 161.853   3 EE  .215620E-03 115.790
  2 I   3  4  .105061E+01 -18.148 SI  .776303E+02  18.356 E  .282147E+02 170.531 II  .966054E+00 -18.106   2 EE  .282146E+02  -9.468

  3 I   1  5  .345668E-05  38.669 SI  .101803E+03  25.181 E  .000000E+00    .000 II  .954996E+00 -99.469   3 EE  .215619E-03 115.790
  2 I   3  5  .954998E+00  80.531 SI  .101803E+03  25.181 E  .282147E+02 170.531 II  .945240E+00  75.465   2 EE  .282146E+02  -9.468

  3 I   1  6  .498499E-05  97.830 SI  .950258E+02   6.702 E  .000000E+00    .000 II  .741965E+00  75.973   3 EE  .215620E-03 115.790
  2 I   3  6  .741961E+00-104.027 SI  .950258E+02   6.702 E  .289899E+02  83.855 II  .736918E+00-105.510   2 EE  .289897E+02 -96.146

  3 I   1  7  .170222E-05 -66.577 SI  .917496E-05 172.562 E  .000000E+00    .000 II  .981238E+00  -6.145   3 EE  .215620E-03 115.790
  2 I   3  7  .981237E+00 173.855 SI  .917496E-05 172.562 E  .289899E+02  83.855 II  .963103E+00 174.322   2 EE  .289897E+02 -96.146

ZG=     .96300    9.63000   ZL=  24.00000  18.00000   ZLL=  30.00000        PHI=  20.00000
ZLLL=   .281908D+02  .102606D+02   COSPHI=   .939693D+00
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00
    1   EO=  3.7423839E+01 -4.6260892E+00  3.7708679E+01 -7.0467808E+00
    2   EO= -2.0749655E+01 -3.1804925E+01  3.7975011E+01 -1.2312058E+02
    3   EO= -1.6674159E+01  3.6431098E+01  4.0065602E+01  1.1459311E+02
    4   EO= -9.7386687E-05  1.9386843E-04  2.1695422E-04  1.1667193E+02
    5   EO= -9.7386472E-05  1.9386806E-04  2.1695379E-04  1.1667192E+02
    6   EO= -9.7386391E-05  1.9386842E-04  2.1695408E-04  1.1667186E+02
    7   EO= -9.7386173E-05  1.9386828E-04  2.1695386E-04  1.1667183E+02
TZ= 6.316819E+01 3.242410E+01     TZA= 7.100382E+01     TZP= 2.717133E+01
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00

  3 I   1  1  .569187E+00 -27.172 SI  .893542E-05  -7.673 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .377087E+02  -7.047
  2 I   3  1  .569187E+00 -27.172 SI  .390531E-04 105.782 E  .564470E+02  -7.255 II  .252067E+00  -6.266   2 EE  .187391E+02 172.327

  3 I   1  2  .334859E+00-164.655 SI  .124861E-10-122.470 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .379750E+02-123.121
  2 I   3  2  .334859E+00-164.655 SI  .126424E+01  19.988 E  .343762E+02 -93.633 II  .370772E+00-166.561   2 EE  .187391E+02 172.327

  3 I   1  3  .393874E+00 117.761 SI  .940478E+00-110.000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .400656E+02 114.593
  2 I   3  3  .393874E+00 117.761 SI  .940478E+00-110.000 E  .339819E+02  86.800 II  .158219E+00  45.934   2 EE  .187391E+02 172.327

  3 I   1  4  .551176E-05-130.153 SI  .710039E+02  27.172 E  .000000E+00    .000 II  .114829E+01 153.001   3 EE  .216954E-03 116.672
  2 I   3  4  .114829E+01 -26.999 SI  .710039E+02  27.172 E  .272773E+02 170.183 II  .106780E+01 -24.451   2 EE  .272771E+02  -9.816

  3 I   1  5  .364080E-05  14.379 SI  .120691E+03  44.655 E  .000000E+00    .000 II  .967594E+00 -99.817   3 EE  .216954E-03 116.672
  2 I   3  5  .967595E+00  80.183 SI  .120691E+03  44.655 E  .272773E+02 170.183 II  .900417E+00  76.115   2 EE  .272771E+02  -9.816

  3 I   1  6  .304533E-05  85.562 SI  .102608E+03   2.239 E  .000000E+00    .000 II  .533653E+00  72.716   3 EE  .216954E-03 116.672
  2 I   3  6  .533650E+00-107.284 SI  .102608E+03   2.239 E  .291055E+02  85.702 II  .532850E+00-109.622   2 EE  .291053E+02 -94.298

  3 I   1  7  .342834E-06 127.384 SI  .893551E-05 172.327 E  .000000E+00    .000 II  .103245E+01  -4.298   3 EE  .216954E-03 116.672
  2 I   3  7  .103245E+01 175.702 SI  .893551E-05 172.327 E  .291055E+02  85.702 II  .101157E+01 176.047   2 EE  .291053E+02 -94.298
```

```
ZG=    .96300   9.63000   ZL=  24.00000  18.00000   ZLL=  30.00000        PHI=  30.00000
ZLLL=   .259808D+02  .150000D+02   COSPHI=  .866025D+00
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00
    1   EO=  3.6431674E+01 -4.5490868E+00  3.6714589E+01 -7.1174713E+00
    2   EO= -1.9509755E+01 -3.2301086E+01  3.7735801E+01 -1.2113185E+02
    3   EO= -1.6921894E+01  3.6850253E+01  4.0549866E+01  1.1466492E+02
    4   EO= -9.5538124E-05  1.9878444E-04  2.2055110E-04  1.1566948E+02
    5   EO= -9.5537911E-05  1.9878401E-04  2.2055062E-04  1.1566948E+02
    6   EO= -9.5537851E-05  1.9878434E-04  2.2055089E-04  1.1566943E+02
    7   EO= -9.5537583E-05  1.9878424E-04  2.2055069E-04  1.1566938E+02
TZ= 5.267015E+01 3.755874E+01     TZA= 6.469006E+01     TZP= 3.549242E+01
ZU=  .496385D+04  .281515D+05   ZT=  .121564D+04  .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=  .165462D+04  .938385D+04
ZW=  .165462D+04  .938385D+04   ZM=  .121564D+04  .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=  .141813D+04  .804260D+04
ZVM= -.141813D+04 -.804260D+04   ZL=  .240000D+02  .180000D+02   ZO=  .121554D+04  .689365D+04   A12=  .857143D+00

  3 I   1  1  .624742E+00 -35.492 SI  .867850E-05  -7.761 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .367146E+02  -7.117
  2 I   3  1  .624742E+00 -35.492 SI  .399905E-04 105.235 E  .549136E+02  -7.331 II  .255389E+00 -24.512   2 EE  .181998E+02 172.239

  3 I   1  2  .288034E+00 171.221 SI  .111485E-10-130.416 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .377358E+02-121.132
  2 I   3  2  .288034E+00 171.221 SI  .123225E+01  12.495 E  .347900E+02 -92.433 II  .323497E+00 170.207   2 EE  .181998E+02 172.239

  3 I   1  3  .389600E+00 125.098 SI  .909230E+00-120.000 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .405499E+02 114.665
  2 I   3  3  .389600E+00 125.098 SI  .909230E+00-120.000 E  .344106E+02  88.149 II  .100297E+00  30.518   2 EE  .181998E+02 172.239
```

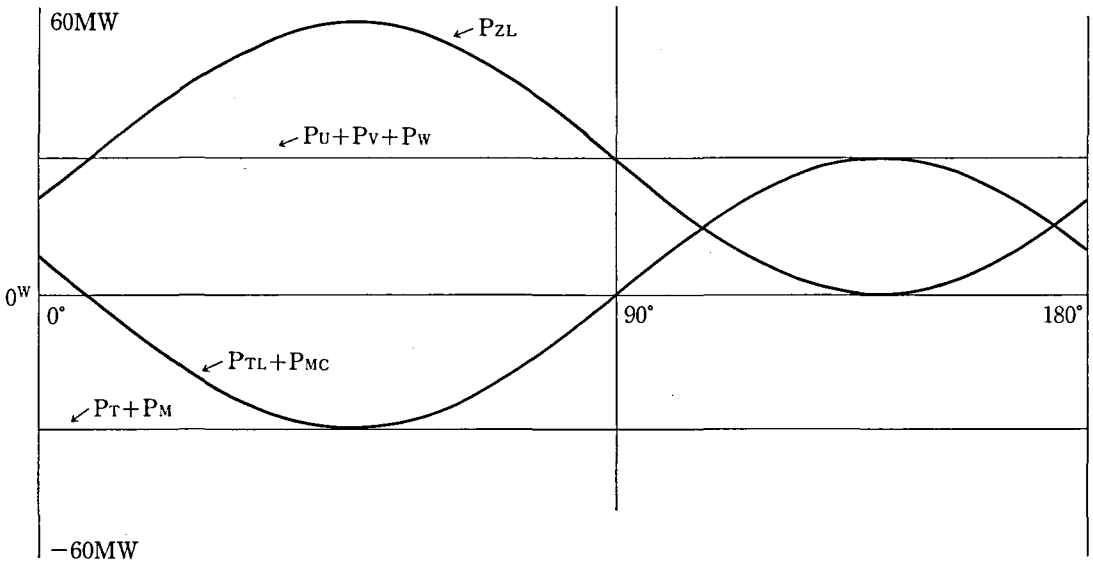
6．各電圧、電流、瞬時電力

力行時の各電圧、電流、瞬時電力を計算するプログラムが第4表、入力データが第5表、結果が第6表、瞬時電力の時間（角度）変化グラフが第16図であり、回生時の結果が第7表、瞬時電力の時間（角度）変化グラフが第17図である。

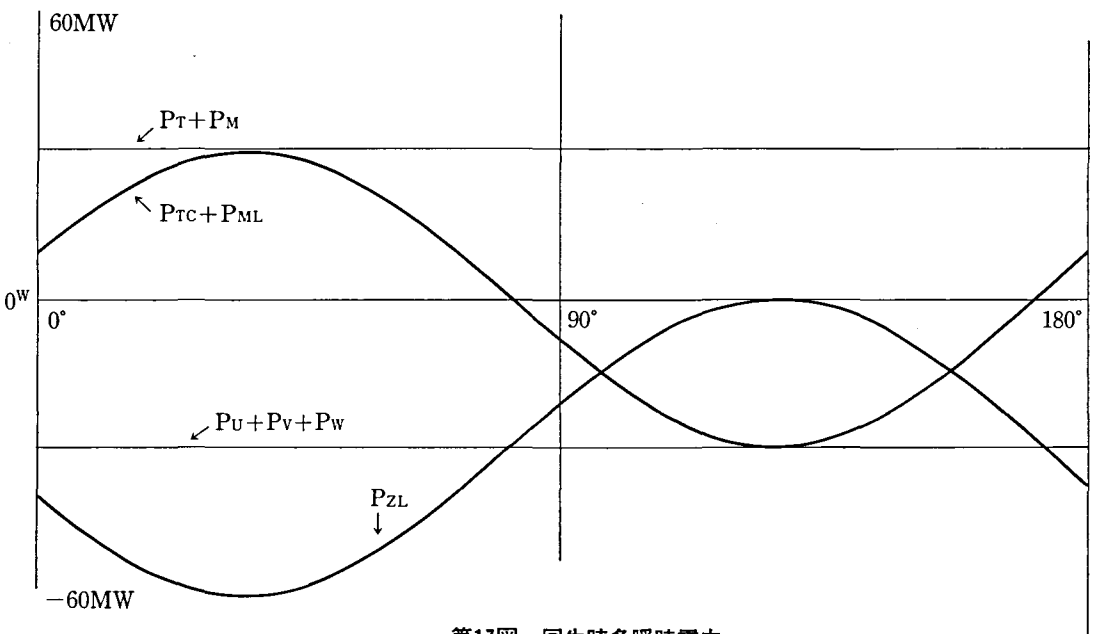
例えば、第16図をみると、次のようになっている。

$$(P_U+P_V+P_W) = -(P_T+P_M)$$
$$\text{時間的に一定} \qquad \text{時間的に一定}$$
$$= (P_{TL}+P_{MC}) + P_{ZL}$$
$$\text{時間変化} \qquad \text{時間変化}$$

つまり、時間に関係なく一定な電力である3相電力U、V、W相の和$P_U+P_V+P_W$がコイルT、Mに（P_T+P_M）なる時間に関係なく一定な電力を誘起させ、その－（P_T+P_M）が時間変化する



第16図　力行時各瞬時電力



第17図　回生時各瞬時電力

2つの単相電力（$P_{TL}+P_{MC}$）と単相電力P_{ZL}とに分かれる。上の添字TはT座コイル、MはM座コイル、TLはT座コイルに並列に設置したリアクタL、MCはM座コイルに並列に設置したコンデンサC、ZLは単相負荷を表わす。

すなわち、L、Cに1時的に時間変化するエネルギーが蓄積される。その（$P_{TL}+P_{MC}$）が3相電力（$P_U+P_V+P_W$）（時間的に一定）と単相電力P_{ZL}（時間的に変化する）とを両立させるダンパーとなるのである。

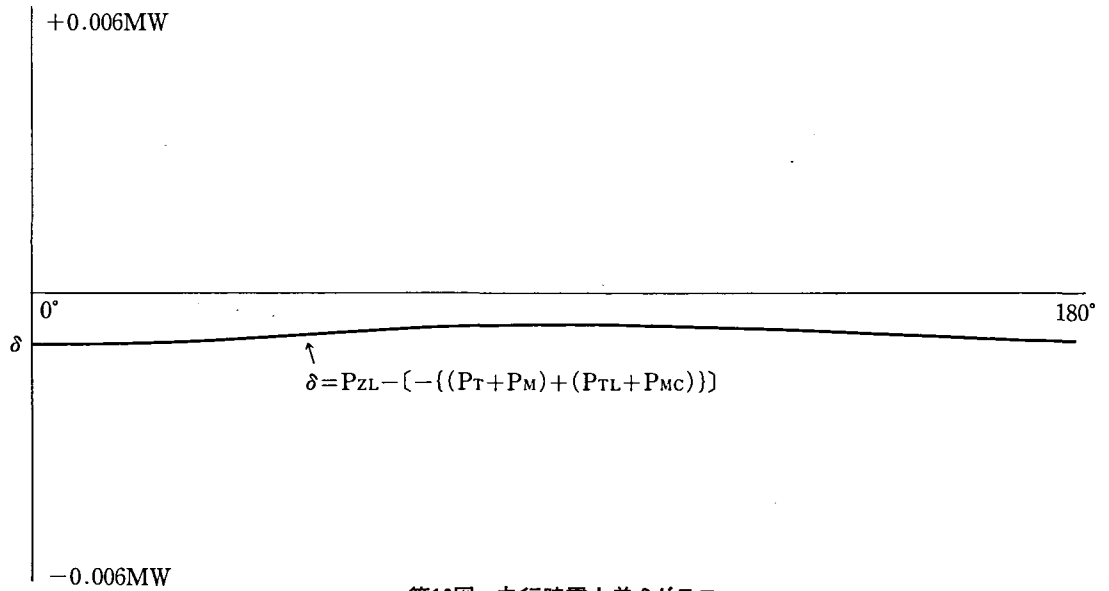
回生時の第17図についても同様で

$$\underset{\text{時間的変化}}{P_{ZL}} = -\underset{\text{時間的に一定}}{(P_T+P_M)} - \underset{\text{時間変化}}{(P_{TC}+P_{ML})}$$

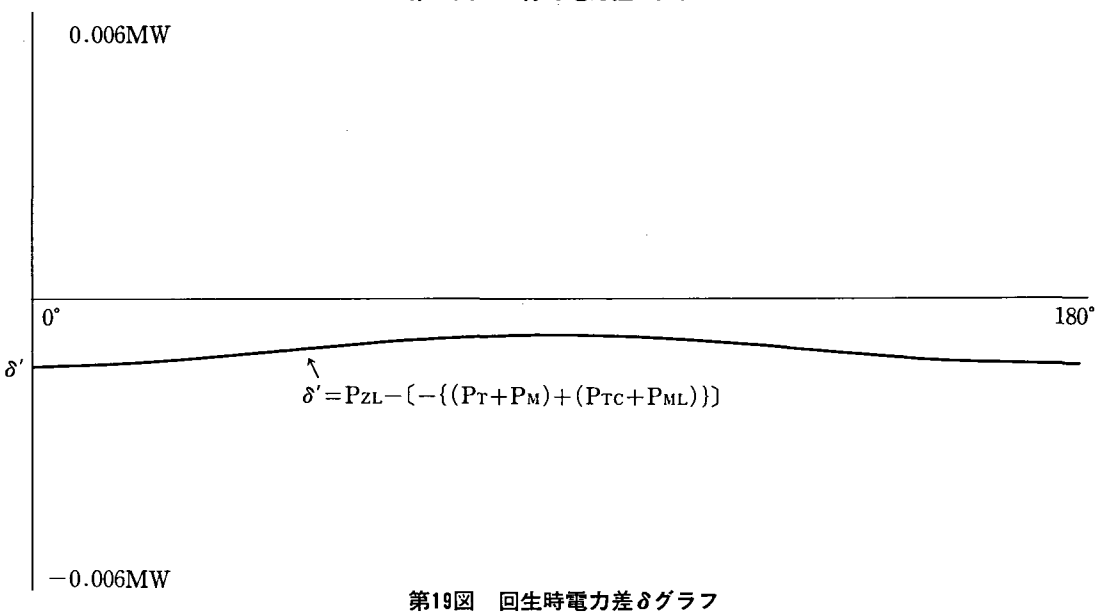
$$= \underset{\text{時間的に一定}}{(P_U+P_V+P_W)} - \underset{\text{時間変化}}{(P_{TC}+P_{ML})}$$

つまり、時間変化するP_{ZL}が時間的に一定な3相電力と時間変化する$P_{TC}+P_{ML}$とに分かれる。

ただし添字TLとMLは回生時なので力行時のLとCとを取りかえるつまりT座コイルには並列にコンデンサを、M座コイルには並列にリアクタを設置したことを表示している。



第18図　力行時電力差δグラフ



第19図　回生時電力差δグラフ

なお、回生時の各電圧、電流、電力は第7表に、回生時各瞬時電力は第17図に示した。

次に

$\delta = P_{ZL} - 〔- \{(P_T + P_M) + (P_{TL} + P_{MC})\}〕$

すなわち、負荷Z_Lにこの3相単相変換器の2次側T、M、TL、MCの電力が渡るとき、力行時、回生時とも、どれだけの損失となるかを計算するプログラムが第8表、力行時入力データが第9表、計算結果が第10表、δの時間変化グラフが第18図、回生時の計算結果が第11表、$\delta' = P_{ZL} - 〔- \{(P_T + P_M) + (P_{TC} + P_{ML})\}〕$の時間変化グラフが第19図である。

なお、回生時にEG(1)＝1．D－8にして検査してみたが、全体が10^{-20}程度小となるだけけであった。つまり設備的にも電源起電力をδボルトにすることは無意味である。

第4表　SC31GWA.FOR
SC31GWA.DAT

$P_U + P_V + P_W$等のグラフ

力行時（PHI＝0.）
回生時（PHI＝180.）　} 共に用いるプログラム

データで {ZMORE / ZO} 変化して検討可

1ケース計算後、任意数字をキーインし、リターンキー入れ、次のケースを計算する。

```
C   61.3.14 , 61.3.24  SCOTT L,C IRI  1 PHASE LOAD  3-PHASE  BALANSE
C   S 61.3.26
C       S 62.10.21
CCC     SC31
        CALL MOTOSC
        STOP
        END
        SUBROUTINE MOTOSC
C   60 CON. (TN IRI )
        PARAMETER(L1=7, L2=L1+1, K2=3)
        IMPLICIT REAL*8 (A-H,O-Z)
        INTEGER PERM
        COMPLEX*16  Z(L1,L2),Y(L1,L1),Y1(L1,L2)
       1        , ZL,          EG(L1),E0(L1),D1(L1),D2(L1),E1(L1),E2(L1)
       2,   XX(L2),TZ,ZG,S1(L1),                YH( K2,L1,L1)      ,ZLLL
       3 ,ZM ,ZMORE
        DIMENSION            E0A(L1),E0P(L1),D1A( K2,L1),D1P( K2,L1),D2A(
       1  K2,L1),D2P( K2,L1),E1A( K2,L1),E1P( K2,L1),E2A( K2,L1),E2P( K2,
       2 L1),S1A( K2,L1),S1P( K2,L1)
       3,PERM(L1)           ICOUNT( K2)
                    PI=3.1415926535897932D0
                                              PI180=180.D0/PI
        ICNYH=99
        DS3=DSQRT(3.D0)
 1000     READ(5,1005)NCASE,N ,ZE ,YEN,YTM
 1005 FORMAT(2I10,3D10.3)
        WRITE (6, 1007)
 1007 FORMAT ('1H ,'NCASE,N,ZE,YEN,YTM')
        WRITE(6,1010)NCASE,N  ,ZE ,YEN,YTM
 1010 FORMAT('1H ,  215, 3D10.3)
        IF(NCASE.EQ.0) STOP
        READ(5,1015) ZG, ZL,ZLL
 1015 FORMAT(8F10.5)
         WRITE(6,1016)ZG,ZL,ZLL
 1150 READ(5,1030)NZYM,(ICOUNT(I),I=1,NZYM)
 1030 FORMAT(2014)
        WRITE (6, 1032)
 1032 FORMAT ('1H ,'NZYM,ICOUNT(I)')
        WRITE(6,1031)NZYM,(ICOUNT(I),I=1,NZYM)
 1031 FORMAT('1H ,2014)
    1 READ (5,8)   PHI,ZMORE ,ZOA
    8 FORMAT( F5.1,3D10.2)
        WRITE(6,9) PHI,ZMORE     ,ZOA
    9 FORMAT('1H ,'PHI=',F5.1,'   ZMORE=',2D10.2,'   ZOA=',D10.2)
C   1 PHI= PHI+10.D0
 1016 FORMAT(1H0,'ZG=', 2F10.5,'   ZL=',2F10.5,'   ZLL=' F10.5)
        IF( ZOA.EQ.0.)STOP
        P=PHI*PI/180.D0
        ZLLL= ZLL * DCMPLX(DCOS(P), DSIN(P))
        COSPHI=DCOS(P)
        WRITE(6,1017)ZLLL,COSPHI
```

```
 1017 FORMAT(1H ,'ZLLL=',2D13.6,'   COSPHI=',D13.6)
      NN=NZYM+1
                 K1=N
CCCC
CCCC
 2000 CONTINUE
                        DO 1050 J=1,L2
                                      DO 1050 I=1,L1
 1050 Y1(I,J)=(0.D0,0.D0)
 1130 NN=NN-1
      IC=ICOUNT(NN)
 1002                 IF(IC.GT.ICNYH) GO TO 1001
CCCC
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P,ZMORE,ZOA)
      CALL YZGOSE (Y1,Y,Z,PERM,XX, K1,IZM,L1,L2)
 1001 CONTINUE
      DO 1003 J=1,L1
                        DO 1003 I=1,L1
 1003 YH(NN, I,J)= Y1(I,J)
 1111  IF(NN.NE.1) GO TO 1130
 1120 DO   35 J=1,K1
                        DO 35  I=1,K1
   35 Z(I,J)= Y1 (I,J)
      CALL DCINV( Z,K1,0,L1,L2,1.D-14,XX,PERM, NSTOP)
      EG(1)=  70.D0/DS3
      EG(2)= DCMPLX(-0.5D0,-DS3*0.5D0) *EG(1)
      EG(3)= DCMPLX(-0.5D0, DS3*0.5D0) *EG(1)
      DO 39 I=1,L1
      D1(I)=(0.D0,0.D0)
      DO 39 J=1,L1
   39 Y(I,J)=(0.D0,0.D0)
      DO 38 I=1,3
   38 Y(I,4 ) =EG(I)
      Y(1,1)=ZG+ZE+Z(1,1)
      Y(1,2)=   ZE+Z(1,2)
      Y(1,3)=   ZE+Z(1,3)
      Y(2,1)=   ZE+Z(2,1)
      Y(2,2)=ZG+ZE+Z(2,2)
      Y(2,3)=   ZE+Z(2,3)
      Y(3,1)=   ZE+Z(3,1)
      Y(3,2)=   ZE+Z(3,2)
      Y(3,3)=ZG+ZE+Z(3,3)
      CALL DCINV(Y ,3 ,1,L1,L2,1.D-14,XX,PERM, NSTOP)
      D1(1)=Y (1,4)
      D1(2)=Y (2,4)
      D1(3)=Y (3,4)
      DO 50 I=1,K1
   50 E0(I)= (0.D0,0.D0)
C     DO  36  I=1,N
C     DO  36  J=1,N
C  36 WRITE(6,37 ) I,J,Z(I,J)
C  37 FORMAT(1H ,2I5,'Z=' 2D15.7)
      DO 55 I=1,K1
                      DO 55 J=1,K1
   55 E0(I)=E0(I)+ Z(I,J)*D1(J)
      DO 80 I=1,3
      D1A(I,I)=CDABS(D1(I))
      IF(D1A(I,I).EQ.0.D0) GO TO 81
         D1P(I,I)=PI180*DATAN2(DIMAG(D1( I)),DREAL(D1( I)))
      GO TO 80
   81 D1P(I,I)=0.D0
   80 CONTINUE
C     DO 84 I=1,K1
C                     WRITE(6,85) I,D1(I),D1A(I,I), D1P(I,I)
C  85 FORMAT(1H ,I5,3X,3HIR=,1P4E15.7)
C  84 CONTINUE
      DO  87 I=1,K1
       E0A(I)=CDABS(E0(I))
      IF( E0(I).EQ. 0.D0) GO TO 88
      E0P(I)= PI180*DATAN2( DIMAG(E0(I)), DREAL(E0(I)))
      GO TO 87
   88  E0P(I)=0.D0
   87 CONTINUE
      DO   90 I=1,K1
      WRITE(6,  95) I, E0(I), E0A(I), E0P(I)
   95 FORMAT(1H ,I5,3X,3HE0=,1P4E15.7)
   90 CONTINUE
      TZ =EG( 1)/D1(1)
   92 TZ A=CDABS(TZ )
                      TZ P  =PI180*DATAN2(DIMAG(TZ     ),DREAL(TZ     ))
      WRITE(6,9182)TZ,TZA,TZP
 9182 FORMAT(1H ,3HTZ=,1P2E13.6,5X,4HTZA=,E13.6,5X,4HTZP=,E13.6)
      NN=0
```

```
      DO 619 I=1,L1
  619 D1(I)=(0.D0,0.D0)
  620 NN=NN+1
      IC=ICOUNT(NN)
CCCC
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P,ZMORE,ZOA)
      DO 502  I=1,K1
      D1(I)=(0.D0,0.D0)
                          DO 502 J=1,K1
  502 D1(I)=D1(I)+YH(NN,I,J)*E0(J)
      DO  506 I=1,K1
      E1(I)=(0.D0,0.D0)
                          DO 506 J=1,K1
  506 E1(I)=E1(I)+Z(I,J)*D1(J)
      DO  550 I=1,K1
  550 E2(I)=E0(I)-E1(I)
 8560 DO 508 I=1,K1
                    D2(I)=(0.D0,0.D0)
                                        DO 508 J=1,K1
  508 D2(I)=D2(I)+ Y(I,J)*E2(J)
      DO 4301 I=1,K1
 4301 S1(I)=(0.D0,0.D0)
      DO 10 I=1,N
   10 S1(1) =S1(1)-D1(I)
      S1(2)=(E2(5)-E2(6)) / ZLLL
      S1 (3) = (E2(15)- E2(14)) / ZLLL
      S1(4) = EG(1)/ D1(1)
      S1(5) = EG(2)/ D1(2)
      S1(6) = EG(3)/ D1(3)
      S1(7)= D1(1)+D1(2)+D1(3)
 2325 DO 1200 I=1,K1
      D1A(NN,I)=CDABS(D1(I))
      D2A(NN,I)=CDABS(D2(I))
      E1A(NN,I)=CDABS(E1(I))
      E2A(NN,I)=CDABS(E2(I))
      IF(D1A(NN,I).EQ.0.D0)  GO TO 415
      D1P(NN,I)=PI180*DATAN2(DIMAG(D1(I) ),DREAL(D1(I)))
      GO TO 1506
  415 D1P(NN,I)=0.D0
 1506 IF(E1A(NN,I).EQ.0.D0)  GO TO 420
      E1P(NN,I)=PI180*DATAN2(DIMAG(E1(I) ),DREAL(E1(I)))
      GO TO  507
  420 E1P(NN,I)=0.0D0
  507 E2P(NN,I)=PI180*DATAN2(DIMAG(E2(I) ),DREAL(E2(I)))
      IF(D2A(NN,I).EQ.0.D0)  GO TO 425
      D2P(NN,I)=PI180*DATAN2(DIMAG(D2(I) ),DREAL(D2(I)))
      GO TO 607
  425 D2P(NN,I)=0.0D0
  607 E0(I)=E2(I)
 1200 CONTINUE
      DO 1201 I=1,K1
      S1A(NN,I)= CDABS(S1(I))
      IF(S1A(NN,I).EQ.0.D0) GO TO 552
      S1P(NN,I)=PI180*DATAN2(DIMAG(S1(I))  , DREAL(S1(I)))
      GO TO 1201
  552 S1P(NN,I)=0.D0
 1201 CONTINUE
      IF(NN.NE.NZYM) GO TO 620
      DO 1253 I=1,N
                          WRITE(6,1251)
 1251 FORMAT(1H ,2H  )
      DO 1253 NN=1,NZYM
                          NP=2*NN-1
 1253 WRITE(6,1254)ICOUNT(NN), NP,I,D1A(NN,I),D1P(NN,I),S1A(NN,I),S1P(NN
     1,I), E1A(NN,I),E1P(NN,I)          ,D2A(NN,I),D2P(NN,I)
     2 ,ICOUNT(NN), E2A(NN,I), E2P(NN,I)
 1254 FORMAT(1H ,I3,2H I,I4,I3,  E13.6,F8.3,1X,2HSI,  E13.6,F8.3, 1X,1HE
     1,  E13.6,F8.3       ,3H II,  E13.6,F8.3,I4,1X,2HEE,  E13.6,F8.3)
CCCC
      CALL SC31PG(E1A,E1P,D1A,D1P,S1A,S1P,ZLL,K2,L1,P)
      GO TO 1
CCC    GOTO 1000
      END
      SUBROUTINE ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P
     @,ZMORE,ZOA)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMPLEX*16 Z(L1,L2),Y(L1,L1) ,ZL
     1,ZU,ZT,ZUT,ZV,ZW,ZM,ZVM,ZWM,ZVW
     2          ,ZO,ZMORE ,ZLLL
     3,ZUM,ZUW,ZVT
      COMPLEX*16 ZU1,ZV1,ZW1,ZU2,ZV2,ZW2, ZU1U2,ZV1V2,ZW1W2
      DO 9000 J=1,N+1
```

```
      DO 9000 I=1,N
 9000 Z(I,J)=(0.D0,0.0D0)
      DO 9003 J=1,N
      DO 9003 I=1,N
 9003 Y(I,J)=(0.D0,0.0D0)
      IZM=1
      G=1.D9
       GO TO (100,200,300),IC
  100 RETURN
  200  CONTINUE
       PI=3.1415926535897932D0
      THETA= PI/180.D0*80.D0
      ZO= ZOA*DCMPLX (DCOS(THETA), DSIN(THETA))
      A12= 30.D0/35.D0
      ZM=ZMORE+ZO
      ZV= ZM/( A12**2)
      ZW=ZV
      ZT=ZM
      ZU=3.D0*ZV
CC    ZWM  NO MI   +  NO SUUCHI
      ZWM= ZO/A12
      ZVM=-ZO/A12
      ZVW=-ZO/(A12*A12)
      ZUT=-ZO/A12 * DSQRT(3.D0)
      WRITE(6, 197) ZU,ZT,ZUT,ZV
  197  FORMAT(1H ,'ZU=',2D13.6,'   ZT=',2D13.6, '   ZUT=',2D13.6,'   ZV=
     1',2D13.6)
      WRITE(6, 198)     ZW,ZM,ZVW,ZWM
  198  FORMAT(1H ,'ZW=',2D13.6,'   ZM=',2D13.6, '   ZVW=',2D13.6,'  ZWM=
     1',2D13.6)
      WRITE(6, 199)ZVM, ZL,ZO, A12
  199  FORMAT(1H ,'ZVM=' 2D13.6,'   ZL=', 2D13.6,'   ZO=',2D13.6,'   A12
     1='D13.6)
      Y(1,2)=-G
      Y(1,3)=-G
      Y(2,3)=-G
CCC YEN=0.D0  DENAITO  3-PHASE CURRENT DAI NI NARI  UNBALANCE TO NARU
      Y(1,1)=G*2.D0 +  YEN/3.D0
      Y(2,2)=G*2.D0 +  YEN/3.D0
      Y(3,3)=G*2.D0 +  YEN/3.D0
CC    SC31 NO TOKI IKA END MADE NISURU
       Y(4,5)= -G
       Y(5,6)=-1.D0/ZLLL
       Y(6,7)= -G
       Y(4,4)= G
       Y(5,5)= G+1.D0/ZLLL
       Y(6,6)= Y(5,5)
       Y(7,7)= G
CC     KAISEIJI WA SC31.DAT NO DATA COSPHI O -1 NI SURU TO NEXT 2GYOO L,C
CC      MO IREKAETA KOTONINARU
CCC    ZLLL(FUKUSOSUU) DEWA DAME -R O IRERUKOTO NIMO NARU.
       Z(5,5)=ZLL *DCOS(P)*( 0.D0, 1.D0)
       Z(7,7)=ZLL *DCOS(P)*( 0.D0,-1.D0)
      Z(1,4)=ZUT
      Z(2,6)=ZVM
      Z(3,6)=ZWM
      Z(2,3)=ZVW
      Z(1,1)=ZU
      Z(2,2)=ZV
      Z(3,3)=ZW
      Z(4,4)=ZT
      Z(6,6)=ZM
      DO 220 I=1,N
      DO 220 J=1,N
      Y(J,I)=Y(I,J)
  220 Z(J,I)=Z(I,J)
      DO  207  I=1,N
  207 Y(I,I)=Y(I,I)   +1.0D-7  *FLOAT(I)
      RETURN
  300 IZM=0
      Y(4,5)=-G
      Y(4,6)=-G
      Y(4,7)=-G
      Y(5,6)=-G
      Y(5,7)=-G
      Y(6,7)=-G
      Y(4,4)=G*3.D0+YTM/4.D0
      Y(6,6)=Y(4,4)
      Y(5,5)=Y(4,4)
      Y(7,7)=Y(4,4)
      DO 321 I=4,N
      DO 321 J=4,N
  321 Y(J,I)=Y(I,J)
```

```
      RETURN
      END
      SUBROUTINE   YZGOSE (Y1,Y,Z,PERM,XX,K1,IZM,L1,L2)
      COMPLEX*16 Y1(L1,L2),Y(L1,L1),Z(L1,L2),XX(L2)
      INTEGER PERM(L1)
      DO 1070 I=1,K1
                        Y1(I,K1+1)=(1.D0,0.D0)
                                                    DO 1070 J=1,K1
 1070 Y1(I,J)=Y(I,J)+Y1(I,J)
      IF(IZM.EQ.0) RETURN
       CALL      DCINV(Y1,K1,0,L1,L2,1.D-14,     XX,PERM,NSTOP)
      DO 1080 I=1,K1
                        Y1(I,K1+1)=(1.D0,0.D0)
                                                    DO 1080 J=1,K1
 1080 Y1(I,J)=Z(I,J)+Y1(I,J)
       CALL       DCINV(Y1,K1,0,L1,L2,1.D-14,     XX,PERM,NSTOP)
      RETURN
      END
      SUBROUTINE DCINV(A,N,M,N1,M1,EPS,     W,IP,NSTOP)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 A,     PIVOT,W,AWK, PIVI
      REAL*8 MAX
      DIMENSION A(N1,M1), IP(N1), W(M1)
      NM = N+M
      IF ( N ) 1000,1000,100
  100 CONTINUE
      IF ( N-N1 ) 110,110,1000
  110 CONTINUE
      IF ( M ) 1000,120,120
  120 CONTINUE
      IF ( NM-M1 ) 130,130,1000
  130 CONTINUE
      IF ( EPS ) 140,150,150
  140 CONTINUE
      EPS = 1.0D-14
  150 CONTINUE
      EPSS = 1.0D-2*EPS
      DO 160 I=1,N
      IP(I) = 0
  160 CONTINUE
      DO 270 K=1,N
      MAX = -1.0D0
      DO 190 I=1,N
      IF ( IP(I) ) 170,170,190
  170 CONTINUE
      ABSS = CDABS(A(I,K))
      IF ( MAX-ABSS) 180,190,190
  180 CONTINUE
      MAX = ABSS
      L = I
  190 CONTINUE
      IF ( MAX-EPS ) 1010,1010,200
  200 CONTINUE
      PIVOT = A(L,K)
      IP(L) = K
      PIVI = -1.0D+0/PIVOT
      DO 250 J=1,NM
      IF ( J-K ) 210,250,210
  210 CONTINUE
      AWK = A(L,J) * PIVI
      IF ( CDABS(AWK)-EPSS ) 240,240,220
  220 CONTINUE
      DO 230 I=1,N
      A(I,J) = A(I,J) + A(I,K)*AWK
  230 CONTINUE
  240 CONTINUE
      A(L,J) = -AWK
  250 CONTINUE
      DO 260 I=1,N
      A(I,K) = A(I,K) * PIVI
  260 CONTINUE
      A(L,K) = -PIVI
  270 CONTINUE
      DO 290 J=1,NM
      DO 280 I=1,N
      W(I) = A(I,J)
  280 CONTINUE
      DO 290 I=1,N
      A( IP(I), J) = W(I)
  290 CONTINUE
      IF ( N-1 ) 350,350,300
  300 CONTINUE
      DO 320 I=1,N
```

```
      DO 310 J=1,N
      W(J) = A(I,J)
  310 CONTINUE
      DO 320 J=1,N
      A(I,J) = W( IP(J) )
  320 CONTINUE
  350 CONTINUE
      NSTOP = 0
      RETURN
 1000 CONTINUE
      NSTOP = 3
      WRITE(6,10) N,M,N1,M1
      RETURN
 1010 CONTINUE
      IF ( MAX ) 1011,1020,1011
 1011 CONTINUE
      NSTOP = 2
      WRITE(6,20) K
      RETURN
 1020 CONTINUE
      NSTOP = 1
      WRITE(6,30)
   10 FORMAT(1H0,'(SUBR.DCINV) INVALID ARGUMENT. N,M,N1,M1 =',4I5)
   20 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR AT STEP #',I5)
   30 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR.')
      RETURN
      END
       SUBROUTINE SC31PG(E1A,E1P,D1A,D1P,S1A,S1P,ZLL,K2,L1,P)
      PARAMETER (NUM = 256)
      PARAMETER (XMIN = 0., XMAX = 3.1415926535897932)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION Y(NUM),Y1(NUM),Y2(NUM),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
      DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
      COMMON /FUNX/ NUMO,XMINO,XMAXO
        NUMO = NUM
        XMINO = XMIN
        XMAXO =  XMAX
        YMIN =- 6.0D1
        YMAX = 6.0D1
         PI180= 3.1415926535897932/180.D0
C
      CALL CURSOF
      CALL FUNCOF
      CALL GRPSTA
      CALL CLS(3)
      CALL VIEW(10,10,630,390)
      CALL WINDOW(XMIN,SNGL(YMAX),XMAX,SNGL(YMIN))
      CALL LINE(XMIN, 0.0, XMAX, 0.0, 1)
      CALL LINE(0.0, SNGL(YMIN), 0.0, SNGL(YMAX), 1)
C
      CALL CALC1(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1,P)
        CALL DSPGRP(Y,NUM,1)
      CALL CALC2(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        CALL DSPGRP(Y,NUM,1)
       CALL CALC3(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        DO 160 I=1,NUM
        WRITE(6,60)I, Y(I)
   60   FORMAT(1H ,'PWA=Y(',I3,')=',  D24.16)
  160   CONTINUE
        CALL DSPGRP(Y,NUM,1)
      CALL CALC4(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        CALL DSPGRP(Y,NUM,1)
C
       CALL CURSON
       CALL LOCATE(0,23)
       READ (*,*) I
       CALL FUNCON
         CALL CLS(3)
       RETURN
        END
C---------------C
C  CALCULATE 1    : PZL
C---------------C
C
       SUBROUTINE CALC1(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1,P)
       IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
      DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
        E1A22=S1A(2,2)*ZLL
        E1P22=S1P(2,2) -P  /PI180
        DO 100 I=1, NUM
        X = XOF1(I)
      Y(I) = E1A22*DSIN(X+E1P22*PI180)*S1A(2,2)*DSIN(X+S1P(2,2)*PI180)
```

```
  100      CONTINUE
           RETURN
           END
C--------------C
C  CALCULATE 2     : PT+PM
C--------------C
C
           SUBROUTINE CALC2(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
           IMPLICIT REAL*8 (A-H,O-Z)
          DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
          DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
           DO 100 I=1, NUM
            X = XOFI(I)
          Y(I) = E1A(2,4)*DSIN(X+E1P(2,4)*PI180)*D1A(2,4)*DSIN(X+D1P(2,4)*
         1PI180)+E1A(2,6)*DSIN(X+E1P(2,6)*PI180)*D1A(2,6)*DSIN(X+D1P(2,6)*
         2PI180)
  100 CONTINUE
           RETURN
           END
C--------------C
C  CALCULATE 3     : PTL+PMC(RIKKOOJI) , PTC+PML(KAISEIJI)              0
C--------------C
C
          SUBROUTINE CALC3(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
          IMPLICIT REAL*8 (A-H,O-Z)
          DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
          DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
           DO 100 I=1, NUM
            X = XOFI(I)
            Y(I) = E1A(2,5)*DSIN(X+E1P(2,5)*PI180)*D1A(2,5)*DSIN(X+D1P(2,5)*
         1PI180)+E1A(2,7)*DSIN(X+E1P(2,7)*PI180)*D1A(2,7)*DSIN(X+D1P(2,7)*
         2PI180)
  100 CONTINUE
           RETURN
           END
C--------------C
C  CALCULATE 4     :PU+PV+PW
C--------------C
C
           SUBROUTINE CALC4(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
           IMPLICIT REAL*8 (A-H,O-Z)
          DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
          DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
            DO 100 I=1, NUM
            X = XOFI(I)
          Y(I) = E1A(2,1)*DSIN(X+E1P(2,1)*PI180)*D1A(2,1)*DSIN(X+D1P(2,1)*
         1PI180)+E1A(2,2)*DSIN(X+E1P(2,2)*PI180)*D1A(2,2)*DSIN(X+D1P(2,2)*
         2PI180)+E1A(2,3)*DSIN(X+E1P(2,3)*PI180)*D1A(2,3)*DSIN(X+D1P(2,3)*
         3PI180)
  100  CONTINUE
           RETURN
           END
C---------------------------C
C  DISPLAY GRAPH OF Y(NUM)  C
C---------------------------C
C
           SUBROUTINE DSPGRP(Y,NUM,IC)
           IMPLICIT REAL*8 (A-H,O-Z)
           DIMENSION Y(NUM)
C
           I = 1
           X = XOFI(I)
           CALL PSET(SNGL(X),SNGL(Y(1)),IC)
           DO 200 I=2, NUM
           X = XOFI(I)
           CALL CLINE(SNGL(X),SNGL(Y(I)),IC)
  200 CONTINUE
C
           RETURN
           END
C-----------------------------C
C  FUNCTION XOFI(I)   N:1-NUM  C
C-----------------------------C
C
           FUNCTION XOFI(N)
           IMPLICIT REAL*8 (A-H,O-Z)
           COMMON /FUNX/ NUM,XMIN,XMAX
           XOFI = XMIN + (XMAX - XMIN)*(FLOAT(N)-1.D0)/FLOAT(NUM)
           RETURN
           END
```

第5表　SC31GWA.DAT

```
          2          7      0.2D0       0.D0       0.2D0
    0.963        9.63         24.         18.         30.
    2   3   2
    0.       0.1D0      0.6D0    7000.D0
180.         0.1D0      0.6D0    7000.D0   ←これのみ回生時、他は力行時。
0.           0.1D1      0.6D1    7000.D0
0.           0.1D2      0.6D2    7000.D0
0.           0.1D3      0.6D3    7000.D0
0.           0.1D4      0.6D4    7000.D0
0.           0.1D5      0.6D5    7000.D0
```

第6表　力行時の各電圧、電流、電力

```
NCASE,N,ZE,YEN,YTM
    2     7   .200D+00   .000D+00   .200D+00

ZG=     .96300    9.63000    ZL=   24.00000   18.00000    ZLL=   30.00000
NZYM,ICOUNT(I)
    2     3     2
PHI=    .0    ZMORE=    .10D+00    .60D+00    ZOA=    .70D+04
ZLLL=   .300000D+02   .000000D+00    COSPHI=   .100000D+01
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00
     1    EO=  3.9255896E+01 -4.4425936E+00  3.9506481E+01 -6.4566977E+00
     2    EO= -2.3503605E+01 -3.1819328E+01  3.9558679E+01 -1.2645173E+02
     3    EO= -1.5752266E+01  3.6262009E+01  3.9535645E+01  1.1348019E+02
     4    EO= -8.9908509E-05  1.9498571E-04  2.1471602E-04  1.1475457E+02
     5    EO= -8.9908309E-05  1.9498544E-04  2.1471568E-04  1.1475455E+02
     6    EO= -8.9908239E-05  1.9498591E-04  2.1471609E-04  1.1475448E+02
     7    EO= -8.9908031E-05  1.9498564E-04  2.1471575E-04  1.1475446E+02
TZ= 8.416480E+01 1.318964E+01      TZA= 8.519202E+01      TZP= 8.906499E+00
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00

  3 I   1  1  .474396E+00  -8.907 SI  .940023E-05  -7.016 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .395065E+02  -6.457
  2 I   3  1  .474396E+00  -8.907 SI  .388253E-04 102.876 E  .592195E+02  -6.643 II  .280760E+00  31.219   2 EE  .197136E+02 172.985

  3 I   1  2  .473307E+00-128.267 SI  .160962E-10 -98.422 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .395587E+02-126.452
  2 I   3  2  .473307E+00-128.267 SI  .136578E+01  36.578 E  .344528E+02 -96.563 II  .522629E+00-129.563   2 EE  .197136E+02 172.985

  3 I   1  3  .478433E+00 111.527 SI  .000000E+00     .000 E  .000000E+00     .000 II  .000000E+00     .000   3 EE  .395356E+02 113.480
  2 I   3  3  .478433E+00 111.527 SI  .101218E-04 135.000 E  .340684E+02  83.573 II  .273594E+00  70.180   2 EE  .197136E+02 172.985

  3 I   1  4  .940087E-05 -54.975 SI  .851914E+02   8.907 E  .000000E+00     .000 II  .957822E+00 171.338   3 EE  .214716E-03 114.755
  2 I   3  4  .957828E+00  -8.662 SI  .851914E+02   8.907 E  .290940E+02 171.108 II  .889152E+00 -11.316   2 EE  .290939E+02  -8.892

  3 I   1  5  .368044E-05 100.749 SI  .853875E+02   8.267 E  .000000E+00     .000 II  .969796E+00 -98.892   3 EE  .214716E-03 114.755
  2 I   3  5  .969799E+00  81.108 SI  .853875E+02   8.267 E  .290940E+02 171.108 II  .101362E+01  77.178   2 EE  .290939E+02  -8.892

  3 I   1  6  .993858E-05 162.493 SI  .844727E+02   8.473 E  .000000E+00     .000 II  .961808E+00  82.053   3 EE  .214716E-03 114.754
  2 I   3  6  .961806E+00 -97.948 SI  .844727E+02   8.473 E  .292115E+02  81.814 II  .956916E+00 -99.131   2 EE  .292113E+02 -98.186

  3 I   1  7  .489281E-05  12.907 SI  .940019E-05 172.985 E  .000000E+00     .000 II  .973721E+00  -8.186   3 EE  .214716E-03 114.754
  2 I   3  7  .973716E+00 171.814 SI  .940019E-05 172.985 E  .292115E+02  81.814 II  .953952E+00 172.115   2 EE  .292113E+02 -98.186
PWA=Y(  1)=   .8317539003012696D+01
PWA=Y(  2)=   .7650488564795646D+01
PWA=Y(  3)=   .6978829757334971D+01
PWA=Y(  4)=   .6302967162803861D+01
PWA=Y(  5)=   .5623307895579788D+01
PWA=Y(  6)=   .4940261357014014D+01
PWA=Y(  7)=   .4254238988823515D+01
PWA=Y(  8)=   .3565654025253858D+01
PWA=Y(  9)=   .2874921244162330D+01
PWA=Y( 10)=   .2182456717171252D+01
PWA=Y( 11)=   .1488677559041983D+01
PWA=Y( 12)=   .7940016764205621D+00
PWA=Y( 13)=   .9884751610636433D-01
PWA=Y( 14)=  -.5963661870046219D+00
PWA=Y( 15)=  -.1291220662150052D+01
PWA=Y( 16)=  -.1985297354953086D+01
PWA=Y( 17)=  -.2678178179543913D+01
```

$P_{TL}+P_{MC}$

θ(角度または秒)

```
PWA=Y( 18)=  -.3369445770399054D+01
PWA=Y( 19)=  -.4058683733746764D+01
PWA=Y( 20)=  -.4745476898387086D+01
PWA=Y( 21)=  -.5429411565775467D+01
PWA=Y( 22)=  -.6110075759219309D+01
PWA=Y( 23)=  -.6787059472037338D+01
PWA=Y( 24)=  -.7459954914532309D+01
PWA=Y( 25)=  -.8128356759628286D+01
PWA=Y( 26)=  -.8791862387024535D+01
PWA=Y( 27)=  -.9450072125718938D+01
PWA=Y( 28)=  -.1010258949475489D+02
PWA=Y( 29)=  -.1074902144204661D+02
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PWA=Y(255)=    .9636205907068923D+01
PWA=Y(256)=    .8979574568242246D+01
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第7表　回生時各電圧、電流、電力

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NCASE,N,ZE,YEN,YTM
    2    7  .200D+00  .000D+00  .200D+00

ZG=     .96300    9.63000    ZL=   24.00000   18.00000    ZLL=   30.00000
NZYM,ICOUNT(I)
    2    3    2
PHI=180.0    ZMORE=     .10D+00    .60D+00    ZOA=     .70D+04
ZLLL= -.300000D+02  .367545D-14    COSPHI= -.100000D+01
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04     ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00
     1    EO=   4.0076477E+01   4.8656261E+00   4.0370760E+01   6.9223173E+00
     2    EO= -1.5821270E+01 -3.7197265E+01   4.0422136E+01 -1.1304171E+02
     3    EO= -2.4255204E+01   3.2331733E+01   4.0418509E+01   1.2687716E+02
     4    EO= -1.6061741E-04   1.8702249E-04   2.4652660E-04   1.3065642E+02
     5    EO= -1.6061771E-04   1.8702270E-04   2.4652695E-04   1.3065644E+02
     6    EO= -1.6061763E-04   1.8702220E-04   2.4652652E-04   1.3065651E+02
     7    EO= -1.6061791E-04   1.8702241E-04   2.4652687E-04   1.3065652E+02
TZ=-7.905073E+01 1.349093E+01       TZA= 8.019366E+01      TZP= 1.703151E+02
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04     ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00

  3 I   1  1  .503961E+00-170.315 SI   .963747E-05   7.509 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .403708E+02   6.922
  2 I   3  1  .503961E+00-170.315 SI   .447691E-04 120.273 E  .605808E+02   7.118 II  .284996E+00-130.437   2 EE  .202108E+02-172.490

  3 I   1  2  .506880E+00  69.101 SI   .168674E-10 -80.941 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .404221E+02-113.042
  2 I   3  2  .506880E+00  69.101 SI   .143128E+01-125.941 E  .348121E+02 -83.044 II  .554866E+00  68.699   2 EE  .202108E+02-172.490

  3 I   1  3  .500954E+00 -50.898 SI   .000000E+00    .000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .404185E+02 126.877
  2 I   3  3  .500954E+00 -50.898 SI   .116214E-04 -45.000 E  .352265E+02  96.877 II  .300514E+00 -93.189   2 EE  .202108E+02-172.490

  3 I   1  4  .333609E-05 -64.616 SI   .801937E+02 170.315 E  .000000E+00    .000 II  .101902E+01   9.446   3 EE  .246527E-03 130.656
  2 I   3  4  .101902E+01-170.554 SI   .801937E+02 170.315 E  .301562E+02-170.544 II  .970799E+00-169.026   2 EE  .301561E+02   9.456

  3 I   1  5  .238858E-05  69.423 SI   .797319E+02 170.899 E  .000000E+00    .000 II  .100521E+01  99.456   3 EE  .246527E-03 130.656
  2 I   3  5  .100521E+01 -80.544 SI   .797319E+02 170.899 E  .301562E+02-170.544 II  .980516E+00 -83.383   2 EE  .301561E+02   9.456

  3 I   1  6  .233031E-05 161.374 SI   .806751E+02 170.898 E  .000000E+00    .000 II  .101893E+01 -81.332   3 EE  .246527E-03 130.657
  2 I   3  6  .101893E+01  98.668 SI   .806751E+02 170.898 E  .301541E+02  98.667 II  .107150E+01  97.593   2 EE  .301539E+02 -81.333

  3 I   1  7  .701746E-07 151.352 SI   .963725E-05-172.490 E  .000000E+00    .000 II  .100514E+01-171.333   3 EE  .246527E-03 130.657
  2 I   3  7  .100514E+01   8.667 SI   .963725E-05-172.490 E  .301541E+02  98.667 II  .986425E+00   5.624   2 EE  .301539E+02 -81.333
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PWA=Y(73)= .2641192806304855D+02
PWA=Y(74)= .2603914548666266D+02
PWA=Y(75)= .2565067790103097D+02
PWA=Y(76)= .2524675930451434D+02
PWA=Y(77)= .2482763300258538D+02
PWA=Y(78)= .2439355146127026D+02
PWA=Y(79)= .2394477615507268D+02
PWA=Y(80)= .2348157740947135D+02
PWA=Y(81)= .2300423423808602D+02
PWA=Y(82)= .2251303417461013D+02
PWA=Y(83)= .2200827309961123D+02
PWA=Y(84)= .2149025506230358D+02
PWA=Y(85)= .2095929209740029D+02
PWA=Y(86)= .2041570403715523D+02
PWA=Y(87)= .1985981831870805D+02
PWA=Y(88)= .1929196978684826D+02
PWA=Y(89)= .1871250049231728D+02
PWA=Y(90)= .1812175948576979D+02
PWA=Y(91)= .1752010260751873D+02
PWA=Y(92)= .1690789227319030D+02
PWA=Y(93)= .1628549725541843D+02
PWA=Y(94)= .1565329246170984D+02
PWA=Y(95)= .1501165870861377D+02
PWA=Y(96)= .1436098249233239D+02
PWA=Y(97)= .1370165575590983D+02
PWA=Y(98)= .1303407565314041D+02
PWA=Y(99)= .1235864430933798D+02
PWA=Y(100)= .1167576857911070D+02
PWA=Y(101)= .1098585980128697D+02
PWA=Y(102)= .1028933355114032D+02
PWA=Y(103)= .9586609390062419D+01
PWA=Y(104)= .8878110612834890D+01
PWA=Y(105)= .8164263992652414D+01
PWA=Y(106)= .7445499524050477D+01
PWA=Y(107)= .6722250163892721D+01
PWA=Y(108)= .5994951570573920D+01
PWA=Y(109)= .5264041841595621D+01
PWA=Y(110)= .4529961249672589D+01
PWA=Y(111)= .3793151977528966D+01
PWA=Y(112)= .3054057851543916D+01
PWA=Y(113)= .2313124074407201D+01
PWA=Y(114)= .1570796956945707D+01
PWA=Y(115)= .8275236492824801D+00
PWA=Y(116)= .8375187149019359D-01
PWA=Y(117)= -.6600703560986952D+00
PWA=Y(118)= -.1403494982762656D+01
PWA=Y(119)= -.2146074197280103D+01
PWA=Y(120)= -.2887360697674141D+01
PWA=Y(121)= -.3626907960650572D+01
PWA=Y(122)= -.4364270510566840D+01
PWA=Y(123)= -.5099004187769917D+01
PWA=Y(124)= -.5830666416141490D+01
PWA=Y(125)= -.6558816469689272D+01
PWA=Y(126)= -.7283015738023878D+01

PWA=Y(127)= -.8002827990561347D+01
PWA=Y(128)= -.8717819639292127D+01
PWA=Y(129)= -.9427559999958319D+01
PWA=Y(130)= -.1013162155148176D+02
PWA=Y(131)= -.1082958019348678D+02
PWA=Y(132)= -.1152101550176238D+02
PWA=Y(133)= -.1220551098151011D+02
PWA=Y(134)= -.1288265431822497D+02
PWA=Y(135)= -.1355203762605822D+02
PWA=Y(136)= -.1421325769351265D+02
PWA=Y(137)= -.1486591622632207D+02
PWA=Y(138)= -.1550962008736892D+02
PWA=Y(139)= -.1614398153349535D+02
PWA=Y(140)= -.1676861844906525D+02
PWA=Y(141)= -.1738315457613642D+02
PWA=Y(142)= -.1798721974110431D+02
PWA=Y(143)= -.1858045007768073D+02
PWA=Y(144)= -.1916248824607337D+02
PWA=Y(145)= -.1973298364823386D+02
PWA=Y(146)= -.2029159263904504D+02
PWA=Y(147)= -.2083797873331983D+02
PWA=Y(148)= -.2137181280848742D+02
PWA=Y(149)= -.2189277330284439D+02
PWA=Y(150)= -.2240054640925143D+02
PWA=Y(151)= -.2289482626415908D+02
PWA=Y(152)= -.2337531513184848D+02
PWA=Y(153)= -.2384172358377628D+02
PWA=Y(154)= -.2429377067291553D+02
PWA=Y(155)= -.2473118410298771D+02
PWA=Y(156)= -.2515370039248382D+02
PWA=Y(157)= -.2556106503337580D+02
PWA=Y(158)= -.2595303264412268D+02
PWA=Y(159)= -.2632936711897903D+02
PWA=Y(160)= -.2668984176721681D+02
PWA=Y(161)= -.2703423945267485D+02
PWA=Y(162)= -.2736235272305376D+02
PWA=Y(163)= -.2767398393517739D+02
PWA=Y(164)= -.2796894537404577D+02
PWA=Y(165)= -.2824705936590755D+02
PWA=Y(166)= -.2850815838528406D+02
PWA=Y(167)= -.2875208515588039D+02
PWA=Y(168)= -.2897869274532278D+02
PWA=Y(169)= -.2918784465366514D+02
PWA=Y(170)= -.2937941489561157D+02
PWA=Y(171)= -.2955328807640518D+02
PWA=Y(172)= -.2970935946133757D+02
PWA=Y(173)= -.2984753503883710D+02
PWA=Y(174)= -.2996773157709798D+02
PWA=Y(175)= -.3006987667421595D+02
PWA=Y(176)= -.3015390880180056D+02
PWA=Y(177)= -.3021977734203749D+02
PWA=Y(178)= -.3026744261817887D+02
PWA=Y(179)= -.3029687591844307D+02
PWA=Y(180)= -.3030805951330963D+02
PWA=Y(181)= -.3030098666619878D+02
PWA=Y(182)= -.3027566163752940D+02
PWA=Y(183)= -.3023209968215265D+02
PWA=Y(184)= -.3017032704016302D+02
PWA=Y(185)= -.3009038092109228D+02
PWA=Y(186)= -.2999230948149587D+02
PWA=Y(187)= -.2987617179594515D+02
PWA=Y(188)= -.2974203782144314D+02
PWA=Y(189)= -.2958998835528497D+02

$P_{TC}+P_{ML}$

θ(角度または秒)

```
PWA=Y(190)=  -.2942011498638865D+02
PWA=Y(191)=  -.2923252004012534D+02
PWA=Y(192)=  -.2902731651668233D+02
PWA=Y(193)=  -.2880462802299595D+02
PWA=Y(194)=  -.2856458869829542D+02
PWA=Y(195)=  -.2830734313330233D+02
PWA=Y(196)=  -.2803304628313462D+02
PWA=Y(197)=  -.2774186337396741D+02
PWA=Y(198)=  -.2743396980350692D+02
PWA=Y(199)=  -.2710955103533743D+02
PWA=Y(200)=  -.2676880248720496D+02
PWA=Y(201)=  -.2641192941330493D+02
PWA=Y(202)=  -.2603914678064465D+02
PWA=Y(203)=  -.2565067913955532D+02
PWA=Y(204)=  -.2524676048843120D+02
PWA=Y(205)=  -.2482763413277778D+02
PWA=Y(206)=  -.2439355253865360D+02
PWA=Y(207)=  -.2394477718059418D+02
PWA=Y(208)=  -.2348157838410945D+02
PWA=Y(209)=  -.2300423516284983D+02
PWA=Y(210)=  -.2251303505053879D+02
PWA=Y(211)=  -.2200827392777329D+02
PWA=Y(212)=  -.2149025584379639D+02
PWA=Y(213)=  -.2095929283334929D+02
PWA=Y(214)=  -.2041570472871329D+02
PWA=Y(215)=  -.1985981896705479D+02
PWA=Y(216)=  -.1929197039318933D+02
PWA=Y(217)=  -.1871250105788362D+02
PWA=Y(218)=  -.1812176001181692D+02
PWA=Y(219)=  -.1752010309532596D+02
PWA=Y(220)=  -.1690789272405999D+02
PWA=Y(221)=  -.1628549767067517D+02
PWA=Y(222)=  -.1565329284269967D+02
PWA=Y(223)=  -.1501165905670340D+02
PWA=Y(224)=  -.1436098280890832D+02
PWA=Y(225)=  -.1370165604237756D+02
PWA=Y(226)=  -.1303407591092357D+02
PWA=Y(227)=  -.1235864453987747D+02
PWA=Y(228)=  -.1167576878386384D+02
PWA=Y(229)=  -.1098585998172661D+02
PWA=Y(230)=  -.1028933370875397D+02
PWA=Y(231)=  -.9586609526351305D+01
PWA=Y(232)=  -.8878110729313109D+01
PWA=Y(233)=  -.8164264090845993D+01
PWA=Y(234)=  -.7445499605496452D+01
PWA=Y(235)=  -.6722250230138220D+01
PWA=Y(236)=  -.5994951623175225D+01
PWA=Y(237)=  -.5264041882117233D+01
PWA=Y(238)=  -.4529961279686286D+01
PWA=Y(239)=  -.3793151998612853D+01
PWA=Y(240)=  -.3054057865281481D+01
PWA=Y(241)=  -.2313124082386355D+01
PWA=Y(242)=  -.1570796960757831D+01
PWA=Y(243)=  -.8275236505214627D+00
PWA=Y(244)=  -.8375187175147519D-01
PWA=Y(245)=   .6600703552190856D+00
PWA=Y(246)=   .1403494979669062D+01
PWA=Y(247)=   .2146074190378202D+01
PWA=Y(248)=   .2887360685371904D+01
PWA=Y(249)=   .3626907941359222D+01
PWA=Y(250)=   .4364270482701812D+01
PWA=Y(251)=   .5099004149751810D+01
PWA=Y(252)=   .5830666366397018D+01
PWA=Y(253)=   .6558816406652213D+01
PWA=Y(254)=   .7283015660136018D+01
PWA=Y(255)=   .8002827896273413D+01
PWA=Y(256)=   .8717819527064732D+01
```

第8表 SC31GSA.FOR

ZLにT、M、TL、MCの電力が渡るときの損失δの計算プログラム

```
C   61.3.14 , 61.3.24  SCOTT L,C IRI  1 PHASE LOAD  3-PHASE  BALANSE
C   S 61.3.26
C       S 62.10.21
CCC     SC31
      CALL MOTOSC
      STOP
      END
      SUBROUTINE MOTOSC
C   60 CON. (TN IRI )
      PARAMETER(L1=7, L2=L1+1, K2=3)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER PERM
      COMPLEX*16  Z(L1,L2),Y(L1,L1),Y1(L1,L2)
     1          , ZL,          EG(L1),EO(L1),D1(L1),D2(L1),E1(L1),E2(L1)
     2,   XX(L2),TZ,ZG,S1(L1),                YH( K2,L1,L1)      ,ZLLL
     3 ,ZM ,ZMORE
      DIMENSION              EOA(L1),EOP(L1),D1A( K2,L1),D1P( K2,L1),D2A(
     1  K2,L1),D2P( K2,L1),E1A( K2,L1),E1P( K2,L1),E2A( K2,L1),E2P( K2,
     2 L1),S1A( K2,L1),S1P( K2,L1)
     3,PERM(L1)           ,ICOUNT( K2)
                    PI=3.1415926535897932D0
                                                PI180=180.D0/PI
      ICNYH=99
      DS3=DSQRT(3.D0)
 1000    READ(5,1005)NCASE,N ,ZE ,YEN,YTM
 1005 FORMAT(2I10,3D10.3)
      WRITE (6, 1007)
 1007 FORMAT (1H ,'NCASE,N,ZE,YEN,YTM')
      WRITE(6,1010)NCASE,N  ,ZE ,YEN,YTM
 1010 FORMAT(1H ,  2I5, 3D10.3)
      IF(NCASE.EQ.0) STOP
      READ(5,1015) ZG, ZL,ZLL
 1015 FORMAT(8F10.5)
       WRITE(6,1016)ZG,ZL,ZLL
 1150 READ(5,1030)NZYM,(ICOUNT(I),I=1,NZYM)
 1030 FORMAT(2014)
      WRITE (6, 1032)
 1032 FORMAT (1H ,'NZYM,ICOUNT(I)')
      WRITE(6,1031)NZYM,(ICOUNT(I),I=1,NZYM)
 1031 FORMAT(1H ,2014)
    1 READ (5,8)   PHI,ZMORE ,ZOA
    8 FORMAT( F5.1,3D10.2)
      WRITE(6,9) PHI,ZMORE  ,,ZOA
    9 FORMAT(1H ,'PHI=',F5.1,'   ZMORE=',2D10.2,'   ZOA=',D10.2)
C   1 PHI= PHI+10.D0
 1016 FORMAT(1H0,'ZG=', 2F10.5,'   ZL=',2F10.5,'   ZLL=' F10.5)
```

```
      IF( ZOA.EQ.0.)STOP
      P=PHI*PI/180.D0
      ZLLL= ZLL * DCMPLX(DCOS(P), DSIN(P))
      COSPHI=DCOS(P)
      WRITE(6,1017)ZLLL,COSPHI
 1017 FORMAT(1H ,'ZLLL=',2D13.6,'   COSPHI=',D13.6)
      NN=NZYM+1
                K1=N
CCCC
CCCC
 2000 CONTINUE
                        DO 1050 J=1,L2
                                        DO 1050 I=1,L1
 1050 Y1(I,J)=(0.D0,0.D0)
 1130 NN=NN-1
      IC=ICOUNT(NN)
 1002                IF(IC.GT.ICNYH) GO TO 1001
CCCC
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P,ZMORE,ZOA)
      CALL YZGOSE (Y1,Y,Z,PERM,XX, K1,IZM,L1,L2)
 1001 CONTINUE
      DO 1003 J=1,L1
                        DO 1003 I=1,L1
 1003 YH(NN, I,J)= Y1(I,J)
 1111  IF(NN.NE.1) GO TO 1130
 1120 DO   35 J=1,K1
                        DO 35  I=1,K1
   35 Z(I,J)= Y1 (I,J)
      CALL DCINV( Z,K1,0,L1,L2,1.D-14,XX,PERM, NSTOP)
      EG(1)=  70.D0/DS3
      EG(2)= DCMPLX(-0.5D0,-DS3*0.5D0) *EG(1)
      EG(3)= DCMPLX(-0.5D0, DS3*0.5D0) *EG(1)
      DO 39 I=1,L1
      D1(I)=(0.D0,0.D0)
      DO 39 J=1,L1
   39 Y(I,J)=(0.D0,0.D0)
      DO 38 I=1,3
   38 Y(I,4 ) =EG(I)
      Y(1,1)=ZG+ZE+Z(1,1)
      Y(1,2)=    ZE+Z(1,2)
      Y(1,3)=    ZE+Z(1,3)
      Y(2,1)=    ZE+Z(2,1)
      Y(2,2)=ZG+ZE+Z(2,2)
      Y(2,3)=    ZE+Z(2,3)
      Y(3,1)=    ZE+Z(3,1)
      Y(3,2)=    ZE+Z(3,2)
      Y(3,3)=ZG+ZE+Z(3,3)
      CALL DCINV(Y ,3 ,1,L1,L2,1.D-14,XX,PERM, NSTOP)
      D1(1)=Y (1,4)
      D1(2)=Y (2,4)
      D1(3)=Y (3,4)
      DO 50 I=1,K1
   50 E0(I)= (0.D0,0.D0)
C     DO  36  I=1,N
C     DO  36  J=1,N
C  36 WRITE(6,37 ) I,J,Z(I,J)
C  37 FORMAT(1H ,2I5,'Z=' 2D15.7)
      DO 55 I=1,K1
                      DO 55 J=1,K1
   55 E0(I)=E0(I)+ Z(I,J)*D1(J)
      DO 80 I=1,3
      D1A(1,I)=CDABS(D1(I))
      IF(D1A(1,I).EQ.0.D0) GO TO 81
          D1P(1,I)=PI180*DATAN2(DIMAG(D1( I)),DREAL(D1( I)))
      GO TO 80
   81 D1P(1,1)=0.D0
   80 CONTINUE
C     DO 84 I=1,K1
C                     WRITE(6,85) I,D1(I),D1A(1,I), D1P(1,I)
C  85 FORMAT(1H ,I5,3X,3HIR=,1P4E15.7)
C  84 CONTINUE
      DO  87 I=1,K1
       E0A(I)=CDABS(E0(I))
      IF( E0(I).EQ. 0.D0) GO TO 88
      E0P(I)= PI180*DATAN2( DIMAG(E0(I)), DREAL(E0(I)))
      GO TO 87
   88  E0P(I)=0.D0
   87 CONTINUE
      DO   90 I=1,K1
      WRITE(6,  95) I, E0(I), E0A(I), E0P(I)
   95 FORMAT(1H ,I5,3X,3HE0=,1P4E15.7)
   90 CONTINUE
      TZ =EG( 1)/D1(1)
   92 TZ A=CDABS(TZ )
```

```
                        TZ P  =PI180*DATAN2(DIMAG(TZ     ),DREAL(TZ     ))
      WRITE(6,9182)TZ,TZA,TZP
 9182 FORMAT(1H ,3HTZ=,1P2E13.6,5X,4HTZA=,E13.6,5X,4HTZP=,E13.6)
      NN=0
      DO 619 I=1,L1
  619 D1(I)=(0.D0,0.D0)
  620 NN=NN+1
      IC=ICOUNT(NN)
CCCC
      CALL ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P,ZMORE,ZOA)
      DO 502  I=1,K1
      D1(I)=(0.D0,0.D0)
                            DO 502 J=1,K1
  502 D1(I)=D1(I)+YH(NN,I,J)*E0(J)
      DO  506 I=1,K1
      E1(I)=(0.D0,0.D0)
                            DO 506 J=1,K1
  506 E1(I)=E1(I)+Z(I,J)*D1(J)
      DO  550 I=1,K1
  550 E2(I)=E0(I)-E1(I)
 8560 DO 508 I=1,K1
                      D2(I)=(0.D0,0.D0)
                                          DO 508 J=1,K1
  508 D2(I)=D2(I)+ Y(I,J)*E2(J)
      DO 1301 I=1,K1
 1301 S1(I)=(0.D0,0.D0)
      DO 10 I=1,N
   10 S1(1) =S1(1)-D1(I)
      S1(2)=(E2(5)-E2(6)) / ZLLL
      S1 (3) = (E2(15)- E2(14)) / ZLLL
      S1(4) = EG(1)/ D1(1)
      S1(5) = EG(2)/ D1(2)
      S1(6) = EG(3)/ D1(3)
      S1(7)= D1(1)+D1(2)+D1(3)
 2325 DO 1200 I=1,K1
      D1A(NN,I)=CDABS(D1(I))
      D2A(NN,I)=CDABS(D2(I))
      E1A(NN,I)=CDABS(E1(I))
      E2A(NN,I)=CDABS(E2(I))
      IF(D1A(NN,I).EQ.0.D0)  GO TO 415
      D1P(NN,I)=PI180*DATAN2(DIMAG(D1(I) ),DREAL(D1(I)))
      GO TO 1506
  415 D1P(NN,I)=0.D0
 1506 IF(E1A(NN,I).EQ.0.D0)  GO TO 420
      E1P(NN,I)=PI180*DATAN2(DIMAG(E1(I) ),DREAL(E1(I)))
      GO TO  507
  420 E1P(NN,I)=0.0D0
  507 E2P(NN,I)=PI180*DATAN2(DIMAG(E2(I) ),DREAL(E2(I)))
      IF(D2A(NN,I).EQ.0.D0)  GO TO 425
      D2P(NN,I)=PI180*DATAN2(DIMAG(D2(I) ),DREAL(D2(I)))
      GO TO  607
  425 D2P(NN,I)=0.0D0
  607 E0(I)=E2(I)
 1200 CONTINUE
      DO 1201 I=1,K1
      S1A(NN,I)= CDABS(S1(I))
      IF(S1A(NN,I).EQ.0.D0) GO TO 552
      S1P(NN,I)=PI180*DATAN2(DIMAG(S1(I))  , DREAL(S1(I)))
      GO TO 1201
  552 S1P(NN,I)=0.D0
 1201 CONTINUE
      IF(NN.NE.NZYM) GO TO 620
      DO 1253 I=1,N
                      WRITE(6,1251)
 1251 FORMAT(1H ,2H  )
      DO 1253 NN=1,NZYM
                            NP=2*NN-1
 1253 WRITE(6,1254)ICOUNT(NN), NP,I,D1A(NN,I),D1P(NN,I),S1A(NN,I),S1P(NN
     1,I), E1A(NN,I),E1P(NN,I)                ,D2A(NN,I),D2P(NN,I)
     2 ,ICOUNT(NN), E2A(NN,I), E2P(NN,I)
 1254 FORMAT(1H ,I3,2H I,I4,I3,  E13.6,F8.3,1X,2HSI,  E13.6,F8.3, 1X,1HE
     1,  E13.6,F8.3       ,3H II,  E13.6,F8.3,I4,1X,2HEE,  E13.6,F8.3)
CCCC
      CALL SC31PG(E1A,E1P,D1A,D1P,S1A,S1P,ZLL,K2,L1,P)
      GO TO 1
CCC    GOTO 1000
      END
      SUBROUTINE ZYME(N,IC,ZL,Z,Y,IZM,ZLL,ZLLL,YEN,YTM,ZM,L1,L2,P
     @,ZMORE,ZOA)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMPLEX*16 Z(L1,L2),Y(L1,L1) ,ZL
     1,ZU,ZT,ZUT,ZV,ZW,ZM,ZVM,ZWM,ZVW
     2       ,ZO,ZMORE ,ZLLL
```

```
     3,ZUM,ZUW,ZVT
      COMPLEX*16 ZU1,ZV1,ZW1,ZU2,ZV2,ZW2, ZU1U2,ZV1V2,ZW1W2
      DO 9000 J=1,N+1
      DO 9000 I=1,N
 9000 Z(I,J)=(0.D0,0.0D0)
      DO 9003 J=1,N
      DO 9003 I=1,N
 9003 Y(1,J)=(0.D0,0.0D0)
      IZM=1
      G=1.D9
       GO TO (100,200,300),IC
  100 RETURN
  200  CONTINUE
       PI=3.1415926535897932D0
      THETA= PI/180.D0*80.D0
      Z0= Z0A*DCMPLX (DCOS(THETA), DSIN(THETA))
      A12= 30.D0/35.D0
      ZM=ZMORE+Z0
      ZV= ZM/( A12**2)
      ZW=ZV
      ZT=ZM
      ZU=3.D0*ZV
CC    ZWM  NO MI  +  NO SUUCHI
      ZWM= Z0/A12
      ZVM=-Z0/A12
      ZVW=-Z0/(A12*A12)
      ZUT=-Z0/A12 * DSQRT(3.D0)
      WRITE(6, 197) ZU,ZT,ZUT,ZV
  197  FORMAT(1H ,'ZU=',2D13.6,'   ZT=',2D13.6, '   ZUT=',2D13.6,'   ZV=
     1',2D13.6)
      WRITE(6, 198)    ZW,ZM,ZVW,ZWM
  198  FORMAT(1H ,'ZW=',2D13.6,'   ZM=',2D13.6, '   ZVW=',2D13.6,'  ZWM=
     1',2D13.6)
      WRITE(6, 199)ZVM, ZL,Z0, A12
  199  FORMAT(1H ,'ZVM=' 2D13.6,'   ZL=', 2D13.6,'   Z0=',2D13.6,'   A12
     1='D13.6)
      Y(1,2)=-G
      Y(1,3)=-G
      Y(2,3)=-G
CCC YEN=0.D0  DENAITO  3-PHASE CURRENT DAI NI NARI  UNBALANCE TO NARU
      Y(1,1)=G*2.D0 +  YEN/3.D0
      Y(2,2)=G*2.D0 +  YEN/3.D0
      Y(3,3)=G*2.D0 +  YEN/3.D0
CC    SC31 NO TOKI IKA END MADE NISURU
       Y(4,5)= -G
       Y(5,6)=-1.D0/ZLLL
       Y(6,7)= -G
       Y(4,4)= G
       Y(5,5)= G+1.D0/ZLLL
       Y(6,6)= Y(5,5)
       Y(7,7)= G
CC    KAISEIJI WA SC31.DAT NO DATA COSPHI 0 -1 NI SURU TO NEXT 2GYOO L,C
CC     NO IREKAETA KOTONINARU
CCC   ZLLL(FUKUSOSUU) DEWA DAME -R 0 IRERUKOTO NIMO NARU.
       Z(5,5)=ZLL *DCOS(P)*( 0.D0, 1.D0)
       Z(7,7)=ZLL *DCOS(P)*( 0.D0,-1.D0)
      Z(1,4)=ZUT
      Z(2,6)=ZVM
      Z(3,6)=ZWM
      Z(2,3)=ZVW
      Z(1,1)=ZU
      Z(2,2)=ZV
      Z(3,3)=ZW
      Z(4,4)=ZT
      Z(6,6)=ZM
      DO 220 I=1,N
      DO 220 J=1,N
      Y(J,I)=Y(I,J)
  220 Z(J,I)=Z(I,J)
      DO  207  I=1,N
  207 Y(I,I)=Y(I,I)   +1.0D-7  *FLOAT(I)
      RETURN
  300 IZM=0
      Y(4,5)=-G
      Y(4,6)=-G
      Y(4,7)=-G
      Y(5,6)=-G
      Y(5,7)=-G
      Y(6,7)=-G
      Y(4,4)=G*3.D0+YTM/4.D0
      Y(6,6)=Y(4,4)
      Y(5,5)=Y(4,4)
      Y(7,7)=Y(4,4)
```

```
      DO 321 I=4,N
      DO 321 J=4,N
  321 Y(J,I)=Y(I,J)
      RETURN
      END
      SUBROUTINE   YZGOSE (Y1,Y,Z,PERM,XX,K1,IZM,L1,L2)
      COMPLEX*16 Y1(L1,L2),Y(L1,L1),Z(L1,L2),XX(L2)
      INTEGER PERM(L1)
      DO 1070 I=1,K1
                        Y1(I,K1+1)=(1.D0,0.D0)
                                                  DO 1070 J=1,K1
 1070 Y1(I,J)=Y(I,J)+Y1(I,J)
      IF(IZM.EQ.0) RETURN
       CALL       DCINV(Y1,K1,0,L1,L2,1.D-14,    XX,PERM,NSTOP)
      DO 1080 I=1,K1
                        Y1(I,K1+1)=(1.D0,0.D0)
                                                  DO 1080 J=1,K1
 1080 Y1(I,J)=Z(I,J)+Y1(I,J)
       CALL       DCINV(Y1,K1,0,L1,L2,1.D-14,    XX,PERM,NSTOP)
      RETURN
      END
      SUBROUTINE DCINV(A,N,M,N1,M1,EPS,    W,IP,NSTOP)
      IMPLICIT REAL*8(A-H,O-Z)
      COMPLEX*16 A,    PIVOT,W,AWK, PIVI
      REAL*8 MAX
      DIMENSION A(N1,M1), IP(N1), W(M1)
      NM = N+M
      IF ( N ) 1000,1000,100
  100 CONTINUE
      IF ( N-N1 ) 110,110,1000
  110 CONTINUE
      IF ( M ) 1000,120,120
  120 CONTINUE
      IF ( NM-M1 ) 130,130,1000
  130 CONTINUE
      IF ( EPS ) 140,150,150
  140 CONTINUE
      EPS = 1.0D-14
  150 CONTINUE
      EPSS = 1.0D-2*EPS
      DO 160 I=1,N
      IP(I) = 0
  160 CONTINUE
      DO 270 K=1,N
      MAX = -1.0D0
      DO 190 I=1,N
      IF ( IP(I) ) 170,170,190
  170 CONTINUE
      ABSS = CDABS(A(I,K))
      IF ( MAX-ABSS) 180,190,190
  180 CONTINUE
      MAX = ABSS
      L = I
  190 CONTINUE
      IF ( MAX-EPS ) 1010,1010,200
  200 CONTINUE
      PIVOT = A(L,K)
      IP(L) = K
      PIVI = -1.0D+0/PIVOT
      DO 250 J=1,NM
      IF ( J-K ) 210,250,210
  210 CONTINUE
      AWK = A(L,J) * PIVI
      IF ( CDABS(AWK)-EPSS ) 240,240,220
  220 CONTINUE
      DO 230 I=1,N
      A(I,J) = A(I,J) + A(I,K)*AWK
  230 CONTINUE
  240 CONTINUE
      A(L,J) = -AWK
  250 CONTINUE
      DO 260 I=1,N
      A(I,K) = A(I,K) * PIVI
  260 CONTINUE
      A(L,K) = -PIVI
  270 CONTINUE
      DO 290 J=1,NM
      DO 280 I=1,N
      W(I) = A(I,J)
  280 CONTINUE
      DO 290 I=1,N
      A( IP(I), J) = W(I)
  290 CONTINUE
      IF ( N-1 ) 350,350,300
```

```
  300 CONTINUE
      DO 320 I=1,N
      DO 310 J=1,N
      W(J) = A(I,J)
  310 CONTINUE
      DO 320 J=1,N
      A(I,J) = W( IP(J) )
  320 CONTINUE
  350 CONTINUE
      NSTOP = 0
      RETURN
 1000 CONTINUE
      NSTOP = 3
      WRITE(6,10) N,M,N1,M1
      RETURN
 1010 CONTINUE
      IF ( MAX ) 1011,1020,1011
 1011 CONTINUE
      NSTOP = 2
      WRITE(6,20) K
      RETURN
 1020 CONTINUE
      NSTOP = 1
      WRITE(6,30)
   10 FORMAT(1H0,'(SUBR.DCINV) INVALID ARGUMENT. N,M,N1,M1 =',4I5)
   20 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR AT STEP #',I5)
   30 FORMAT(1H0,'(SUBR.DCINV) MATRIX IS SINGULAR.')
      RETURN
      END
       SUBROUTINE SC31PG(E1A,E1P,D1A,D1P,S1A,S1P,ZLL,K2,L1,P)
      PARAMETER (NUM = 256)
      PARAMETER (XMIN = 0., XMAX = 3.1415926535897932)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION Y(NUM),Y1(NUM),Y2(NUM),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
      DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
      COMMON /FUNX/ NUMO,XMINO,XMAXO
        NUMO = NUM
        XMINO = XMIN
        XMAXO =  XMAX
        YMIN =- 6.0D-3
        YMAX = 6.0D-3
         PI180= 3.1415926535897932/180.D0
C
      CALL CURSOF
      CALL FUNCOF
      CALL GRPSTA
      CALL CLS(3)
      CALL VIEW(10,10,630,390)
      CALL WINDOW(XMIN,SNGL(YMAX),XMAX,SNGL(YMIN))
      CALL LINE(XMIN, 0.0, XMAX, 0.0, 1)
      CALL LINE(0.0, SNGL(YMIN), 0.0, SNGL(YMAX), 1)
C
      CALL CALC1(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1,P)
        DO 140 I=1,NUM
        Y1(I)=Y(I)
 140  CONTINUE
      CALL CALC2(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        DO 150 I=1,NUM
        Y1(I)=Y1(I)+Y(I)
        Y2(I)=Y1(I)
 150   CONTINUE
       CALL CALC3(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        DO 160 I=1,NUM
        Y(I)=Y2(I)+Y(I)
        WRITE(6,60)I, Y(I)
  60    FORMAT(1H ,'PSA=Y(',I3,')=',  D24.16)
 160   CONTINUE
        CALL DSPGRP(Y,NUM,1)
C
       CALL CURSON
       CALL LOCATE(0,23)
       READ (*,*) I
       CALL FUNCON
         CALL CLS(3)
       RETURN
        END
C---------------C
C  CALCULATE 1   :PZL
C---------------C
C
       SUBROUTINE CALC1(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1,P)
       IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
      DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
```

```
          E1A22=S1A(2,2)*ZLL
          E1P22=S1P(2,2) -P  /PI180
          DO 100 I=1, NUM
          X = XOFI(I)
        Y(I) = E1A22*DSIN(X+E1P22*PI180)*S1A(2,2)*DSIN(X+S1P(2,2)*PI180)
  100   CONTINUE
        RETURN
        END
C---------------C
C  CALCULATE 2   : PT+PM
C---------------C
C
        SUBROUTINE CALC2(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
        IMPLICIT REAL*8 (A-H,O-Z)
       DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
       DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
        DO 100 I=1, NUM
         X = XOFI(I)
       Y(I) = E1A(2,4)*DSIN(X+E1P(2,4)*PI180)*D1A(2,4)*DSIN(X+D1P(2,4)*
      1PI180)+E1A(2,6)*DSIN(X+E1P(2,6)*PI180)*D1A(2,6)*DSIN(X+D1P(2,6)*
      2PI180)
  100 CONTINUE
        RETURN
        END
C---------------C
C  CALCULATE 3   : PTL+PMC(KIKIKOJI),PTC+PML(KAISEIJI)
C---------------C
C
       SUBROUTINE CALC3(Y,NUM,E1A,E1P,D1A,D1P,S1A,S1P,ZLL,PI180,K2,L1)
       IMPLICIT REAL*8 (A-H,O-Z)
       DIMENSION Y(256),Y1(256),Y2(256),E1A(K2,L1),E1P(K2,L1),D1A(K2,L1)
       DIMENSION D1P(K2,L1),S1A(K2,L1),S1P(K2,L1)
        DO 100 I=1, NUM
         X = XOFI(I)
         Y(I) = E1A(2,5)*DSIN(X+E1P(2,5)*PI180)*D1A(2,5)*DSIN(X+D1P(2,5)*
      1PI180)+E1A(2,7)*DSIN(X+E1P(2,7)*PI180)*D1A(2,7)*DSIN(X+D1P(2,7)*
      2PI180)
  100 CONTINUE
        RETURN
        END
C---------------------------C
C  DISPLAY GRAPH OF Y(NUM)   C
C---------------------------C
C
        SUBROUTINE DSPGRP(Y,NUM,IC)
        IMPLICIT REAL*8 (A-H,O-Z)
        DIMENSION Y(NUM)
C
        I = 1
        X = XOFI(I)
        CALL PSET(SNGL(X),SNGL(Y(1)),IC)
        DO 200 I=2, NUM
        X = XOFI(I)
        CALL CLINE(SNGL(X),SNGL(Y(I)),IC)
  200 CONTINUE
C
        RETURN
        END
C-----------------------------C
C  FUNCTION XOFI(I)   N:1-NUM  C
C-----------------------------C
C
        FUNCTION XOFI(N)
        IMPLICIT REAL*8 (A-H,O-Z)
        COMMON /FUNX/ NUM,XMIN,XMAX
        XOFI = XMIN + (XMAX - XMIN)*(FLOAT(N)-1.D0)/FLOAT(NUM)
        RETURN
        END
```

第9表 入力データ SC31GSA.DAT

```
         2          7      0.2D0       0.D0       0.2D0
   0.963       9.63         24.         18.         30.
   2   3   2
   0.        0.1D0      0.6D0    7000.D0
 180.        0.1D0      0.6D0    7000.D0
   0.        0.1D1      0.6D1    7000.D0
   0.        0.1D2      0.6D2    7000.D0
   0.        0.1D3      0.6D3    7000.D0
   0.        0.1D4      0.6D4    7000.D0
   0.        0.1D5      0.6D5    7000.D0
```

第10表　力行時δ計算時の各電圧、電流、電力

PZL＋PT＋PM＋PTL＋PMC グラフ入り

AA.FOR、AA.DAT

```
NCASE,N,ZE,YEN,YTM
    2    7  .200D+00  .000D+00  .200D+00

ZG=     .96300    9.63000    ZL=  24.00000  18.00000   ZLL=  30.00000
NZYM,ICOUNT(I)
   2   3   2
PHI=    .0   ZMORE=    .10D+00    .60D+00    ZOA=    .70D+04
ZLLL=   .300000D+02  .000000D+00    COSPHI=  .100000D+01
ZU=   .496385D+04   .281515D+05   ZT=   .121564D+04   .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04   ZM=   .121564D+04   .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02   ZO=   .121554D+04   .689365D+04   A12=   .857143D+00
    1   EO=  3.9255896E+01 -4.4425936E+00  3.9506481E+01 -6.4566977E+00
    2   EO= -2.3503605E+01 -3.1819328E+01  3.9558679E+01 -1.2645173E+02
    3   EO= -1.5752266E+01  3.6262009E+01  3.9535645E+01  1.1348019E+02
    4   EO= -8.9908509E-05  1.9498571E-04  2.1471602E-04  1.1475457E+02
    5   EO= -8.9908309E-05  1.9498544E-04  2.1471568E-04  1.1475455E+02
    6   EO= -8.9908239E-05  1.9498591E-04  2.1471609E-04  1.1475448E+02
    7   EO= -8.9908031E-05  1.9498564E-04  2.1471575E-04  1.1475446E+02
TZ= 8.416480E+01 1.318964E+01      TZA= 8.519202E+01      TZP= 8.906499E+00
ZU=   .496385D+04   .281515D+05   ZT=   .121564D+04   .689425D+04   ZUT= -.245627D+04 -.139302D+05   ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04   ZM=   .121564D+04   .689425D+04   ZVW= -.165448D+04 -.938303D+04  ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02   ZO=   .121554D+04   .689365D+04   A12=   .857143D+00

  3 I   1  1  .474396E+00  -8.907 SI   .940023E-05  -7.016 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395065E+02  -6.457
  2 I   3  1  .474396E+00  -8.907 SI   .388253E-04 102.876 E  .592195E+02  -6.643 II  .280760E+00  31.219   2 EE  .197136E+02 172.985

  3 I   1  2  .473307E+00-128.267 SI   .160962E-10 -98.422 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395587E+02-126.452
  2 I   3  2  .473307E+00-128.267 SI   .136578E+01  36.578 E  .344528E+02 -96.563 II  .522629E+00-129.563   2 EE  .197136E+02 172.985

  3 I   1  3  .478433E+00 111.527 SI   .000000E+00    .000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .395356E+02 113.480
  2 I   3  3  .478433E+00 111.527 SI   .101218E-04 135.000 E  .340684E+02  83.573 II  .273594E+00  70.180   2 EE  .197136E+02 172.985

  3 I   1  4  .940087E-05 -54.975 SI   .851914E+02   8.907 E  .000000E+00    .000 II  .957822E+00 171.338   3 EE  .214716E-03 114.755
  2 I   3  4  .957828E+00  -8.662 SI   .851914E+02   8.907 E  .290940E+02 171.108 II  .889152E+00 -11.316   2 EE  .290939E+02  -8.892

  3 I   1  5  .368044E-05 100.749 SI   .853875E+02   8.267 E  .000000E+00    .000 II  .969796E+00 -98.892   3 EE  .214716E-03 114.755
  2 I   3  5  .969799E+00  81.108 SI   .853875E+02   8.267 E  .290940E+02 171.108 II  .101362E+01  77.178   2 EE  .290939E+02  -8.892

  3 I   1  6  .993858E-05 162.493 SI   .844727E+02   8.473 E  .000000E+00    .000 II  .961808E+00  82.053   3 EE  .214716E-03 114.754
  2 I   3  6  .961806E+00 -97.948 SI   .844727E+02   8.473 E  .292115E+02  81.814 II  .956916E+00 -99.131   2 EE  .292113E+02 -98.186

  3 I   1  7  .489281E-05  12.907 SI   .940019E-05 172.985 E  .000000E+00    .000 II  .973721E+00  -8.186   3 EE  .214716E-03 114.754
  2 I   3  7  .973716E+00 171.814 SI   .940019E-05 172.985 E  .292115E+02  81.814 II  .953952E+00 172.115   2 EE  .292113E+02 -98.186
PSA=Y(  1)=  -.1042683639338904D-02
PSA=Y(  2)=  -.1043741682776655D-02
PSA=Y(  3)=  -.1044690941878201D-02
PSA=Y(  4)=  -.1045530844829834D-02
PSA=Y(  5)=  -.1046260885716244D-02
PSA=Y(  6)=  -.1046880624782531D-02
PSA=Y(  7)=  -.1047389688722866D-02
PSA=Y(  8)=  -.1047787770881214D-02
PSA=Y(  9)=  -.1048074631495144D-02
PSA=Y( 10)=  -.1048250097756664D-02
PSA=Y( 11)=  -.1048314063967437D-02
PSA=Y( 12)=  -.1048266491592176D-02
PSA=Y( 13)=  -.1048107409306831D-02
```

PSA=Y(14)= -.1047836912919764D-02
PSA=Y(15)= -.1047455165368749D-02
PSA=Y(16)= -.1046962396614282D-02
PSA=Y(17)= -.1046358903480371D-02
PSA=Y(18)= -.1045645049480015D-02
PSA=Y(19)= -.1044821264613027D-02
PSA=Y(20)= -.1043888045106911D-02
PSA=Y(21)= -.1042845953080018D-02
PSA=Y(22)= -.1041695616275540D-02
PSA=Y(23)= -.1040437727585442D-02
PSA=Y(24)= -.1039073044735161D-02
PSA=Y(25)= -.1037602389754255D-02
PSA=Y(26)= -.1036026648504773D-02
PSA=Y(27)= -.1034346770159900D-02
PSA=Y(28)= -.1032563766617756D-02
PSA=Y(29)= -.1030678711877897D-02
PSA=Y(30)= -.1028692741437354D-02
PSA=Y(31)= -.1026607051578310D-02
PSA=Y(32)= -.1024422898634469D-02
PSA=Y(33)= -.1022141598250315D-02
PSA=Y(34)= -.1019764524619049D-02
PSA=Y(35)= -.1017293109569550D-02
PSA=Y(36)= -.1014728841816748D-02
PSA=Y(37)= -.1012073265963309D-02
PSA=Y(38)= -.1009327981641661D-02
PSA=Y(39)= -.1006494642485478D-02
PSA=Y(40)= -.1003574955227293D-02
PSA=Y(41)= -.1000570678556301D-02
PSA=Y(42)= -.9974836221289252D-03
PSA=Y(43)= -.9943156454781388D-03
PSA=Y(44)= -.9910686569014615D-03
PSA=Y(45)= -.9877446122246170D-03
PSA=Y(46)= -.9843455137534818D-03
PSA=Y(47)= -.9808734089666871D-03
PSA=Y(48)= -.9773303893396701D-03
PSA=Y(49)= -.9737158890372757D-03
PSA=Y(50)= -.9700401836916228D-03
PSA=Y(51)= -.9662973890272042D-03
PSA=Y(52)= -.9624924595748041D-03
PSA=Y(53)= -.9586276872575183D-03
PSA=Y(54)= -.9547054000869082D-03
PSA=Y(55)= -.9507279607099406D-03
PSA=Y(56)= -.9466977649772446D-03
PSA=Y(57)= -.9426172405184730D-03
PSA=Y(58)= -.9384888453141116D-03
PSA=Y(59)= -.9343150661322852D-03
PSA=Y(60)= -.9300984171041193D-03
PSA=Y(61)= -.9258414381925206D-03
PSA=Y(62)= -.9215466936396410D-03
PSA=Y(63)= -.9172167704463163D-03
PSA=Y(64)= -.9128542767733450D-03
PSA=Y(65)= -.9084618404351374D-03
PSA=Y(66)= -.9040421072832316D-03
PSA=Y(67)= -.8995977395898080D-03
PSA=Y(68)= -.8951314144738376D-03
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PSA=Y(202)= -.8582674353370123D-03

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第11表　回生時の各電圧、電流、電力

$P_{ZL}+P_T+P_M+P_{TC}+P_{ML}$ グラフ入り

AA.FOR、AA.DAT

```
NCASE,N,ZE,YEN,YTM
    2     7   .200D+00   .000D+00   .200D+00

ZG=     .96300    9.63000    ZL=   24.00000   18.00000    ZLL=   30.00000
NZYM,ICOUNT(I)
    2     3     2
PHI=180.0    ZMORE=     .10D+00    .60D+00    ZOA=     .70D+04
ZLLL= -.300000D+02   .367545D-14    COSPHI= -.100000D+01
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00
     1    EO=   4.0076477E+01  4.8656261E+00  4.0370760E+01  6.9223173E+00
     2    EO= -1.5821270E+01 -3.7197265E+01  4.0422136E+01 -1.1304171E+02
     3    EO= -2.4255204E+01  3.2331733E+01  4.0418509E+01  1.2687716E+02
     4    EO= -1.6061741E-04  1.8702249E-04  2.4652660E-04  1.3065642E+02
     5    EO= -1.6061771E-04  1.8702270E-04  2.4652695E-04  1.3065644E+02
     6    EO= -1.6061763E-04  1.8702220E-04  2.4652652E-04  1.3065651E+02
     7    EO= -1.6061791E-04  1.8702241E-04  2.4652687E-04  1.3065652E+02
TZ=-7.905073E+01 1.349093E+01      TZA= 8.019366E+01      TZP= 1.703151E+02
ZU=   .496385D+04   .281515D+05    ZT=   .121564D+04   .689425D+04    ZUT= -.245627D+04 -.139302D+05    ZV=   .165462D+04   .938385D+04
ZW=   .165462D+04   .938385D+04    ZM=   .121564D+04   .689425D+04    ZVW= -.165448D+04 -.938303D+04   ZWM=   .141813D+04   .804260D+04
ZVM= -.141813D+04 -.804260D+04    ZL=   .240000D+02   .180000D+02    ZO=   .121554D+04   .689365D+04    A12=   .857143D+00

  3 I   1  1  .503961E+00-170.315 SI  .963747E-05   7.509 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .403708E+02   6.922
  2 I   3  1  .503961E+00-170.315 SI  .447691E-04 120.273 E  .605808E+02   7.118 II  .284996E+00-130.437   2 EE  .202108E+02-172.490

  3 I   1  2  .506880E+00  69.101 SI  .168674E-10 -80.941 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .404221E+02-113.042
  2 I   3  2  .506880E+00  69.101 SI  .143128E+01-125.941 E  .348121E+02 -83.044 II  .554866E+00  68.699   2 EE  .202108E+02-172.490

  3 I   1  3  .500954E+00 -50.898 SI  .000000E+00    .000 E  .000000E+00    .000 II  .000000E+00    .000   3 EE  .404185E+02 126.877
  2 I   3  3  .500954E+00 -50.898 SI  .116214E-04 -45.000 E  .352265E+02  96.877 II  .300514E+00 -93.189   2 EE  .202108E+02-172.490

  3 I   1  4  .333609E-05 -64.616 SI  .801937E+02 170.315 E  .000000E+00    .000 II  .101902E+01   9.446   3 EE  .246527E-03 130.656
  2 I   3  4  .101902E+01-170.554 SI  .801937E+02 170.315 E  .301562E+02-170.544 II  .970799E+00-169.026   2 EE  .301561E+02   9.456
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 3 I   1  5  .238858E-05  69.423 SI  .797319E+02 170.899 E  .000000E+00    .000 II  .100521E+01  99.456   3 EE  .246527E-03 130.656
 2 I   3  5  .100521E+01 -80.544 SI  .797319E+02 170.899 E  .301562E+02-170.544 II  .980516E+00 -83.383   2 EE  .301561E+02   9.456

 3 I   1  6  .233031E-05 161.374 SI  .806751E+02 170.898 E  .000000E+00    .000 II  .101893E+01 -81.332   3 EE  .246527E-03 130.657
 2 I   3  6  .101893E+01  98.668 SI  .806751E+02 170.898 E  .301541E+02  98.667 II  .107150E+01  97.593   2 EE  .301539E+02 -81.333

 3 I   1  7  .701746E-07 151.352 SI  .963725E-05-172.490 E  .000000E+00    .000 II  .100514E+01-171.333   3 EE  .246527E-03 130.657
 2 I   3  7  .100514E+01   8.667 SI  .963725E-05-172.490 E  .301541E+02  98.667 II  .986425E+00   5.624   2 EE  .301539E+02 -81.333
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PSA=Y(113)=  -.7993273347448593D-03
PSA=Y(114)=  -.7969801084535266D-03
PSA=Y(115)=  -.7948092151609520D-03
PSA=Y(116)=  -.7928159625262277D-03
PSA=Y(117)=  -.7910015512161417D-03
PSA=Y(118)=  -.7893670741736525D-03
PSA=Y(119)=  -.7879135159343242D-03
PSA=Y(120)=  -.7866417520623337D-03
PSA=Y(121)=  -.7855525486335502D-03
PSA=Y(122)=  -.7846465617333820D-03
PSA=Y(123)=  -.7839243371021709D-03
PSA=Y(124)=  -.7833863097772564D-03
PSA=Y(125)=  -.7830328038442858D-03
PSA=Y(126)=  -.7828640322431468D-03
PSA=Y(127)=  -.7828800966400706D-03
PSA=Y(128)=  -.7830809873503597D-03
PSA=Y(129)=  -.7834665833819088D-03
PSA=Y(130)=  -.7840366524440867D-03
PSA=Y(131)=  -.7847908511529056D-03
PSA=Y(132)=  -.7857287252246437D-03
PSA=Y(133)=  -.7868497097049953D-03
PSA=Y(134)=  -.7881531293527644D-03
PSA=Y(135)=  -.7896381990484258D-03
PSA=Y(136)=  -.7913040242240044D-03
PSA=Y(137)=  -.7931496014617068D-03
PSA=Y(138)=  -.7951738190534741D-03
PSA=Y(139)=  -.7973754576866554D-03
PSA=Y(140)=  -.7997531911776434D-03
PSA=Y(141)=  -.8023055872534712D-03
PSA=Y(142)=  -.8050311084630835D-03
PSA=Y(143)=  -.8079281130441984D-03
PSA=Y(144)=  -.8109948559607005D-03
PSA=Y(145)=  -.8142294899187164D-03
PSA=Y(146)=  -.8176300664857195D-03
PSA=Y(147)=  -.8211945372842422D-03
PSA=Y(148)=  -.8249207552175619D-03
PSA=Y(149)=  -.8288064757415725D-03
PSA=Y(150)=  -.8328493582538954D-03
PSA=Y(151)=  -.8370469674652270D-03
PSA=Y(152)=  -.8413967749021367D-03
PSA=Y(153)=  -.8458961603921011D-03
PSA=Y(154)=  -.8505421367643610-03
PSA=Y(155)=  -.8553327360267815D-03
PSA=Y(156)=  -.8602642419361928D-03
PSA=Y(157)=  -.8653339608422073D-03
PSA=Y(158)=  -.8705388389387281D-03
PSA=Y(159)=  -.8758757410056717D-03
PSA=Y(160)=  -.8813414522848007D-03
PSA=Y(161)=  -.8869326804408217D-03
PSA=Y(162)=  -.8926460575295891D-03
```

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PSA=Y(163)=  -.8984781420160459D-03
PSA=Y(164)=  -.9044254208774305D-03
PSA=Y(165)=  -.9104843117029304D-03
PSA=Y(166)=  -.9166511648217579D-03
PSA=Y(167)=  -.9229222655768865D-03
PSA=Y(168)=  -.9292938364779957D-03
PSA=Y(169)=  -.9357620395249455D-03
PSA=Y(170)=  -.9423229785170406D-03
PSA=Y(171)=  -.9489727014013738D-03
PSA=Y(172)=  -.9557072026176172D-03
PSA=Y(173)=  -.9625224255600529D-03
PSA=Y(174)=  -.9694142649934179D-03
PSA=Y(175)=  -.9763785695326987D-03
PSA=Y(176)=  -.9834111441335835D-03
PSA=Y(177)=  -.9905077526468631D-03
PSA=Y(178)=  -.9976641203373049D-03
PSA=Y(179)=  -.1004875936466476D-02
PSA=Y(180)=  -.1012138856914646D-02
PSA=Y(181)=  -.1019448506777820D-02
PSA=Y(182)=  -.1026800482975432D-02
PSA=Y(183)=  -.1034190356971720D-02
PSA=Y(184)=  -.1041613677369213D-02
PSA=Y(185)=  -.1049065972647867D-02
PSA=Y(186)=  -.1056542753808287D-02
PSA=Y(187)=  -.1064039517135740D-02
PSA=Y(188)=  -.1071551746850474D-02
PSA=Y(189)=  -.1079074917861078D-02
PSA=Y(190)=  -.1086604498489407D-02
PSA=Y(191)=  -.1094135953213282D-02
PSA=Y(192)=  -.1101664745348785D-02
PSA=Y(193)=  -.1109186339846246D-02
PSA=Y(194)=  -.1116696205965440D-02
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PSA=Y(196)=  -.1131662668221622D-02
PSA=Y(197)=  -.1139110249127384D-02
PSA=Y(198)=  -.1146528076610309D-02
PSA=Y(199)=  -.1153911682461484D-02
PSA=Y(200)=  -.1161256619059969D-02
PSA=Y(201)=  -.1168558462097735D-02
PSA=Y(202)=  -.1175812813215771D-02
PSA=Y(203)=  -.1183015302661516D-02
PSA=Y(204)=  -.1190161591921424D-02
PSA=Y(205)=  -.1197247376349964D-02
PSA=Y(206)=  -.1204268387724028D-02
PSA=Y(207)=  -.1211220396854173D-02
PSA=Y(208)=  -.1218099216107049D-02
PSA=Y(209)=  -.1224900701934928D-02
PSA=Y(210)=  -.1231620757387475D-02
PSA=Y(211)=  -.1238255334548910D-02
PSA=Y(212)=  -.1244800436996485D-02
PSA=Y(213)=  -.1251252122205671D-02
PSA=Y(214)=  -.1257606503923370D-02
PSA=Y(215)=  -.1263859754509156D-02
PSA=Y(216)=  -.1270008107230325D-02
PSA=Y(217)=  -.1276047858560503D-02
PSA=Y(218)=  -.1281975370364563D-02
PSA=Y(219)=  -.1287787072151048D-02
PSA=Y(220)=  -.1293479463146952D-02
PSA=Y(221)=  -.1299049114486195D-02
PSA=Y(222)=  -.1304492671206248D-02
PSA=Y(223)=  -.1309806854315809D-02
PSA=Y(224)=  -.1314988462752353D-02
PSA=Y(225)=  -.1320034375304147D-02
PSA=Y(226)=  -.1324941552507397D-02
PSA=Y(227)=  -.1329707038459915D-02
PSA=Y(228)=  -.1334327962604576D-02
PSA=Y(229)=  -.1338801541475476D-02
PSA=Y(230)=  -.1343125080355279D-02
PSA=Y(231)=  -.1347295974907681D-02
PSA=Y(232)=  -.1351311712733505D-02
PSA=Y(233)=  -.1355169874912576D-02
PSA=Y(234)=  -.1358868137427471D-02
PSA=Y(235)=  -.1362404272585493D-02
PSA=Y(236)=  -.1365776150346498D-02
PSA=Y(237)=  -.1368981739620523D-02
PSA=Y(238)=  -.1372019109473932D-02
PSA=Y(239)=  -.1374886430320021D-02
PSA=Y(240)=  -.1377581974976838D-02
PSA=Y(241)=  -.1380104119764081D-02
PSA=Y(242)=  -.1382451345430358D-02
PSA=Y(243)=  -.1384622238091104D-02
PSA=Y(244)=  -.1386615490081511D-02
PSA=Y(245)=  -.1388429900755161D-02
PSA=Y(246)=  -.1390064377162492D-02
PSA=Y(247)=  -.1391517934755448D-02
PSA=Y(248)=  -.1392789697975960D-02
PSA=Y(249)=  -.1393878900759038D-02
PSA=Y(250)=  -.1394784887001066D-02
PSA=Y(251)=  -.1395507110981242D-02
PSA=Y(252)=  -.1396045137642687D-02
PSA=Y(253)=  -.1396398642921071D-02
PSA=Y(254)=  -.1396567413857852D-02
PSA=Y(255)=  -.1396551348815223D-02
PSA=Y(256)=  -.1396350457431694D-02
```

7．瞬時電力の数式表示

7．1　力行時、負荷力率　cosφ＝1

各瞬時電力の傾向は第6節で記した通りで明確になったが、更に数式で表示しておくと、なお分かりやすいので以下に数式（第15表）を示す。

プログラムＳＣ31Ｐ．ＦＯＲ(第12表)、入力データＳＣ31Ｐ．ＤＡＴ（第13表 力行時）を用い詳細に計算した結果が第14表でありこの数値を用いて第15表のP_Uなどの各数式を書いた。各瞬時値ｐ：電力、ｅ：電圧、ｉ：電流など慣習的に用いられている文字を使用してあり、添字も第6節と同じなので一々の説明は省く。また、各瞬時電力の左にベクトル図を画いて電圧電流の起電力的または負荷的な働きを示し、損失率なども記した。

7．2　回生時、負荷力率　cosφ＝－1

第7．1節につづき回生時のケースを示す。

第12表がこのプログラムＳＣ31Ｐ．ＦＯＲで、第16表にＳＣ31Ｐ．ＤＡＴ（回生時 入力データ）、第17表に計算結果、第18表がこれらを用いた瞬時電力の数式である。

8．おわりに

送電側平衡3相電力は脈動しない電力を送り出すが、受電側単相負荷電力は電源周波数の2倍のcos脈動をしている。

本装置のように負荷力率を1として、更にＬ、ＣをＴ座巻線、Ｍ座巻線に並列に挿入することでＬ、Ｃをダンパーとして受電側電力を脈動なくしている。つまり3相から脈動なき電力を単相側装置に脈動なく受取っていることをコンピュータ計算により詳細に描き出してみた。

以上は3相を単相に変換するときの装置であるが、逆に単相を3相に変換するのにも用いることができる。

（いどがわ いさお　教授）

（1991．12．9受理）

参考文献

(1) スコット変圧器（3相2相変換変圧器）の多導体はしご形回路理論による解法
長野大学紀要　1991．12　井戸川功雄

(2) 電気鉄道新幹線き電気回路の計算法に関する研究　井戸川功雄　1976．7　博士論文(東京工大)

第12表 SC31P.FOR

瞬時電力計算式用プログラム

データは力行時 SC31P.DAT

回生時 SC31PK.DAT

```
C     SC31POWER ....SC31P.FOR
       IMPLICIT REAL*8(A-H,O-Z)
       REAL*8 I
     1 READ(5,500)E,A,I,B
   500 FORMAT(4F20.13)
       IF(E.LE.0.)STOP
       EI=E*I
       AMB=A-B
       APB=A+B
         EI=EI/2.D0
         APBD2=APB/2.D0
       WRITE(6,600)E,A,I,B
   600 FORMAT(1H0,'E=',F24.14,' A=',F24.14,' I=',F24.14,' B=' ,F24.14)
       WRITE(6,610)EI,AMB,APBD2
   610 FORMAT(1H ,'   EI=',F24.14,'    AMB=',F24.14,'   APBD2=',F24.14)
         COSAMB= DCOS(AMB*3.14159265358979320D0/180.D0)
         EICOSAMB= EI*COSAMB
          WRITE(6,620)COSAMB, EICOSAMB
   620     FORMAT(1H ,'COSAMB=',F24.14,'   EICOSAMB=',F24.14)
           GOTO 1
       END
```

第13表 SC31P.DAT

力行時入力データ

59219.42216710881	-6.64272240715	474.3959056931188	-8.906965102
34152.76530482308	-96.56255042512	473.3076363470163	-128.2673872
34068.38898184674	83.57260975865	478.4339760490193	111.52705808
40973.30981679315	36.57800653817	1365.776993893105	36.578006538
29093.9447071350	171.10791025527	969.7981590237832	81.107910255
29211.45881683027	81.81427976831	973.7152938943425	171.81427976
29093.94477191227	171.10791025482	957.8268367190919	-8.662198327
29211.45881704981	81.81427977066	961.8034970983656	-97.94798080

第14表　SP31P.DATを入力したときの力行時の解

```
PU E=     59219.42216710881000 A=      -6.64272240715000 I=      474.39590569311880 B=       -8.90696510200000
   EI= 14046725.70679437000000   AMB=       2.26424269485000   APBD2=       -7.77484375457500
COSAMB=          .99921924608780 EICOSAMB= 14035758.67074516000000

PV E=     34452.76530482308000 A=     -96.56255042511999 I=      473.30763634701630 B=      -128.26738720000000
   EI=  8153378.45602215100000   AMB=      31.70483677488001   APBD2=      -112.41496881256000
COSAMB=          .85076674731226 EICOSAMB=  6936623.26863580800000

PW E=     34068.38898184674000 A=      83.57260975865000 I=      478.43397604901930 B=       111.52705808000000
   EI=  8149737.39908476900000   AMB=     -27.95444832135000   APBD2=       97.54983391932501
COSAMB=          .88332055623958 EICOSAMB=  7198830.57256606300000

PZL E=     40973.30981679315000 A=      36.57800653817000 I=     1365.77699389310500 B=       36.57800653800000
   EI= 27980201.95571530000000   AMB=          .00000000017000   APBD2=       36.57800653808500
COSAMB=         1.00000000000000 EICOSAMB= 27980201.95571530000000

PTL E=     29093.94470713500000 A=     171.10791025527000 I=      969.79815902378320 B=       81.10791025499999
   EI= 14107627.00785963000000   AMB=      90.00000000027002   APBD2=      126.10791025513500
COSAMB=          -.00000000000471 EICOSAMB=         -.00006648379261

PMC E=     29211.45881683027000 A=      81.81427976831000 I=      973.71529389434250 B=       171.81427976000000
   EI= 14221822.10345618000000   AMB=     -89.99999999169000   APBD2=      126.81427976415500
COSAMB=          .00000000014504 EICOSAMB=          .00206268945471

PT E=     29093.94477191227000 A=     171.10791025482000 I=      957.82683671909190 B=       -8.66219832700000
   EI= 13933480.54428035000000   AMB=     179.77010858182000   APBD2=       81.22285596391001
COSAMB=          -.99999195048571 EICOSAMB=-13933368.38652960000000

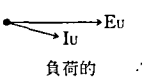
PM E=     29211.45881704981000 A=      81.81427977065999 I=      961.80349709836560 B=       -97.94798080000000
   EI= 14047841.62279170000000   AMB=     179.76226057066000   APBD2=       -8.06685051467000
COSAMB=          -.99999139151854 EICOSAMB=-14047720.69220760000000
```

第15表　瞬時電力数式（力行時）

$\cos\varphi = 1$

数値計算は2倍長で行ったので多くのケタが出力されているが式の見通しの出来るケタで以下の式を書く。

（参考）$\sin A \sin B = \frac{1}{2}\{\cos(A-B) - \cos(A+B)\}$



負荷的

E（ボルト）　A（度）　I（アンペア）　B（度）

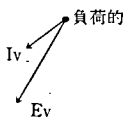
$P_U = e_U i_U = 59219.422 \sin(\omega t - 6.643) \cdot 474.396 \sin(\omega t - 8.907)$

EI（ボルトアンペア）　ANB（度）　APBD2（度）

$= 14046725.707\{\cos(2.2642) - \cos 2(\omega t - 7.7748)\}$

EI cos AMB（ワット）

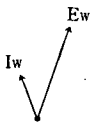
$= 14035758.671 - 14046725.707 \cos 2(\omega t - 7.7748)$



$P_V = e_V i_V = 34452.765 \sin(\omega t - 96.563) \cdot 473.308 \sin(\omega t - 128.267)$

$= 8153378.456\{\cos 31.705) - \cos 2(\omega t - 112.415)\}$

$= 6936623.263 - 8153378.456 \cos 2(\omega t - 112.415)$



$P_W = e_W i_W = 34068.389(\omega t + 83.573) \cdot 478.434 \sin(\omega t + 111.527)$

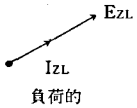
$= 8149737.399\{\cos(-27.954) - \cos 2(\omega t + 97.550)\}$

$= 7198830.572 - 8149737.399 \cos 2(\omega t + 97.550)$

3相の有効電力はP_U、P_V、P_Wのtに無関係の成分の和から

$14035758.7 + 6936623.3 + 7198830.552$

$= 28171211$、ワットとなる。　（1）



負荷的

$P_{ZL} = e_{ZL} i_{ZL} = 40973.310 \sin(\omega t + 36.578) \cdot 1365.777 \sin(\omega t + 36.578)$

$= 27980201.956\{\cos(0°) - \cos 2(\omega t + 36.578)\}$

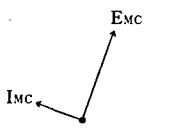
$= 27980201.956 - 27980201.956 \cos 2(\omega t + 36.578)$　（2）

負荷的とも起電力的ともいえない

$P_{TL} = e_{TL} i_{TL} = 29093.945 \sin(\omega t + 171.108) \cdot 969.798 \sin(\omega t + 81.108)$

$= 141107627.008\{\cos(90.0000) - \cos 2(\omega t + 126.108)\}$

$= 0. - 141107627.008 \cos 2(\omega t + 126.108)$

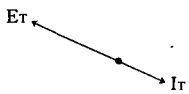


負荷的とも起電力的ともいえない

$P_{MC} = e_{MC} i_{MC} = 29211.459 \sin(\omega t + 81.814) \cdot 973.715 \sin(\omega t + 171.814)$

$= 14221822.103\{\cos(-90.0000) - \cos 2(\omega t + 126.814)\}$

$= 0. - 14221822.103 \cos 2(\omega t + 126.814)$



起電力的

$P_T = e_T i_T = 29093.945 \sin(\omega t + 171.08) \cdot 957.828 \sin(\omega t - 8.662)$

$= 13933480.544\{\cos(179.770) - \cos 2(\omega t + 81.233)\}$

$= -13933368.387 - 13933480.544 \cos 2(\omega t + 81.233)$

起電力的

$P_M = e_M i_M = 29211.459 \sin(\omega t + 81.814) \cdot 961.804 \sin(\omega t - 97.948)$

$= 14047841.623\{\cos(179.762) - \cos 2(\omega t - 8.067)\}$

$= -14047720.692 - 14047841.623 \cos 2(\omega t - 8.067)$

P_TとP_Mの有効分の和

$= -13933382.654314 - 14047163.351989$

$= -27981088.$（ワット）　（3）

（負荷的）　（起電力的）
3相有効分＋単相起電力的（P_TとP_Mの有効分の和）

＝28171211.－27981088.

＝190123.（ワット）

即ち、3相単相変換で失われる電力損失率

＝190123／28171211×100％＝0.67488％

P_{ZL}の有効分≒－（P_TとP_Mの有効分の和）
（2）　（3）

第16表　SC31PK.DAT

回生時入力データ

60580.78552079199	7.11816128383	503.9589505987508	-170.31482143481
34812.12616116828	-83.04364068539	506.8825926059734	69.10201399227
35226.51182038576	96.876790699400	500.956800344595	-50.89847570809
42938.25415226220	54.05948091922	1431.275138408740	-125.94051908078
30156.15586350344	-170.54421008394	1005.205195450114	-80.54421008394
30154.05238254965	98.66711397454	1005.135079418322	8.66711397454
30156.15586227882	-170.54421008349	1019.014312411994	-170.55356037397
30154.05238220055	98.66711397213	1018.942527160404	98.66852610417

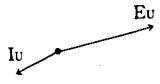
第17表　SC31PK.DATを入力した時の回生時の解

P_U	E= 60580.78552079199000	A= 7.11816128383000
	I= 503.95895059875080	B= -170.31482143481000
	EI= 15265114.54875316000000	AMB= 177.43298271864000
	APBD2= -81.59833007549000	
	COSAMB= -.99899651779265	EICOSAMB=-15249796.27791028000000
P_V	E= 34812.12616116828000	A= -83.04364068539000
	I= 506.88259260597340	B= 69.10201399227000
	EI= 8822830.38134960500000	AMB= -152.14565467766000
	APBD2= -6.97081334656000	
	COSAMB= -.88413820739908	EICOSAMB= -7800601.43755257700000
P_W	E= 35226.51182038576000	A= 96.87679069940000
	I= 500.95680032445950	B= -30.89847570809000
	EI= 8823480.32406610100000	AMB= 147.77526640749000
	APBD2= 22.98915749565500	
	COSAMB= -.84596305386098	EICOSAMB= -7464338.36062919300000
P_{ZL}	E= 42938.25415226220000	A= 54.05948091922000
	I= 1431.27513840874000	B= -125.94051908078000
	EI= 30728227.82740437000000	AMB= 180.00000000000000
	APBD2= -35.94051908078001	
	COSAMB= -1.00000000000000	EICOSAMB=-30728227.82740437000000
P_{TC}	E= 30156.15586350344000	A= -170.54421008394000
	I= 1005.20519545011400	B= -80.54421008394000
	EI= 15156562.27439854000000	AMB= -89.99999999999999
	APBD2= -125.54421008394000	
	COSAMB= .00000000000000	EICOSAMB= .00000000429388
P_{ML}	E= 30154.05238254965000	A= 98.66711397454000
	I= 1005.13507941832200	B= 8.66711397454000
	EI= 15154447.91815914000000	AMB= 90.00000000000000
	APBD2= 53.66711397454000	
	COSAMB= .00000000000000	EICOSAMB= .00000000092832
P_T	E= 30156.15586227882000	A= -170.54421008349000
	I= 1019.01431241199400	B= -170.55356037397000
	EI= 15364777.21549449000000	AMB= .00935029048000
	APBD2= -170.54888522873000	
	COSAMB= .99999998668396	EICOSAMB= 15364777.01089657000000
P_M	E= 30154.05238220055000	A= 98.66711397213000
	I= 1018.94252716040400	B= 98.66852610417000
	EI= 15362623.16922331000000	AMB= -.00141213204000
	APBD2= 98.66782003815000	
	COSAMB= .99999999969628	EICOSAMB= 15362623.16455736000000

第18表　瞬時電力（回生時）

$\cos\varphi = -1$

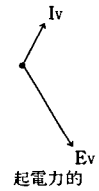
数値計算は2倍長で行ったので多くのケタが出力されているが、式の見通しの出来るケタで以下の式を書く。



$P_U = e_U i_U = 60580.79 \sin(\omega t + 7°.118) \cdot 503.959 \sin(\omega t - 170°.315)$

$= 15265114.549 \{\cos(177.433) - \cos 2(\omega t - 81.598)\}$

$= -15249796.278 - 15265114.549 \cos 2(\omega t - 81.598)$



$P_V = e_V i_V = 34812.126 \sin(\omega t - 83.044) \cdot 506.883 \sin(\omega t + 69.102)$

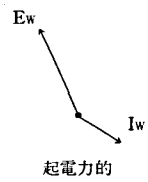
$= 8822830.381 \{\cos(-152.146) - \cos 2(\omega t - 6.971)\}$

$= -7800601.438 - 8822830.381 \cos 2(\omega t - 6.971)$

$P_W = e_W i_W = 35226.512 \sin(\omega t + 96.877) \cdot 500.957 \sin(\omega t - 50.899)$

$= 8823480.324 \{\cos(147.775) - \cos 2(\omega t + 22.989)\}$

$= -7464338.361 - 8823480.324 \cos 2(\omega t + 22.989)$



P_U、P_V、P_Wの有効分合計$= -30514735.$（ワット）

$P_{ZL} = e_{ZL} i_{ZL} = 42938.254 \sin(\omega t + 54.059) \cdot 1431.275 \sin(\omega j - 125.941)$

$= 30728227.827 \{\cos(180) - \cos 2(\omega t - 35.941)\}$

$= -30728227.827 + 30728227.827 \cos 2(\omega t - 35.941)$

$P_{TC} = e_{TC} i_{TC} = 30156.156 \sin(\omega t - 170.544) \cdot 1005.205 \sin(\omega t - 80.544)$

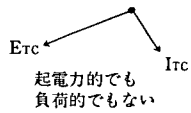
$= 15156562.274 \{\cos(-90.0000) - \cos 2(\omega t - 125.544)\}$

$= 0. - 15156562.274 \cos 2(\omega t - 125.544)$

$P_{ML} = e_{ML} i_{ML} = 30154.052 \sin(\omega t + 98.667) \cdot 1005.135 \sin(\omega t + 8.667)$

$= 15154447.918 \{\cos(90.0000) - \cos 2(\omega t + 53.667)\}$

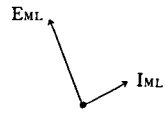
$= 0. - 15154447.918 \cos 2(\omega t + 53.6671)$



$P_T = e_T i_T = 30156.156 \sin(\omega t - 170.544) \cdot 1019.014 \sin(\omega t - 170.554)$

$= 15364777.216 \{\cos(0.0094) - \cos 2(\omega t - 170.549)\}$

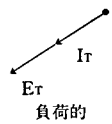
$= 15364777.019 - 15364777.216 \cos 2(\omega t - 170.549)$



$P_M = e_M i_M = 30154.052 \sin(\omega t + 98.667) \cdot 1018.943 \sin(\omega t + 98.669)$

$= 15362623.169 \{\cos(-0.0014) - \cos 2(\omega t + 98.667)\}$

$= 15362623.169 - 15362623.169 \cos 2(\omega t + 98.668)$

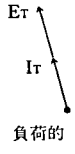


P_TとP_Mの有効分の和

$= 30727400.$（ワット）

（負荷的）　（起電力的）
単相有効分＋ 3相有効分

$= 30727400. - 30514735. = 212665.$（ワット）



即ち、単相3相変換で失われる損失率

$= 212265. / 30728227.8 \times 100\% = 0.69208351\%$

↑
P_{ZL}の有効分