

APPENDIX 1

```

C      IN PUT PROGRAMME
      DIMENSION A(21),B(21),HP(6),HQ(6)
      READ 111,N
      READ 110,VP,VQ
      DO 20 J=1,N
      HP(J)=0.
20     HQ(J)=0.
      KJ=N*(N-1)/2 +N
      DO 21 J=1,KJ
      A(J)=0
21     B(J)=0
30     READ 111,J,K,R,X
      IF (J)27,22,27
27     IF (J-K)26,24,26
24     AN=R
      BN=X
      GO TO 25
26     Z=R*R+X*X
      AN=R/Z
      BN=-X/Z
      IF(J-1)22,10,11
10     I=K
      GO TO 13
11     IF(K-1)22,12,14
12     I=J
13     HP(I)=VP*AN-VQ*BN
      HQ(I)=VP*BN+VQ*AN
14     IF(J-K)15,25,16
15     KJ=K*(K-1)/2 +J
      GO TO 23
16     KJ=J*(J-1)/2 +K
23     KK=K*(K-1)/2 +K
      A(KK)=A(KK)+AN
      B(KK)=B(KK)+BN
      A(KJ)=A(KJ)-AN
      B(KJ)=B(KJ)-BN
25     JJ=J*(J-1)/2 +J
      A(JJ)=A(JJ)+AN
      B(JJ)=B(JJ)+BN
      GO TO 30
22     PRINT 101
      PRINT 102
      DO 17 I=1,N
      PRINT 103,HP(I),HQ(I)
17     PUNCH 104,HP(I),HQ(I)
      PRINT 105

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PRINT 106
DO 18 J=2,N
DO 18 K=2,J
KJ=J*(J-1)/2 +K
PRINT 107,K,J,A(KJ),B(KJ)
18 PUNCH 104,A(KJ),B(KJ)
PRINT 109
PRINT 106
DO 19 J=1,N
DO 19 K=1,J
KJ=J*(J-1)/2 +K
PRINT 107,K,J,A(KJ),B(KJ)
19 PUNCH 104,A(KJ),B(KJ)
101 FORMAT (35H INJECT. CURRENT FOR VOLT. SOLUTION)
102 FORMAT (32H ACT. CURR. REACT. CURR. )
103 FORMAT (F10.0,F10.0)
104 FORMAT (F14.6,1XF14.6)
105 FORMAT (30H ADMITTANCE FOR INVERT MATRIX )
106 FORMAT (31H K J A(K,J) B(K,J) )
107 FORMAT (15,15,F12.6,F12.6)
109 FORMAT (32H ADMITTANCE FOR OUT-PUT PROGRAM )
110 FORMAT (F15.0,F15.0)
111 FORMAT (15,15,F15.0,F15.0)
STOP
END

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C   MATRIX INVERSION
   DIMENSION A(10,11),B(10,11),LOC(10),CK(12),LAC(10)
   READ 1,N
47  DO 21 I=1,N
     DO 21 J=1,11
       READ 2,A(J,I),B(J,I)
       A(I,J)=A(J,I)
21  B(I,J)=B(J,I)
     NP=N+1
     DO 23 I=1,N
23  CK(I)=0.
C   SET COLUMN
     DO 25 J=1,N
C   FIND MAX ELEMENT IN JTH COL.
     AMAX=0.
     DO 24 K=1,N
       CD=SQRT(A(K,J)*A(K,J)+B(K,J)*B(K,J))
       IF(AMAX-CD) 43,24,24
C   IS NEW MAX IN ROW PREVIOUSLY USED AS PIVOT
43  IF(CK(K)) 44,44,24
44  LOC(J)=K
     AMAX=CD
24  CONTINUE
C   MAX ELEMENT IN JTH COL IS A(L,J)
     IF (AMAX)22,31,22
31  PRINT 3
     PAUSE
22  L=LOC(J)
     LAC(L)=J
     CK(L)=1.
C   STORE JTH COL OF UNIT MATRIX IN N+1TH COL OF A
     DO 26 I=1,N
       A(I,NP)=0.
26  B(I,NP)=0.
       A(L,NP)=1.
       B(L,NP)=0.
C   DIVIDE PIVOT ROW BY PIVOT ELEMENT
     ADR=A(L,J)
     BDR=B(L,J)
     DO 27 M=1,NP
       ALM=A(L,M)
       BLM=B(L,M)
       A(L,M)=(ALM*ADR+BLM*BDR)/(ADR*ADR+BDR*BDR)
27  B(L,M)=(ADR*BLM-ALM*BDR)/(ADR*ADR+BDR*BDR)
C   PERFORM ELIMINATION ,L IS PIVOT ROW,A,L,J) IS PIVOT ELEM
ENT
     DO 29 I=1,N

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AER=A(I,J)
BER=B(I,J)
IF (L-1) 45,29,45
45 DO 29 K=1,NP
A(I,K)=A(I,K)-AER*A(L,K)+BER*B(L,K)
B(I,K)=B(I,K)-BER*A(L,K)-AER*B(L,K)
29 CONTINUE
DO 23 M=1,N
A(M,J)=A(M,NP)
23 B(M,J)=B(M,NP)
25 CONTINUE
C PRINT OUT PUT
PRINT 7
7 FORMAT (16H INVERSE MATRIX )
PRINT 8
42 DO 30 M=1,N
J=LAC(M)
DO 30 I=1,M
L=LOC(I)
PUNCH 6, A(L,J),B(L,J)
30 PRINT 5, I,M,A(L,J),B(L,J)
1 FORMAT (15)
2 FORMAT (F15.0,F15.0)
3 FORMAT (17H INTERCHANGE NODE)
5 FORMAT (14,14,F17.8,F18.8)
6 FORMAT (F14.6,1XF14.6)
8 FORMAT (40H .ROW COL R X )
END

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APPENDIX 3

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C ESTIMATE VOLTAGE SOLUTION
  DIMENSION HCP(6),HCQ(6),GT(2),VP(6),VQ(6),DVA(6)
  DIMENSION SX(6),SN(6),VS(6),TR(2),JA(2),JB(2)
  DIMENSION G(6),B(6),PG(6),IW(6),R(21),X(21),HP(6),HQ(6)
  READ 127,N,MA
  READ 100,VP(1),VQ(1)
  DO 13 J=2,N
13 READ 100,PG(J),SX(J),SN(J)
  DO 10 J=1,N
10 READ 100,VS(J),DVA(J)
  DO 20 K=1,MA
  TR(K)=1.
20 READ 127,JA(K),JB(K),GT(K)
  DO 19 J=1,N
  READ 100,G(J),B(J)
  HCQ(J)=0.
  HCP(J)=0.
  HP(J)=G(J)
19 HQ(J)=B(J)
  DO 11 M=2,N
  DO 11 K=2,M
  MJ=(M*(M-1))/2+K
11 READ 100,R(MJ),X(MJ)
  ID=0
42 IC=0
  DO 40 IR=1,8
  ID=ID+1
  DO 16 M=2,N
  VNP=0.
  VNQ=0.
  DO 15 J=2,N
  IF (J-M)26,26,25
25 MJ=(J*(J-1))/2+M
  GO TO 27
26 MJ=(M*(M-1))/2+J
27 DL=HP(J)
  RM=HQ(J)
  QX=R(MJ)
  DQ=X(MJ)
  VNQ=DL*DQ+RM*QX+VNQ
15 VNP=DL*QX-RM*DQ+VNP
  VP(M)=VNP
  VQ(M)=VNQ
  VT=VNP*VNP+VNQ*VNQ
  DL=HP(M)-G(M)-HCP(M)
  RM=HQ(M)-B(M)-HCQ(M)
  SP=VNP*DL+VNQ*RM
  SQ=-VNQ*DL+VNP*RM
  DP=PG(M)-SP

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QX= SX(M)
DQ= QX-SQ
DHQ= DQ*DQ
BQ= SN(M)
RM= VS(M)
DL= RM*RM
IF(QX-BQ)46,32,46
32 IF(DHQ-.00000001)14,14,33
46 IF(SQ-QX)47,47,45
47 IF(DHQ-.000016)34,34,48
45 IC=1
34 IF(VT-DL)50,14,14
48 DQ=BQ-SQ
DHQ=DQ*DQ
IF(SQ-BQ)35,49,49
49 IF(DHQ-.000016)36,36,50
35 IC=1
36 IF(VT-DL)14,14,50
33 IC=1
14 DIP= (DP*VNP-DQ*VNQ)/VT
DIQ= (DP*VNQ+DQ*VNP)/VT
GO TO 75
50 DL=DL VT
MJ=(M*(M-1))/2+M
RM=VNP*R(MJ)+VNQ*X(MJ)
DHQ=2.*DP*RM
QX= DHQ-DL*VNP
DHQ=2.*VT*X(MJ)
DIQ=QX/DHQ
DHQ=DIQ*VNQ
QX=DP-DHQ
DIP=QX/VNP
75 HP(M)=HP(M)+DIP*.4
HQ(M)=HQ(M)+DIQ*.4
IF(ID-1)6,16,51
51 KCPM=0.
KQCM=0.
IQ=1
DO 99 KF=1,MA
IA=JA(KF)
IF(IA-M)99,66,99
66 TRK=TR(KF)
IQ=2
JN=JB(KF)
DL=TRK-1.
BL=TRK+1.
RE=DL*GT(KF)
VOP=VP(JN)
VOQ=VQ(JN)

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RM=BL*VNQ
BQ=BL*VNP
HCPM=RE*(RM-VQO)+HCPM
HCQM=-RE*(BQ-VOP)+HCQM
HCPT=-RE*VNQ
HCQT=RE*VNP
HP(JN)=HP(JN)+HCPT-HCP(JN)
HQ(JN)=HQ(JN)+HCQT-HCQ(JN)
HCP(JN)=HCPT
HCQ(JN)=HCQT
99 CONTINUE
GO TO (16,69),IQ
69 HQ(M)=HQ(M)+HCQM-HCQ(M)
HP(M)=HP(M)+HCPM-HCP(M)
HCP(M)=HCPM
HCQ(M)=HCQM
16 CONTINUE
40 CONTINUE
100 FORMAT (F15.0,F15.0,F15.0,F15.0,F15.0)
104 FORMAT (39H      I      ACT. VOLT      REACT. VOLT)
105 FORMAT (15,1XF18.8,F18.8,F18.8)
106 FORMAT (14,1XF14.6)
107 FORMAT (24H      I      TRANSFORMER)
127 FORMAT (15,15,F15.0,F15.0)
DO 12KF=1,MA
M=JA(KF)
IX=1
28 VNP=VP(M)
VNQ=VQ(M)
HCQT=VS(M)
RM=DVA(M)
VT=VNP*VNP+VNQ*VNQ
TRK=TR(KF)
DHQ=HCQT*HCQT
RT=HCQT+RM
VM=RT*RT
DQ=.4
GO TO (30,31),IX
30 IF(VT-DHQ)21,61,21
21 IF(VT-VM)52,52,43
43 IY=1
GO TO 82
52 DV=VM-VT
IF(DV-.04)53,53,54
53 IY=2
GO TO 82
54 RT=HCQT-RM
VM=RT*RT
IF(VT-VM)77,77,59
77 IY=3

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GO TO 82
59 DV=VT-VM
  IF(DV-.04)60,60,61
60 IY=4
  GO TO 82
61 IY=5
62 DL=VT
  N=JB(KF)
  IX=2
  GO TO 28
31 DV=VT-DL
  IW(KF)=IY
  RE=DV*DV
  IF(RE-.000001)63,63,92
92 IF(VT-DL)65,63,62
63 GO TO (12,12,12,12,73),IY
65 GO TO (78,97,74,74,73),IY
97 IF(VT-HCQT)73,12,12
62 GO TO (74,74,78,93,73),IY
93 IF(VT-HCQT)12,12,73
73 RM=DHQ
  GO TO 83
73 DQ=.008
74 RM=DL
83 DL=RM*TRK/VT
  TRO=TRK+(DL-TRK)*DQ
  IF(TRO-1.157895)56,55,55
55 IF(TRK-1.157895)90,12,90
90 TRO=1.157895
  GO TO 58
56 IF(TRO-.857143)57,57,58
57 IF(TRK-.857143)76,12,76
76 TRO=1.157895
58 RM=TRK-TRO
  RE =RM*RM
  IF(RE-.00000001)12,12,84
84 TR(KF)=TRO
  IC=1
  IF(SENSE SWITCH 1)98,12
98 PRINT 105, ID, TRO
12 CONTINUE
  IF(IC)42,18,42
18 PRINT 127, ID
  PRINT 107
  DO 23 K=1, MA
  PRINT 105, K, TR(K)
23 PUNCH 106, IW(K), TR(K)
  PRINT 104
  DO 17 M=2, N
17 PRINT 105, M, VP(M), VQ(M)
  STOP
  END

```


APPENDIX 4

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C   ACTUAL VOLTAGE SOLUTION
    DIMENSION HCP(6),HCQ(6),GT(2),VP(6),VQ(6),DVA(6)
    DIMENSION SX(6),SM(6),VS(6),TR(2),JA(2),JB(2)
    DIMENSION G(6),B(6),PG(6),IW(6),R(21),X(21),HP(6),HQ(6)
    READ 127,N,MA
    READ 100,VP(1),VQ(1)
    DO 13 J=2,N
13  READ 100,PG(J),SX(J),SM(J)
    DO 10 J=1,N
10  READ 100,VS(J),DVA(J)
    DO 20 K=1,MA
    TR(K)=1.
20  READ 127,JA(K),JB(K),GT(K)
    DO 19 J=1,N
    READ 100,G(J),B(J)
    HCQ(J)=0.
    HCP(J)=0.
    HP(J)=G(J)
19  HQ(J)=B(J)
    DO 11 M=2,N
    DO 11 K=2,M
    MJ=(M*(M-1))/2+K
11  READ 100,R(MJ),X(MJ)
    ID=0
42  IC=0
    DO 40 I=1,8
    ID=10+I
    DO 16 M=2,N
    VNP=0.
    VNQ=0.
    DO 15 J=2,N
    IF(J-M)26,26,25
25  MJ=(J*(J-1))/2+M
    GO TO 27
26  MJ=(M*(M-1))/2+J
27  DL=HP(J)
    RM=HQ(J)
    QX=R(MJ)
    DQ=X(MJ)
    VMQ=DL*DQ+RM*QX+VNQ
15  VNP=DL*QX-RM*DQ+VNP
    VP(M)=VNP
    VQ(M)=VNQ
    VT=VNP*VNP+VNQ*VNQ
    DL=HP(M)-G(M)-HCP(M)
    RM=HQ(M)-B(M)-HCQ(M)
    SP=VNP*DL+VNQ*RM
    SQ=-VNQ*DL+VNP*RM
    DP=PG(M)-SP
    QX=SX(M)

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DQ=QX-SQ
DHQ=DQ*DQ
BQ=SN(M)
RM=VS(M)
DL=RM*RM
  IF(QX-BQ)46,32,46
32 IF(DHQ-.00000001)14,14,33
46 IF(SQ-QX)47,47,45
47 IF(DHQ-.000016)34,34,43
45 IC=i
34 IF(VT-DL)50,14,14
48 DQ=BQ-SQ
  DHQ=DQ*DQ
  IF(SQ-BQ)35,49,49
49 IF(DHQ-.000016)36,36,50
35 IC=1
36 IF(VT-DL)14,14,50
33 IC=1
14 DIP=(DP*VNP-DQ*VNQ)/VT
  DIQ=(DP*VNQ+DQ*VNP)/VT
  GU TU 75
50 DL=DL-VT
  MJ=(M*(M-1))/2+M
  RM=VNP*R(MJ)+VNQ*X(MJ)
  DHQ=2.*DP*RM
  QX=DHQ-DL*VNP
  DHQ=2.*VT*X(MJ)
  DIQ=QX/DHQ
  DHQ=DIQ*VNQ
  QX=DP-DHQ
  DIP=QX/VNP
75 HP(M)=HP(M)+DIP*.4
  HQ(M)=HQ(M)+DIQ*.4
  IF(ID-1)16,16,51
51 HCPM=0.
  HCQM=0.
  IQ=1
  OO 99 KF=1,MA
  IA=JA(KF)
  IF(IA-M)99,66,99
66 TRK=TR(KF)
  IQ=2
  JN=JB(KF)
  DL=TRK-1.
  BL=TRK+1.
  RE=DL*GT(KF)
  VOP=VP(JN)
  VOQ=VQ(JN)
  RM=BL*VNQ
  BQ=BL*VNP

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HCPM=RE*(RM-VQO)+HCPM
HCQM=-RE*(BQ-VOP)+HCQM
HCPT=-RE*VNO
HCQT=RE*VNP
HP(JN)=HP(JN)+HCPT-HCP(JN)
HJ(JN)=HJ(JN)+HCQT-HCQ(JN)
HCP(JN)=HCPT
HCQ(JN)=HCQT
99 CONTINUE
GO TO (16,69),IQ
69 HJ(M)=HJ(M)+HCQM-HCQ(M)
HP(M)=HP(M)+HCPM-HCP(M)
HCP(M)=HCPM
HCQ(M)=HCQM
16 CONTINUE
40 CONTINUE
100 FCRMAT (F15.0,F15.0,F15.0,F15.0,F15.0)
104 FCRMAT (39H 1 ACT. VOLT REACT. VOLT)
105 FCRMAT (15,1XF18.8,F18.8,F18.8)
106 FCRMAT (14,1XF14.6)
107 FCRMAT (24H 1 TRANSFORMER)
127 FCRMAT (15,15,F15.0,F15.0)
IF(IQ-5)28,28,30
28 DO 12 KF=1,MA
READ 109, IW(KF),TR(KF)
IY=IW(KF)
TRO=TR(KF)
IF(TRO-1.157895)56,12,12
56 IF(TRO-.857143)12,12,67
67 TP=95.
DL=1.157895
RE=.857143
OO 88 J=1,5
TS=90.
DO 89L=1,31
RM=TS/TP
IF(RM-TRO)81,86,84
81 IF(RM-RE)58,58,79
79 RE=RM
GO TO 58
84 IF(RM-RE)58,58,58
85 DL=RM
58 TS=TS+10./15.
89 CONTINUE
TP=TP+2.5
88 CONTINUE
GO TO (94,94,95,95,95),IY
95 TRO=RE
GO TO 86
94 TRO=DL

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```

86 TR(KF)=TRO
   IC=1
12 CONTINUE
30 IF(IC)42,18,42
18 DO 43 K=1,MA
   PUNCH 103,JA(K),JB(K),TR(K)
43 PRINT 101,K,TR(K)
   PRINT 102
   DO 52 M=2,N
   PRINT 105,M,VP(M),VQ(M)
52 PUNCH 108,VP(M),VQ(M)
101 FORMAT ( /12H TRANSFORMER ,14,5XF12.8)
102 FORMAT(/44H      I      ACTIVE VOLT      REACTIVE VOLT
)
103 FORMAT (14,1X14,1XF14.6)
108 FORMAT (F14.6,1XF14.6)
109 FORMAT(15,F15.0)
   STOP
   ENO

```

APPENDIX 5

```

C      OUT PUT PROGRAMME
      DIMENSION A(21),B(21),VP(6),VQ(6)
      READ 101,N,KF,KN
      DO 10 M=1,KN
10     READ 100,A(M),B(M)
      DO 12 M=1,N
12     READ 100,VP(M),VQ(M)
      DO 13 M=1,KF
      READ 100,JA,JB,TR
      IF (TR-1.)14,13,14
14     IF (JA-JB)32,32,33
33     JAB=(JA*(JA-1))/2+JB
      GO TO 15
32     JAB=(JB*(JB-1))/2+JA
15     JAA=(JA*(JA-1))/2+JA
      B(JAA)=-TR*TR*B(JAB)+B(JAA)+B(JAB)
      B(JAB)=TR*B(JAB)
13     CONTINUE
      PRINT 102
      PLOS=0.
      DO 23 M=1,N
      HP=0.
      HQ=0.
      DO 24 J=1,N
      IF (J-M)25,25,26
26     MJ=(J*(J-1))/2+M
      GO TO 27
25     MJ=(M*(M-1))/2+J
27     DL=VP(J)
      RM=VQ(J)
      QX=A(MJ)
      DQ=B(MJ)
      HP=DL*QX-RM*DQ+HP
24     HQ=DL*DQ+RM*QX+HQ
      DL=VP(M)
      RM=VQ(M)
      DH=DL*DL+RM*RM
      VT=SQRT(DH)
      AG=ATAN(RM/DL)
      ANG=100.*AG/3.14159
      PI=DL*HP+RM*HQ
      QI=-RM*HP+DL*MQ
      PLOS=PLOS+PI
23     PRINT 105,M,VT,ANG,PI,QI
      PRINT 104,PLOS
      PRINT 106
28     READ 100,K,J,TR,CT,YZ

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```

M=(J*(J-1))/2+K
PJ=VF(J)
PK=VP(K)
QJ=VQ(J)
QK=VQ(K)
IF(CT)34,41,42
41 TO=TR
GO TO 35
42 TO=1./TR
GO TO 35
34 TO=1.
35 DQ1=(QJ-QK)*A(M)
DP1=(PJ-PK)*A(M)
DQ2=(QK/TO-QJ)*B(M)
DP2=(PK/TO-PJ)*B(M)
PL1=(DP1+DQ2)*PK-(DP2-DQ1)*QK
QL1=(-DP1-DQ2)*QK-(DP2-DQ1)*PK+(PK*PK+QK*QK)*YZ
DQ2=(QJ*TO-QK)*B(M)
DP2=(PJ*TO-PK)*B(M)
PL2=(-DP1+DQ2)*PJ-(DP2+DQ1)*QJ
QL2=(DP1-DQ2)*QJ-(DP2+DQ1)*PJ+(PJ*PJ+QJ*QJ)*YZ
PRINT107,K,J,PL1,QL1,PL2,QL2
GO TO 28
100 FORMAT (F15.0,F15.0,F15.0,F15.0)
101 FORMAT (15,15,15)
102 FORMAT(40H I VOLT(MAG) DEGREES P. Q.
/)
104 FORMAT(/13H TOTAL LOSS = ,F0.5///)
105 FORMAT(3X14,F11.6,F11.5,F11.5,F11.5)
106 FORMAT(47H I - J P(I-J) Q(I-J) P(J-I) Q(J-I)
/)
107 FORMAT(14,14,F10.6,F10.6,F10.6,F10.6)
108 FORMAT(15,15,F15.0,F15.0,F15.0)
END

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98.

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