

รายการอ้างอิง



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สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก

สถาบันวิทยบริการ
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ภาคผนวก ก

รายละเอียดของโปรแกรมคอมพิวเตอร์ INCF

โปรแกรมคอมพิวเตอร์ INCF ที่ถูกประดิษฐ์ขึ้นในบทที่ 6 มีรายละเอียดดังต่อไปนี้

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C
C PROGRAM INCF
C
C A FINITE ELEMENT COMPUTER PROGRAM FOR SOLVING STEADY-STATE
C TWO-DIMENSIONAL VISCOUS INCOMPRESSIBLE FLOWS.
C
C PRECONDITIONED CGNR USED TO SOLVE SYSTEM OF LINEAR EQUATIONS
C
C THE VALUES DECLARED IN THE PARAMETER STATEMENT BELOW SHOULD
C BE ADJUSTED ACCORDING TO THE SIZE OF THE PROBLEMS AND TYPES
C OF COMPUTERS:
C
C   MXPOIV  = MAXIMUM NUMBER OF VELOCITY NODES IN THE MODEL
C           = MAXIMUM NUMBER OF TEMPERATURE NODES IN THE MODEL
C   MXPOIP  = MAXIMUM NUMBER OF PRESSURE NODES IN THE MODEL
C   MXELE   = MAXIMUM NUMBER OF ELEMENTS IN THE MODEL
C   MXFREE  = MAXIMUM NUMBER OF OUTFLOW BOUNDARY (SPECIFY PRESSURE)
C   MXFLUX  = MAXIMUM NUMBER OF HEATED BOUNDARY (SPECIFY HEAT FLUX)
C   MXLINK  = MAXIMUM NUMBER OF ELEMENTS THAT USE THE SAME NODE
C   NMAX    = MAXIMUM NUMBER OF NON-ZERO COEFFICIENTS
C   ITMAX   = MAXIMUM ITERATIONS FOR CGNR (INTERNAL LOOP)
C
C   PARAMETER (MXPOIV=961, MXPOIP=256, MXELE=450, MXFREE=1,
C             *   MXFLUX= 48, MXLINK= 9 )
C   PARAMETER (NMAX=500000, ITMAX=50000 )
C   PARAMETER (MXNEQ=3*MXPOIV+MXPOIP)
C
C   IMPLICIT REAL*8 (A-H,O-Z)
C
C   DIMENSION COORD(MXPOIV,2), TEXT(20)
C   DIMENSION UVEL(MXPOIV), VVEL(MXPOIV), TEMP(MXPOIV), PRES(MXPOIV)
C   DIMENSION FLUX(MXPOIV)
C   DIMENSION B(MXNEQ), BN(MXNEQ), AAS(MXNEQ)
C   DIMENSION AKELE(21,21,MXELE), RELE(21,MXELE)
C   DIMENSION ICOUNT(MXPOIV), IASSEM(MXPOIV,MXLINK)
C   DIMENSION SOL(MXNEQ), DSOL(MXNEQ)
C   DIMENSION P(MXNEQ), R(MXNEQ), Z(MXNEQ), Q(MXNEQ)
C   DIMENSION SA(NMAX), SB(NMAX), SC(NMAX)
C   CHARACTER*20 NAME1, NAME2, NAME3, NAME4
C
C   INTEGER IJA(NMAX), IJB(NMAX), IJC(NMAX)
C   INTEGER INTMAT(MXELE,6), INTOUT(MXFREE,4), INTFLUX(MXFLUX,4)
C   INTEGER IBCU(MXPOIV), IBCV(MXPOIV), IBCT(MXPOIV), IBCP(MXPOIV)
C
C 10 WRITE(6,20)
C 20 FORMAT(/, ' PLEASE ENTER THE INPUT FILE NAME:', /)
C   READ(5,(A),ERR=10) NAME1
C   OPEN(UNIT=7, FILE=NAME1, STATUS='OLD', ERR=10)
C   OPEN(UNIT=9, FILE='CHECK.OUT', STATUS='NEW')
C
C   READ TITLE OF COMPUTATION:
C
C   READ(7,*) N LINES
C   DO 30 ILINE=1,N LINES
C     READ(7,35) TEXT
C 35  FORMAT(20A4)
C 30  CONTINUE
C
C   READ INPUT DATA:
C
C   READ(7,35) TEXT
C   WRITE(9,45)
C 45  FORMAT(' NPOIV NPOIP NELEM NFREE NFLUX NITER  TOL')
C     READ(7,*) NPOIV, NPOIP, NELEM, NFREE, NPLUX, NITER, TOL
C     WRITE(9,55) NPOIV, NPOIP, NELEM, NFREE, NPLUX, NITER, TOL
C 55  FORMAT(8I8, F8.2)
C     IF(NPOIV.GT.MXPOIV) WRITE(6,65) NPOIV
C 65  FORMAT(/, ' PLEASE INCREASE THE PARAMETER MXPOIV TO',15)
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IF(NPOIV.GT.MXPOIV) STOP
IF(NPOIP.GT.MXPOIP) WRITE(6,75) NPOIP
75 FORMAT(/, ' PLEASE INCREASE THE PARAMETER MXPOIP TO',15)
IF(NPOIP.GT.MXPOIP) STOP
IF(NELEM.GT.MXELE) WRITE(6,85) NELEM
85 FORMAT(/, ' PLEASE INCREASE THE PARAMETER MXELE TO',15)
IF(NELEM.GT.MXELE) STOP
IF(NFREE.GT.MXFREE) WRITE(6,95) NFREE
95 FORMAT(/, ' PLEASE INCREASE THE PARAMETER MXFREE TO',15)
IF(NFREE.GT.MXFREE) STOP
IF(NFLUX.GT.MXFLUX) WRITE(6,105) NFLUX
105 FORMAT(/, ' PLEASE INCREASE THE PARAMETER MXFLUX TO',15)
IF(NFLUX.GT.MXFLUX) STOP
C
C READ FLUID PROPERTIES:
C
READ(7,35) TEXT
WRITE(9,115)
115 FORMAT(' DENSITY VISCOSITY THERM EXP SPBC CV',
* ' THERM CON REF TEMP GRAVITY')
READ(7,*) DEN, VIS, TEXP, CV, TCON, TREF, GRA
VIS = VIS/1000.
TEXP = TEXP/1000.
CV = CV*1000.
WRITE(9,125) DEN, VIS, TEXP, CV, TCON, TREF, GRA
125 FORMAT(7F10.3)
C
C READ NODAL COORDINATES, BOUNDARY CONDITIONS, THEIR VALUES:
C
C REQUIREMENT: MAIN NODES MUST BE NUMBERED FIRST
C
READ(7,35) TEXT
WRITE(9,135) NPOIV
135 FORMAT(' NODAL INFORMATION (NODE NO., U-V-T-P BC, X-Y COORD,',
* ' U-V-T-P VALUES): (', 14, ')' )
DO 150 IP=1,NPOIV
READ(7,*) I, IBCU(I), IBCV(I), IBCT(I), IBCP(I),
* (COORD(I,K), K=1,2), UVEL(I), VVEL(I),
* TEMP(I), PRES(I), FLUX(I)
WRITE(9,145) I, IBCU(I), IBCV(I), IBCT(I), IBCP(I),
* (COORD(I,K), K=1,2), UVEL(I), VVEL(I),
* TEMP(I), PRES(I), FLUX(I)
145 FORMAT(14, 4I9, 7E10.4)
IF(LINE.IP) WRITE(6,155) IP
155 FORMAT(/, ' NODE NO.', 15, ' IN DATA FILE IS MISSING')
IF(LINE.IP) STOP
150 CONTINUE
C
C READ ELEMENT NODAL CONNECTIONS:
C
READ(7,35) TEXT
WRITE(9,165) NELEM
165 FORMAT(' ELEMENT NODAL CONNECTIONS: (', 14, ')' )
DO 180 IE=1,NELEM
READ(7,*) I, (INTMAT(I,J), J=1,6)
WRITE(9,175) I, (INTMAT(I,J), J=1,6)
175 FORMAT(7I8)
IF(LINE.IE) WRITE(6,185) IE
185 FORMAT(/, ' ELEMENT NO.', 15, ' IN DATA FILE IS MISSING')
IF(LINE.IE) STOP
180 CONTINUE
C
C READ OUTFLOW BOUNDARY INFORMATION:
C
READ(7,35) TEXT
WRITE(9,195) NFREE
195 FORMAT(' OUTFLOW INFORMATION (NO., 3 NODE NO.): (',
* ' 14, ')' )
IF (NFREE.NE.0) THEN
DO 210 IB=1,MXFREE
READ(7,*) (INTOUT(IB,J), J=1,4)
WRITE(9,205) (INTOUT(IB,J), J=1,4)
205 FORMAT(4I8)
IF(INTOUT(IB,1).NE.IB) WRITE(6,215) IB
215 FORMAT(/, ' OUTFLOW INFORMATION NO.', 15, ' IN DATA FILE IS',
* ' MISSING')
210 CONTINUE
ENDIF
C
C READ SPECIFIED HEAT FLUX BOUNDARY INFORMATION:
C
READ(7,35) TEXT
WRITE(9,225) NFLUX
225 FORMAT(' SPECIFIED HEAT FLUX INFORMATION (NO., 3 NODE NO.): (',
* ' 14, ')' )
IF (NFLUX.NE.0) THEN
DO 240 IB=1,MXFLUX

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      READ(7,*) (INTFLUX(IB,J),J=1,4)
      WRITE(9,205) (INTFLUX(IB,J),J=1,4)
      IF(INTFLUX(IB,1).NE.IB) WRITE(6,235) IB
235  FORMAT(/, ' SPECIFIED HEAT FLUX INFORMATION NO.', I5, ' IN DATA'
      *      ' FILE IS MISSING')
240  CONTINUE
      ENDIF
C
      WRITE(6,300) NPOIV, NPOIV, NPOIP, NELEM, NFREE, NITER, TOL
300  FORMAT(' THE FINITE ELEMENT MODEL CONSISTS OF:', /,
      *      ' NUMBER OF VELOCITY NODES      =, I6, /,
      *      ' NUMBER OF TEMPERATURE NODES   =, I6, /,
      *      ' NUMBER OF PRESSURE NODES      =, I6, /,
      *      ' NUMBER OF ELEMENTS            =, I6, /,
      *      ' NUMBER OF OUTFLOW BOUNDARY    =, I6, /,
      *      ' WITH NUMBER OF ITERATIONS REQUIRED =, I6, /,
      *      ' OR SPECIFIED STOPPING TOLERANCE =, F6.2 )
C
      DO 400 I=1,NPOIV
      SOL(I ) = UVEL(I)
      SOL(I+NPOIV) = VVEL(I)
      SOL(I+NPOIV+NPOIV) = TEMP(I)
400  CONTINUE
C
      DO 410 I=1,NPOIP
      SOL(I+NPOIV+NPOIV+NPOIV) = PRES(I)
410  CONTINUE
C
      NEQ = 3*NPOIV + NPOIP
C
      CALL COUNT(INTMAT, ICOUNT, IASSEM, MXPOIV, MXELE, MXLINK)
C
C  ENTER ITERATION LOOP:
C
      DO 500 ITER=1,NITER
C
      RESET THE SYSTEM EQUATIONS
C
      DO 510 I=1,21
      DO 510 J=1,21
      DO 510 K=1,MXELE
      AKELE(I,J,K) = 0.
510  CONTINUE
C
      DO 520 I=1,21
      DO 520 J=1,MXELE
      RELE(I,J) = 0.
520  CONTINUE
C
      DO 530 I=1,NMAX
      SA(I) = 0.
      SB(I) = 0.
      SC(I) = 0.
      HA(I) = 0
      HB(I) = 0
      HC(I) = 0
530  CONTINUE
C
C  FIND REFERENCE TEMPERATURE:
C
      TMAX = SOL(2*NPOIV+1)
      TMIN = TMAX
      DO 540 J=2*NPOIV+1,3*NPOIV
      IF (SOL(J).GT.TMAX) THEN
      TMAX = SOL(J)
      ENDIF
      IF (SOL(J).LT.TMIN) THEN
      TMIN = SOL(J)
      ENDIF
540  CONTINUE
      TREF = (TMAX + TMIN)/2.
C
      WRITE(6,545) ITER
545  FORMAT(/, 3X, ' * PERFORMING COMPUTATION AT ITERATION NUMBER',
      *      I3, ':')
C
C  ESTABLISH ELEMENT MATRICES AND ASSEMBLE ELEMENT EQUATIONS
C
      WRITE(6,555)
555  FORMAT(8X, ' ESTABLISHING ELEMENT MATRICES AND',
      *      ' ASSEMBLING ELEMENT EQS.')
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C
      CALL TRI( MXPOIV, MXELE, MXNEQ, DEN, VIS, TEXP,
      *      CV, TCON, TREF, GRA, COORD, INTMAT,
      *      AKELE, RELE, SOL, IBCU, IBCV, IBCT, IBCP )
C
C  ASSEMBLE THE SYSTEM STIFFNESS MATRIX
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C AND CHANGE TO SPARSE STORAGE FORMAT
C
C FIND TRANSPOSE OF STIFFNESS MATRIX
C
      IJB(1) = NEQ + 2
      K = NEQ + 1
C
      DO 560 IJ=1,MXNEQ
      CALL ASSEMA( INTMAT, AKELE, AAS, 1, MXPOIV, MXNEQ, MXELE,
      *           ICOUNT, IASSEM, IJ, MXLINK )
C
C CREAT ROW SPARSE STORAGE OF A
C
      CALL SPRSIN( AAS, NEQ, NMAX, K, IJ, SB, IJB )
560 CONTINUE
C
C ASSEMBLE THE RESIDUALS MATRICES TO FORM SYSTEM RESIDUALS:
C
      WRITE(6,565)
565 FORMAT(8X, ' ASSEMBLING THE SYSTEM RESIDUALS VECTOR' )
C
      CALL ASSEMR( MXPOIV, MXELE, MXNEQ, INTMAT, RELE, B )
C
      IF (NFREE.NE.0) THEN
      CALL FORCE( B, COORD, INTOUT, PRES, MXPOIV,
      *         MXNEQ, MXFREE, DEN )
      ENDIF
C
      IF (NFLUX.NE.0) THEN
      CALL HEATFLUX( B, COORD, INTFLUX, FLUX, MXPOIV, MXNEQ,
      *             MXFLUX, DEN, CV )
      ENDIF
C
C SOLVE A SET OF SIMULTANEOUS EQUATIONS FOR NODAL INCREMENTS:
C
      WRITE(6,570)
570 FORMAT(8X, ' SOLVING SET OF SIMULTANEOUS EQS. FOR',
      *     ' NODAL INCREMENTS' )
C
      DO 580 I=1,NEQ
      BN(I) = 0.0
580 CONTINUE
C
      DO 590 I=1,NEQ
      P(I) = 0.0
      R(I) = 0.0
      Z(I) = 0.0
      Q(I) = 0.0
590 CONTINUE
C
C CHANGE A*X=B TO AT*A*X-AT*B ( NORMAL EQUATIONS )
C
C FIND AT*A
C
      WRITE(6,*) ' FIND AT*A '
      CALL SPRSTM( SB, IJB, SB, IJB, NMAX, SC, IJC )
C
C FIND AT*B
C
      WRITE(6,*) ' FINE AT*B '
      CALL SPRSAX( SB, IJB, B, BN, NEQ, NMAX )
C
C APPLY CONJUGATE GRADIENT METHOD TO NORMAL EQUATION
C
      WRITE(6,600) MXNEQ
600 FORMAT(8X, ' ( TOTAL OF, 15, EQUATIONS TO BE SOLVED )')
      WRITE(6,*) ' APPLYING CONJUGATE GRADIENT METHOD '
      CALL PCGNR( NEQ, SC, IJC, BN, MXNEQ, P, R, Z, Q, DSOL,
      *         ITMAX, NMAX )
C
C CHECK FOR CONVERGENCE:
C
      UP = 0.
      DOWN = 0.
      DO 610 I=1,NEQ
      ERROR = DSOL(I)
      UP = UP + ABS(ERROR)
      VALUE = SOL(I)
      DOWN = DOWN + ABS(VALUE)
610 CONTINUE
C
      RATIO = UP*100./DOWN
      WRITE(6,615) RATIO
615 FORMAT(8X, 'CURRENT SOLUTION HAS GLOBAL ERROR OF',
      *     ' F8.2, ' %')
      WRITE(6,625) ITER, RATIO
625 FORMAT(8X, 'ITERATION NO.', 15, ' HAS GLOBAL ERROR OF',

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      * F8.2, ' #')
      IF(RATIO.GT.TOL) GO TO 650
C
C SOLUTION CONVERGED WITHIN THE SPECIFIED TOLERANCE
C
      WRITE(6,635)
      635 FORMAT(/, 3X, ' *** SOLUTION CONVERGED WITHIN SPECIFIED',
      * ' TOLERANCE ***', //)
      GO TO 700
      650 CONTINUE
C
C UPDATE NODAL SOLUTIONS:
C
      DO 660 I=1,NEQ
      SOL(I) = SOL(I) + DSOL(I)
      660 CONTINUE
      500 CONTINUE
C
C SOLUTION NOT CONVERGED WITHIN THE SPECIFIED TOLERANCE
C
      WRITE(6,665)
      665 FORMAT(/, 3X, ' ??? SOLUTION NOT CONVERGED WITHIN',
      * ' SPECIFIED TOLERANCE ???', //)
C
      700 CONTINUE
      WRITE(9,705) TREF
      705 FORMAT(6X, 'REFERENCE TEMPERATURE = ', F7.4)
C
C PRINT OUT SOLUTIONS OF NODAL VELOCITIES, TEMPERATURES
C AND PRESSURES:
C
      710 WRITE(6,715)
      715 FORMAT(' PLEASE ENTER FILE NAME FOR SOLUTIONS:', /)
      READ(5, '(A)', ERR=710) NAME2
      OPEN(UNIT=8, FILE=NAME2, STATUS='NEW', ERR=710)
      WRITE(8,725) NPOIV
      725 FORMAT(' NODAL SOLUTIONS [', 14, ']:',
      * //, 2X, 'NODE', 6X, 'U-VELOCITY', 6X, 'V-VELOCITY',
      * 6X, 'TEMPERATURE', 6X, 'PRESSURE', /)
C
C ROUND-OFF SOLUTION VALUES FOR NEAT OUTPUT:
C
      ROFF = 1.E-6
      DO 730 IEQ=1,NEQ
      VALUE = SOL(IEQ)
      IF(ABS(VALUE).LT.ROFF) SOL(IEQ) = 0.
      730 CONTINUE
C
      DO 740 IP=1,NPOIP
      IEQU = IP
      IEQV = NPOIV + IP
      IEQT = 2*NPOIV + IP
      IEQP = 3*NPOIV + IP
      WRITE(8,735) IP, SOL(IEQU), SOL(IEQV), SOL(IEQT), SOL(IEQP)
      735 FORMAT(16, 4E16.6)
      740 CONTINUE
C
      DO 750 IP=NPOIP+1,NPOIV
      IEQU = IP
      IEQV = NPOIV + IP
      IEQT = 2*NPOIV + IP
      WRITE(8,755) IP, SOL(IEQU), SOL(IEQV), SOL(IEQT)
      755 FORMAT(16, 3E16.6)
      750 CONTINUE
C
C CREATE DATA NASTRAN GRAPHIC FOR OUTPUT:
C
      800 WRITE (8,805)
      805 FORMAT(' PLEASE ENTER FILE NAME OUTPUT DATA FOR NASTRAN:', /)
      READ(5, '(A)', ERR = 800) NAME3
      OPEN(UNIT = 13, FILE=NAME3, STATUS='NEW', ERR=800)
      WRITE(13,815)
      815 FORMAT('1MSC/NASTRAN PAGE')
      WRITE(13,825)
      825 FORMAT('0')
      WRITE(13,835)
      835 FORMAT(' D I S P L A C E M E N T')
      WRITE(13,845)
      845 FORMAT(' POINT ID. TYPE')
      DO 860 I = 1, NPOIP
      IEQU = I
      IEQV = NPOIV+I
      IEQT = 2*NPOIV+I
      IEQP = 3*NPOIV+I
      WRITE(13,855) I, SOL(IEQU), SOL(IEQV), SOL(IEQT), SOL(IEQP)
      855 FORMAT(112,4X,'G',1X,E12.6,1X,E12.6,10X,'0.0',1X,E12.5,1X,E12.5,
      *10X,'0.0')

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860 CONTINUE
C
  WRITE(13,865)
865 FORMAT('1')
C
900 WRITE (6,905)
905 FORMAT(' PLEASE ENTER FILE NAME VELOCITY DATA FOR NASTRAN:', /)
  READ(5,'(A)', ERR = 900) NAME4
  OPEN(UNIT = 14,FILE=NAME4, STATUS='NEW',ERR=900)
  WRITE(14,915)
915 FORMAT('1MSC/NASTRAN PAGE')
  WRITE(14,925)
925 FORMAT('0')
  WRITE(14,935)
935 FORMAT(' D I S P L A C E M E N T')
  WRITE(14,945)
945 FORMAT(' POINT ID. TYPE')
  DO 960 I = 1, NPOIV
    IEQU = I
    IEQV = NPOIV+I
    IEQT = 2*NPOIV+I
    WRITE(14,955) I, SOL(IEQU), SOL(IEQV), SOL(IEQT)
955 FORMAT(112,4X,'G',1X,E12.5,1X,E12.5,10X,'0.0',1X,E12.5,2(10X,'0.0
  *'))
960 CONTINUE
C
  WRITE(14,965)
965 FORMAT('1')
  STOP
  END
C
C-----
C
SUBROUTINE COUNT( INTMAT, ICOUNT, IASSEM, MXPOIV, MXELE, MXLINK )
DIMENSION INTMAT(MXELE,6), ICOUNT(MXPOIV), IASSEM(MXPOIV,MXLINK)
DO 10 I=1,MXPOIV
  ICOUNT(I) = 0
10 CONTINUE
C
DO 100 I=1,MXELE
  DO 200 J=1,6
    N = INTMAT(I,J)
    ICOUNT(N) = ICOUNT(N) + 1
    IC = ICOUNT(N)
    IF(IC.GT.MXLINK) WRITE(*,125) IC
125 FORMAT(/,' PLEASE INCREASE THE PARAMETER MXLINK TO',I5)
    IF(IC.GT.MXLINK) STOP
    IASSEM(N,IC) = 1
200 CONTINUE
100 CONTINUE
C
  RETURN
  END
C
C-----
C
SUBROUTINE APPLYBC( MXPOIV, MXELE, AKELE, RELE, INTMAT,
  IBCU, IBCV, IBCT, IBCP, IE )
C
C APPLY BOUNDARY CONDITIONS BEFORE SOLVING FOR NODAL INCREMENTS
C WITH CONDITION CODES OF:
C
C 0 = FREE TO CHANGE (INCREMENTS COMPUTED)
C 1 = FIXED AS SPECIFIED (INCREMENTS FIXED AS ZERO)
C
C IMPLICIT REAL*8 (A-H,O-Z)
C
C DIMENSION AKELE(21,21,MXELE), RELE(21,MXELE)
C DIMENSION INTMAT(MXELE,6)
C
C INTEGER IBCU(MXPOIV), IBCV(MXPOIV), IBCT(MXPOIV), IBCP(MXPOIV)
C
C APPLY BOUNDARY CONDITIONS FOR NODAL U-VELOCITIES:
C
DO 100 IEQ=1,6
  IEQU = INTMAT(IE,IEQ)
  IF(IBCUIEQU).EQ.0) GO TO 100
C
DO 110 IR=1,21
  IF(IR.EQ.IEQ) GO TO 110
  AKELE(IR,IEQ,IE) = 0.
110 CONTINUE
C
DO 120 IC=1,21
  AKELE(IEQ,IC,IE) = 0.
120 CONTINUE
C

```

```

      AKELE(IEQ,IEQ,IE) = 1.
      RELE(IEQ,IE) = 0.
C
100 CONTINUE
C
C   APPLY BOUNDARY CONDITIONS FOR NODAL V-VELOCITIES:
C
      DO 200 IEQ=1,6
      IEQV = INTMAT(IE,IEQ)
      IF(IBC(IEQV),EQ,0) GO TO 200
C
      DO 210 IR=1,21
      IF(IR,EQ,IEQ+6) GO TO 210
      AKELE(IR,IEQ+6,IE) = 0.
210 CONTINUE
C
      DO 220 IC=1,21
      AKELE(IEQ+6,IC,IE) = 0.
220 CONTINUE
C
      AKELE(IEQ+6,IEQ+6,IE) = 1.
      RELE(IEQ+6,IE) = 0.
C
200 CONTINUE
C
C   APPLY BOUNDARY CONDITIONS FOR NODAL TEMPERATURES:
C
      DO 300 IEQ=1,6
      IEQT = INTMAT(IE,IEQ)
      IF(IBC(IEQT),EQ,0) GO TO 300
C
      DO 310 IR=1,21
      IF(IR,EQ,IEQ+12) GO TO 310
      AKELE(IR,IEQ+12,IE) = 0.
310 CONTINUE
C
      DO 320 IC=1,21
      AKELE(IEQ+12,IC,IE) = 0.
320 CONTINUE
C
      AKELE(IEQ+12,IEQ+12,IE) = 1.
      RELE(IEQ+12,IE) = 0.
C
300 CONTINUE
C
C   APPLY BOUNDARY CONDITIONS FOR NODAL PRESSURES:
C
      DO 400 IEQ=1,3
      IEQP = INTMAT(IE,IEQ)
      IF(IBC(IEQP),EQ,0) GO TO 400
C
      DO 410 IR=1,21
      IF(IR,EQ,IEQ+18) GO TO 410
      AKELE(IR,IEQ+18,IE) = 0.
410 CONTINUE
C
      DO 420 IC=1,21
      AKELE(IEQ+18,IC,IE) = 0.
420 CONTINUE
C
      AKELE(IEQ+18,IEQ+18,IE) = 1.
      RELE(IEQ+18,IE) = 0.
C
400 CONTINUE
C
      RETURN
      END
C
-----
C
      SUBROUTINE ASSEMA( INTMAT, A, B, ITYPE, MXPOIV, MXNEQ, MXELE,
      *                ICOUNT, IASSEM, N, MXLINK )
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION A(21,21,MXELE), B(MXNEQ)
      DIMENSION INTMAT(MXELE,6), ICOUNT(MXPOIV), IASSEM(MXPOIV,MXLINK)
C
      RESET STIFFNESS MATRICES
C
      DO 10 I=1,MXNEQ
      B(I) = 0.
10 CONTINUE
C
      IF (N.LE.MXPOIV) THEN
      N1 = N
      NN = 0

```

```

ELSE
  IF ((N.GT.MXPOIV).AND.(N.LE.2*MXPOIV)) THEN
    N1 = N - MXPOIV
    NN = 1
  ELSE
    IF ((N.GT.2*MXPOIV).AND.(N.LE.3*MXPOIV)) THEN
      N1 = N - 2*MXPOIV
      NN = 2
    ELSE
      N1 = N - 3*MXPOIV
      NN = 3
    ENDIF
  ENDIF
ENDIF
IC = ICOUNT(N1)
C
C ASSEMBLE STIFFNESS MATRICES
C
  IF (ITYPE.EQ.0) THEN
C
C   ITYPE = 0; COMPUTE [A]
C
    DO 100 IE=1,IC
      IA = IASSEM(N1,IE)
      DO 30 I=1,6
        II = INTMAT(IA,I)
        IF (II.EQ.N1) THEN
C
          DO 40 J=1,6
            JJ = INTMAT(IA,J)
            K = J + 6
            KK = MXPOIV + JJ
            L = J + 12
            LL = 2*MXPOIV + JJ
            B(JJ) = B(JJ) + A(I+6*NN,J,IA)
            B(KK) = B(KK) + A(I+6*NN,K,IA)
            B(LL) = B(LL) + A(I+6*NN,L,IA)
          40 CONTINUE
C
          DO 50 J=1,3
            JJ = INTMAT(IA,J)
            K = J + 18
            KK = 3*MXPOIV + JJ
            B(KK) = B(KK) + A(I+6*NN,K,IA)
          50 CONTINUE
C
          ENDIF
        30 CONTINUE
      100 CONTINUE
C
    ELSE
C
C   ITYPE = 1; COMPUTE TRANPOSE OF [A]
C
      DO 200 IE=1,IC
        IA = IASSEM(N1,IE)
        DO 130 I=1,6
          II = INTMAT(IA,I)
          IF (II.EQ.N1) THEN
C
            DO 140 J=1,6
              JJ = INTMAT(IA,J)
              K = J + 6
              KK = MXPOIV + JJ
              L = J + 12
              LL = 2*MXPOIV + JJ
              B(JJ) = B(JJ) + A(I,I+6*NN,IA)
              B(KK) = B(KK) + A(K,I+6*NN,IA)
              B(LL) = B(LL) + A(L,I+6*NN,IA)
            140 CONTINUE
C
            DO 150 J=1,3
              JJ = INTMAT(IA,J)
              K = J + 18
              KK = 3*MXPOIV + JJ
              B(KK) = B(KK) + A(K,I+6*NN,IA)
            150 CONTINUE
C
            ENDIF
          130 CONTINUE
        200 CONTINUE
C
      ENDIF
    RETURN
  END
END
C

```

```

-----
C
C   SUBROUTINE ASSEMR( MXPOIV, MXELE, MXNEQ, INTMAT, RELE, B )
C
C   ASSEMBLE ELEMENT EQUATIONS INTO SYSTEM EQUATIONS
C
C   IMPLICIT REAL*8 (A-H,O-Z)
C
C   DIMENSION RELE(21,MXELE), B(MXNEQ)
C   DIMENSION INTMAT(MXELE,8)
C
C   RESET SYSTEM LOAD VECTOR
C
C   DO 100 I=1,MXNEQ
C     B(I) = 0.
100 CONTINUE
C
C   ASSEMBLING SYSTEM LOAD VECTOR
C
C   CONTRIBUTION OF VALUES ASSOCIATED WITH U & V VELOCITIES:
C
C   DO 500 IE=1,MXELE
C
C     DO 200 I=1,8
C       II = INTMAT(IE,I)
C       K = I + 8
C       KK = MXPOIV + II
C       B(II) = B(II) + RELE(I,IE)
C       B(KK) = B(KK) + RELE(K,IE)
200 CONTINUE
C
C   CONTRIBUTION OF VALUES ASSOCIATED WITH TEMPERATURE:
C
C   DO 300 I=1,6
C     II = INTMAT(IE,I)
C     K = I + 12
C     KK = 2*MXPOIV + II
C     B(KK) = B(KK) + RELE(K,IE)
300 CONTINUE
C
C   CONTRIBUTION OF VALUES ASSOCIATED WITH PRESSURE:
C
C   DO 400 I=1,3
C     II = INTMAT(IE,I)
C     K = I + 18
C     KK = 3*MXPOIV + II
C     B(KK) = B(KK) + RELE(K,IE)
400 CONTINUE
C
C   500 CONTINUE
C
C   RETURN
C   END
-----
C
C   SUBROUTINE SPRSIN( AAS, N, NMAX, K, IJ, SB, IJB )
C
C   IMPLICIT REAL*8 (A-H,O-Z)
C
C   DIMENSION AAS(N), SB(NMAX), IJB(NMAX)
C
C   CHANGE A(NP,NP) TO SB(NMAX):NONZERO ELEMENTS, IJB(NMAX):INDEX
C
C   SB(IJ) = AAS(IJ)
C
C   DO 10 J=1,N
C     IF (ABS(AAS(J)).GE.1E-16) THEN
C       IF (J.NE.IJ) THEN
C         K = K + 1
C         IF (K.GT.NMAX) PAUSE ' NMAX TOO SMALL IN SPRSIN'
C         SB(K) = AAS(J)
C         IJB(K) = J
C       ENDIF
C     ENDIF
10 CONTINUE
C
C   IJB(IJ+1) = K+1
C   RETURN
C   END
-----
C
C   SUBROUTINE SPRSTM( SA, IJA, SB, IJB, NMAX, SC, IJC )
C
C   IMPLICIT REAL*8 (A-H,O-Z)
C

```

```

      DIMENSION SA(NMAX), SB(NMAX), SC(NMAX)
      DIMENSION IJA(NMAX), IJB(NMAX), IJC(NMAX)
C
C SA, IJA FOR AT
C SB, IJB FOR A
C SC, IJC FOR AT*A
C
      K = 0
      IF (IJA(1).NE.IJB(1)) PAUSE 'SPRSTM SIZES DO NOT MATCH'
      K = IJA(1)
      IJC(1) = K
C
      DO 14 I=1,IJA(1)-2
C
      DO 13 J=1,IJB(1)-2
      IF (I.EQ.J) THEN
        SUM = SA(I)*SB(J)
      ELSE
        SUM = 0.D0
      ENDIF
      MB = IJB(J)
C
      DO 11 MA=IJA(I),IJA(I+1)-1
      IJMA = IJA(MA)
      IF (IJMA.EQ.J) THEN
        SUM = SUM + SA(MA)*SB(J)
      ELSE
        IF (MB.LT.IJB(J+1)) THEN
          IJMB = IJB(MB)
          IF (IJMB.EQ.I) THEN
            SUM = SUM + SA(I)*SB(MB)
            MB = MB + 1
            GOTO 2
          ELSE IF (IJMB.LT.IJMA) THEN
            MB = MB + 1
            GOTO 2
          ELSE IF (IJMB.EQ.IJMA) THEN
            SUM = SUM + SA(MA)*SB(MB)
            MB = MB + 1
            GOTO 2
          ENDIF
        ENDIF
      ENDIF
      ENDIF
      ENDIF
      CONTINUE
11
C
      DO 12 MBB=MB,IJB(J+1)-1
      IF (IJB(MBB).EQ.I) THEN
        SUM = SUM + SA(I)*SB(MBB)
      ENDIF
12
      CONTINUE
C
      IF (I.EQ.J) THEN
        SC(I) = SUM
      ELSE IF (ABS(SUM).GT.1E-16) THEN
        IF (K.GT.NMAX) PAUSE 'SPRSTM: NMAX TOO SMALL'
        SC(K) = SUM
        IJC(K) = J
        K = K + 1
      ENDIF
13
      CONTINUE
C
      IJC(I+1) = K
14
      CONTINUE
C
      WRITE(*,*) K
      RETURN
      END
C-----
C
      SUBROUTINE SPRSAX( SB, IJB, X, B, N, NMAX )
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION B(N), SB(NMAX), X(N), IJB(NMAX)
C
      IF (IJB(1).NE.N+2) PAUSE 'MISMATCHED VECTOR AND MATRIX IN SPRSAX'
C
      DO 11 I=1,N
      B(I) = SB(I)*X(I)
      DO 12 K=IJB(I),IJB(I+1)-1
      B(I) = B(I) + SB(K)*X(IJB(K))
12
      CONTINUE
11
      CONTINUE
C
      RETURN
      END

```

```

C
C-----
C
SUBROUTINE PCONR( N, SA, IJA, BN, MXNEQ, P, R, Z, Q, X,
*             ITMAX, NMAX )
C
  IMPLICIT REAL*8 (A-H,O-Z)
C
  DIMENSION SA(NMAX), IJA(NMAX), BN(MXNEQ)
  DIMENSION P(MXNEQ), R(MXNEQ), Q(MXNEQ), X(MXNEQ), Z(MXNEQ)
C
  ITER1 = 0
  TOL1 = 1.E-6
  DO 140 I=1,N
    X(I) = 0.0
140 CONTINUE
C
  CALL ATIMES( SA, IJA, X, R, N, NMAX )
C
  DO 150 J=1,N
    R(J) = BN(J) - R(J)
150 CONTINUE
C
  500 IF (ITER1.LE.ITMAX) THEN
    ITER1 = ITER1 + 1
    CALL ASOLVE( N, R, Z, SA, NMAX )
    BKNUM = 0.0
C
    DO 160 J=1,N
      BKNUM = BKNUM + Z(J)*R(J)
160 CONTINUE
C
    IF (ITER1.EQ.1) THEN
C
      DO 170 J=1,N
        P(J) = Z(J)
170 CONTINUE
C
      ELSE
        BK = BKNUM/BKDEN
C
        DO 180 J=1,N
          P(J) = Z(J) + BK*P(J)
180 CONTINUE
C
        ENDIF
        CALL ATIMES( SA, IJA, P, Q, N, NMAX )
        BKDEN = BKNUM
        AKDEN = 0.0
C
        DO 190 J=1,N
          AKDEN = AKDEN + P(J)*Q(J)
190 CONTINUE
C
        AK = BKNUM/AKDEN
C
        DO 200 J=1,N
          X(J) = X(J) + AK*P(J)
          R(J) = R(J) - AK*Q(J)
200 CONTINUE
C
        BNRM = SNRM( N, BN )
        ERR1 = SNRM( N, R )/BNRM
        WRITE(*,205) ITER1, ERR1
205  FORMAT(' ITER = ',I5, ' ERR = ',F14.10)
        IF (ERR1.GT.TOL1) GOTO 500
      ENDIF
C
    RETURN
  END
C
C-----
C
SUBROUTINE ATIMES( SA, IJA, X, B, N, NMAX )
C
  IMPLICIT REAL*8 (A-H,O-Z)
C
  DIMENSION B(N), X(N), SA(NMAX), IJA(NMAX)
  IF (IJA(1).NE.N+2) PAUSE 'MISMATCHED VECTOR AND MATRIX IN ATIMES'
C
  DO 10 I=1,N
    B(I) = 0.0
10 CONTINUE
C
  DO 11 I=1,N
    B(I) = SA(I)*X(I)
    DO 12 K=IJA(I),IJA(I+1)-1

```

```

      B(I) = B(I) + SA(K)*X(JA(K))
12  CONTINUE
11  CONTINUE
C
      RETURN
      END
C
-----
C
      SUBROUTINE ASOLVE( N, B, X, SA, NMAX )
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION B(N), X(N), SA(NMAX)
      DO 10 I=1,N
         X(I) = B(I)/SA(I)
10  CONTINUE
      RETURN
      END
C
-----
C
      FUNCTION SNRM( N, SX )
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION SX(N)
      SNRM = 0.0
      DO 10 I=1,N
         SNRM = SNRM + SX(I)*SX(I)
10  CONTINUE
      SNRM = SQRT(SNRM)
      RETURN
      END
C
-----
C
      SUBROUTINE TRI(MXPOIV, MXELE, MXNEQ, DEN, VIS, TEXP,
      * CV, TCON, TREF, GRA, COORD,INTMAT,
      * AKELE, RELE, SOL, IBCU, IBCV, IBCT, IBCP )
C
      ESTABLISH ALL ELEMENT MATRICES AND ASSEMBLE THEM TO FORM
      UP SYSTEM EQUATIONS
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION COORD(MXPOIV,2)
      DIMENSION SOL(MXNEQ)
      DIMENSION A(6,6), B(6,3), C(6,3), G(3,3), R(6,6), F(6,6,3)
      DIMENSION UELE(6), VELE(6), TELE(6), PELE(3)
      DIMENSION SXX(6,6), SKY(6,6), SYX(6,6), SYY(6,6)
      DIMENSION TXX(6,6), TYY(6,6), CAB(6,6)
      DIMENSION HX(3,6), HY(3,6), HXT(6,3), HYT(6,3)
      DIMENSION ABGXUG(6,6), AGBXUG(6,6), AOBXYVG(6,6)
      DIMENSION ABGYVG(6,6), ABGXVG(6,6), ABGYUG(6,6)
      DIMENSION ABGXTG(6,6), ABGYTG(6,6)
      DIMENSION CUU(6,6), CVV(6,6), CVU(6,6), CUV(6,6), CTT(6,6)
      DIMENSION AKELE(21,21,MXELE), RELE(21,MXELE)
      DIMENSION FX(6), FY(6), FT(6), FI(3)
      DIMENSION IBCU(MXPOIV), IBCV(MXPOIV), IBCT(MXPOIV), IBCP(MXPOIV)
C
      INTEGER INTMAT(MXELE,6)
C
      SET UP [A] MATRIX BASED ON TENSOR NOTATIONS:
C
      DO 10 I=1,6
      DO 10 J=1,6
         A(I,J) = 0.
10  CONTINUE
C
      A(1,1) = 1.
      A(2,2) = 1.
      A(3,3) = 1.
      A(4,4) = 4.
      A(5,5) = 4.
      A(6,6) = 4.
      A(1,6) = -1.
      A(1,6) = -1.
      A(2,4) = -1.
      A(2,6) = -1.
      A(3,4) = -1.
      A(3,5) = -1.
C
      COMPUTE KINEMATIC VISCOSITY:
C
      ANEW = VIS/DEN
C

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```

C LOOP OVER THE NUMBER OF ELEMENTS:
C
  DO 500 IE=1,MXELE
C
C FIND ELEMENT LOCAL COORDINATES:
C
  II = INTMAT(IE,1)
  JJ = INTMAT(IE,2)
  KK = INTMAT(IE,3)
  LL = INTMAT(IE,4)
  MM = INTMAT(IE,5)
  NN = INTMAT(IE,6)
C
  XG1 = COORD(II,1)
  XG2 = COORD(JJ,1)
  XG3 = COORD(KK,1)
  YG1 = COORD(II,2)
  YG2 = COORD(JJ,2)
  YG3 = COORD(KK,2)
  AREA = 0.5*(XG2*(YG3-YG1) + XG1*(YG2-YG3) + XG3*(YG1-YG2))
  IF(AREA.LE.0.) WRITE(6,5) IE
5  FORMAT(/, '!!! ERROR !!! ELEMENT NO.', IE,
  * ' HAS NEGATIVE OR ZERO AREA ', /,
  * ' --- CHECK F.E. MODEL FOR NODAL COORDINATES',
  * ' AND ELEMENT NODAL CONNECTIONS ---')
  IF(AREA.LE.0.) STOP
C
  AREA2 = 2.*AREA
  B1 = (YG2 - YG3)/AREA2
  B2 = (YG3 - YG1)/AREA2
  B3 = (YG1 - YG2)/AREA2
  C1 = (XG3 - XG2)/AREA2
  C2 = (XG1 - XG3)/AREA2
  C3 = (XG2 - XG1)/AREA2
C
C SET UP [B] AND [C] MATRICES BASED ON TENSOR NOTATIONS:
C
  DO 30 I=1,6
  DO 30 J=1,3
  B(I,J) = 0.
  C(I,J) = 0.
30 CONTINUE
C
  B(1,1) = 2.*B1
  B(2,2) = 2.*B2
  B(3,3) = 2.*B3
  B(4,2) = B3
  B(4,3) = B2
  B(5,1) = B3
  B(5,3) = B1
  B(6,1) = B2
  B(6,2) = B1
  C(1,1) = 2.*C1
  C(2,2) = 2.*C2
  C(3,3) = 2.*C3
  C(4,2) = C3
  C(4,3) = C2
  C(5,1) = C3
  C(5,3) = C1
  C(6,1) = C2
  C(6,2) = C1
C
C SET UP [G] MATRIX:
C
  FAC = AREA/12.
  FAC2 = 2.*FAC
  G(1,1) = FAC2
  G(2,2) = FAC2
  G(3,3) = FAC2
  G(1,2) = FAC
  G(1,3) = FAC
  G(2,1) = FAC
  G(2,3) = FAC
  G(3,1) = FAC
  G(3,2) = FAC
C
C SET UP [R] MATRIX:
C
  FAC = AREA/360.
  FAC2 = 2.*FAC
  FAC4 = 4.*FAC
  FAC6 = 6.*FAC
  FAC24 = 24.*FAC
  R(1,1) = FAC24
  R(1,2) = FAC4
  R(1,3) = FAC4
  R(1,4) = FAC2

```

R(1,5) = FAC6
 R(1,6) = FAC6
 R(2,2) = FAC24
 R(2,3) = FAC4
 R(2,4) = FAC6
 R(2,5) = FAC2
 R(2,6) = FAC6
 R(3,3) = FAC24
 R(3,4) = FAC6
 R(3,5) = FAC6
 R(3,6) = FAC2
 R(4,4) = FAC4
 R(4,5) = FAC2
 R(4,6) = FAC2
 R(5,5) = FAC4
 R(5,6) = FAC2
 R(6,6) = FAC4

C

DO 35 I=1,6
 DO 35 J=1,6
 R(J,I) = R(I,J)

35

CONTINUE

C

C

SET UP [F] MATRIX BASED ON TENSOR NOTATIONS:

C

FACTOR = 2.*AREA/5040.
 F4 = FACTOR*4.
 F6 = FACTOR*6.
 F12 = FACTOR*12.
 F24 = FACTOR*24.
 F120 = FACTOR*120.

C

F(1,1,1) = F120
 F(1,2,1) = F12
 F(1,3,1) = F12
 F(1,4,1) = F6
 F(1,5,1) = F24
 F(1,6,1) = F24
 F(2,2,1) = F24
 F(2,3,1) = F4
 F(2,4,1) = F6
 F(2,5,1) = F4
 F(2,6,1) = F12
 F(3,3,1) = F24
 F(3,4,1) = F6
 F(3,5,1) = F12
 F(3,6,1) = F4
 F(4,4,1) = F4
 F(4,5,1) = F4
 F(4,6,1) = F4
 F(5,5,1) = F12
 F(5,6,1) = F6
 F(6,6,1) = F12

C

DO 40 I=1,6
 DO 40 J=1,6
 F(J,I,1) = F(I,J,1)

40

CONTINUE

C

F(1,1,2) = F24
 F(1,2,2) = F12
 F(1,3,2) = F4
 F(1,4,2) = F4
 F(1,5,2) = F6
 F(1,6,2) = F12
 F(2,2,2) = F120
 F(2,3,2) = F12
 F(2,4,2) = F24
 F(2,5,2) = F6
 F(2,6,2) = F24
 F(3,3,2) = F24
 F(3,4,2) = F12
 F(3,5,2) = F6
 F(3,6,2) = F4
 F(4,4,2) = F12
 F(4,5,2) = F4
 F(4,6,2) = F6
 F(5,5,2) = F4
 F(5,6,2) = F4
 F(6,6,2) = F12

C

DO 50 I=1,6
 DO 50 J=1,6
 F(J,I,2) = F(I,J,2)

50

CONTINUE

C

F(1,1,3) = F24

```

F(1,2,3) = F4
F(1,3,3) = F12
F(1,4,3) = F4
F(1,5,3) = F12
F(1,6,3) = F6
F(2,2,3) = F24
F(2,3,3) = F12
F(2,4,3) = F12
F(2,5,3) = F4
F(2,6,3) = F6
F(3,3,3) = F120
F(3,4,3) = F24
F(3,5,3) = F24
F(3,6,3) = F6
F(4,4,3) = F12
F(4,5,3) = F6
F(4,6,3) = F4
F(5,5,3) = F12
F(5,6,3) = F4
F(6,6,3) = F4
C
DO 60 I=1,6
DO 60 J=1,6
F(J,I,3) = F(I,J,3)
60 CONTINUE
C
C EXTRACT ELEMENT NODAL U, V, P:
C
UELE(1) = SOL(H)
UELE(2) = SOL(JI)
UELE(3) = SOL(KK)
UELE(4) = SOL(LL)
UELE(5) = SOL(MM)
UELE(6) = SOL(NN)
VELE(1) = SOL(H+MXPOIV)
VELE(2) = SOL(JI+MXPOIV)
VELE(3) = SOL(KK+MXPOIV)
VELE(4) = SOL(LL+MXPOIV)
VELE(5) = SOL(MM+MXPOIV)
VELE(6) = SOL(NN+MXPOIV)
TELE(1) = SOL(H+MXPOIV+MXPOIV)
TELE(2) = SOL(JI+MXPOIV+MXPOIV)
TELE(3) = SOL(KK+MXPOIV+MXPOIV)
TELE(4) = SOL(LL+MXPOIV+MXPOIV)
TELE(5) = SOL(MM+MXPOIV+MXPOIV)
TELE(6) = SOL(NN+MXPOIV+MXPOIV)
PELE(1) = SOL(H+MXPOIV+MXPOIV+MXPOIV)
PELE(2) = SOL(JI+MXPOIV+MXPOIV+MXPOIV)
PELE(3) = SOL(KK+MXPOIV+MXPOIV+MXPOIV)
C
C COMPUTE [SXX], [SKY], [SYX], [SYY], [TXX], [TYY],
C [CAB] MATRICES:
C
DO 100 IA=1,6
DO 100 IB=1,6
CXX = 0.
CYY = 0.
CXY = 0.
CYX = 0.
YTT = 0.
C
DO 110 I=1,6
DO 110 J=1,3
DO 110 K=1,3
DO 110 L=1,6
CXX = CXX + A(IA,I)*B(I,J)*A(IB,L)*B(L,K)*G(J,K)
CYY = CYY + A(IA,I)*C(I,J)*A(IB,L)*C(L,K)*G(J,K)
CXY = CXY + A(IA,I)*C(I,J)*A(IB,L)*B(L,K)*G(J,K)
CYX = CYX + A(IA,I)*B(I,J)*A(IB,L)*C(L,K)*G(J,K)
110 CONTINUE
C
DO 120 I=1,6
DO 120 J=1,6
YTT = YTT + A(IA,I)*R(I,J)*A(IB,J)
120 CONTINUE
C
SXX(IA,IB) = 2.*ANEW*CXX + ANEW*CYY
SKY(IA,IB) = ANEW*CXY
SYX(IA,IB) = ANEW*CYX
SYY(IA,IB) = ANEW*CXX + 2.*ANEW*CYY
TXX(IA,IB) = TCON/DEN/CV*CXX
TYY(IA,IB) = TCON/DEN/CV*CYY
CAB(IA,IB) = -GRA*TEXP*YTT
100 CONTINUE
C
C COMPUTE [HX] AND [HY] MATRICES:
C (SAME AS MATRICES ON THE LOWER LEFT OF LINEAR EQS.)

```

```

C
DO 150 IA=1,3
DO 150 IB=1,6
CX = 0.
CY = 0.

C
DO 160 I=1,6
DO 160 J=1,3
CX = CX + A(IB,I)*B(I,J)*G(J,IA)
CY = CY + A(IB,I)*C(I,J)*G(J,IA)
160 CONTINUE

C
HX(IA,IB) = CX
HY(IA,IB) = CY
160 CONTINUE

C
C THEN THE CORRESPONDING TWO MATRICES ON THE UPPER RIGHT ARE:
C
DO 170 IA=1,3
DO 170 IB=1,6
HXT(IB,IA) = -HX(IA,IB)/DEN
HYT(IB,IA) = -HY(IA,IB)/DEN
170 CONTINUE

C
C COMPUTE ALL MATRICES ASSOCIATED WITH THE INERTIA TERMS:
C (SEE DERIVATION IN NOTE FOR BETTER UNDERSTANDING)
C
DO 200 IA=1,6
DO 200 IB=1,6
CABGXUG = 0.
CAGBXUG = 0.
CAGBYVG = 0.
CABGYVG = 0.
CABGXVG = 0.
CABGYUG = 0.
CABGXTG = 0.
CABGYTG = 0.

C
DO 210 I=1,6
DO 210 J=1,6
DO 210 K=1,6
DO 210 L=1,6
DO 210 M=1,3
CABGXUG = CABGXUG
* + A(IA,I)*A(IB,J)*A(K,L)*B(L,M)*F(I,J,M)*UELE(K)
CAGBXUG = CAGBXUG
* + A(IA,I)*A(K,J)*A(IB,L)*B(L,M)*F(I,J,M)*UELE(K)
CAGBYVG = CAGBYVG
* + A(IA,I)*A(K,J)*A(IB,L)*C(L,M)*F(I,J,M)*VELE(K)
CABGYVG = CABGYVG
* + A(IA,I)*A(IB,J)*A(K,L)*C(L,M)*F(I,J,M)*VELE(K)
CABGXVG = CABGXVG
* + A(IA,I)*A(IB,J)*A(K,L)*B(L,M)*F(I,J,M)*VELE(K)
CABGYUG = CABGYUG
* + A(IA,I)*A(IB,J)*A(K,L)*C(L,M)*F(I,J,M)*UELE(K)
CABGXTG = CABGXTG
* + A(IA,I)*A(IB,J)*A(K,L)*B(L,M)*F(I,J,M)*TELE(K)
CABGYTG = CABGYTG
* + A(IA,I)*A(IB,J)*A(K,L)*C(L,M)*F(I,J,M)*TELE(K)
210 CONTINUE

C
ABGXUG(IA,IB) = CABGXUG
AGBXUG(IA,IB) = CAGBXUG
AGBYVG(IA,IB) = CAGBYVG
ABGYVG(IA,IB) = CABGYVG
ABGXVG(IA,IB) = CABGXVG
ABGYUG(IA,IB) = CABGYUG
ABGXTG(IA,IB) = CABGXTG
ABGYTG(IA,IB) = CABGYTG
200 CONTINUE

C
DO 220 I=1,6
DO 220 J=1,6
CUU(I,J) = ABGXUG(I,J) + AGBXUG(I,J) + AGBYVG(I,J) + SXX(I,J)
CVV(I,J) = ABGYVG(I,J) + AGBYVG(I,J) + AGBXUG(I,J) + SYY(I,J)
CVU(I,J) = ABGXVG(I,J) + SYX(I,J)
CUV(I,J) = ABGYUG(I,J) + SXY(I,J)
CTT(I,J) = AGBXUG(I,J) + AGBYVG(I,J) + TXX(I,J) + TYY(I,J)
220 CONTINUE

C
C THEN THE MATRIX (21X21) ON LHS OF THE ELEMENT EQS. IS:
C
DO 230 I=1,21
DO 230 J=1,21
AKELE(I,J,IE) = 0.
230 CONTINUE
C

```

```

DO 240 I=1,6
DO 250 J=1,6
AKELE(I,J,IE) = CUU(I,J)
AKELE(I+6,J+6,IE) = CVV(I,J)
AKELE(I,J+6,IE) = CUV(I,J)
AKELE(I+6,J,IE) = CVU(I,J)
250 CONTINUE
DO 260 J=1,3
AKELE(I,J+18,IE) = HXT(I,J)
AKELE(I+6,J+18,IE) = HYT(I,J)
260 CONTINUE
240 CONTINUE
C
DO 270 I=1,3
DO 270 J=1,6
AKELE(I+18,J,IE) = HX(I,J)
AKELE(I+18,J+6,IE) = HY(I,J)
270 CONTINUE
C
DO 280 I=1,6
DO 280 J=1,6
AKELE(I+6,J+12,IE) = CAB(I,J)
280 CONTINUE
C
DO 290 I=1,6
DO 290 J=1,6
AKELE(I+12,J,IE) = ABGXUG(I,J)
AKELE(I+12,J+6,IE) = ABGYUG(I,J)
AKELE(I+12,J+12,IE) = CTT(I,J)
290 CONTINUE
C
BEGIN COMPUTING THE RESIDUALS ON RHS OF ELEMENT BQS.:
C
DO 300 I=1,6
TERM1 = 0.
TERM2 = 0.
TERM3 = 0.
TERM4 = 0.
TERM5 = 0.
C
DO 310 J=1,6
TERM1 = TERM1 + ABGXUG(I,J)*UELE(J)
TERM2 = TERM2 + ABGYUG(I,J)*VELE(J)
TERM4 = TERM4 + SXX(I,J)*UELE(J)
TERM5 = TERM5 + SXY(I,J)*VELE(J)
310 CONTINUE
C
DO 320 J=1,3
TERM3 = TERM3 + HXT(I,J)*PELE(J)
320 CONTINUE
C
FX(I) = TERM1 + TERM2 + TERM3 + TERM4 + TERM5
300 CONTINUE
C
DO 350 I=1,6
TERM1 = 0.
TERM2 = 0.
TERM3 = 0.
TERM4 = 0.
TERM5 = 0.
TERM6 = 0.
C
DO 360 J=1,6
TERM1 = TERM1 + ABGXVG(I,J)*UELE(J)
TERM2 = TERM2 + ABGYVG(I,J)*VELE(J)
TERM4 = TERM4 + SYX(I,J)*UELE(J)
TERM5 = TERM5 + SYY(I,J)*VELE(J)
TERM6 = TERM6 + CAB(I,J)*TELE(J)
360 CONTINUE
C
DO 370 J=1,3
TERM3 = TERM3 + HYT(I,J)*PELE(J)
370 CONTINUE
C
FY(I) = TERM1 + TERM2 + TERM3 + TERM4 + TERM5 + TERM6
350 CONTINUE
C
DO 380 I=4,6
FY(I) = FY(I) + GRA*AREA/3.*(1.+TEXP*TREF)
380 CONTINUE
C
DO 400 I=1,6
TERM1 = 0.
TERM2 = 0.
TERM3 = 0.
TERM4 = 0.
C

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```

DO 410 J=1,6
TERM1 = TERM1 + ABGXTG(I,J)*UELE(J)
TERM2 = TERM2 + ABGYTG(I,J)*VELE(J)
TERM3 = TERM3 + TXX(I,J)*TELE(J)
TERM4 = TERM4 + TYX(I,J)*TELE(J)
410 CONTINUE
C
FT(I) = TERM1 + TERM2 + TERM3 + TERM4
400 CONTINUE
C
DO 450 I=1,3
TERM1 = 0.
TERM2 = 0.
C
DO 460 J=1,6
TERM1 = TERM1 + HX(I,J)*UELE(J)
TERM2 = TERM2 + HY(I,J)*VELE(J)
460 CONTINUE
C
FI(I) = TERM1 + TERM2
450 CONTINUE
C
C
C      THUS THE RESIDUAL VECTOR ON RHS OF ELEMENT EQS. IS:
C
DO 420 I=1,6
RELE(I ,IE) = -FX(I)
RELE(I+6 ,IE) = -FY(I)
RELE(I+12,IE) = -FT(I)
420 CONTINUE
C
DO 430 I=1,3
RELE(I+18,IE) = -FI(I)
430 CONTINUE
C
C      APPLY BOUNDARY CONDITIONS FOR ELEMENT MATRICES:
C
CALL APPLYBC( MXPOIV, MXELE, AKELE, RELE, INTMAT,
*             IBCU, IBCV, IBCT, IBCP, IE )
C
500 CONTINUE
C
RETURN
END
C
-----
C
SUBROUTINE FORCE( B, COORD, INTOUT, PRES, MXPOIV,
*               MXNEQ, MXFREE, DEN )
C
IMPLICIT REAL*8 (A-H,O-Z)
C
DIMENSION B(MXNEQ),PRES(MXPOIV)
DIMENSION COORD(MXPOIV,3),INTOUT(MXFREE,4)
C
DO 10 I=1,MXFREE
C
C      FIND BOUNDARY LOCAL COORDINATES:
C
JJ = INTOUT(I,2)
KK = INTOUT(I,3)
LL = INTOUT(I,4)
X1 = COORD(JJ,1)
X2 = COORD(LL,1)
Y1 = COORD(JJ,2)
Y2 = COORD(LL,2)
C
C      CALCULATE LENGTH OF BOUNDARY:
C
DX = X2 - X1
DY = Y2 - Y1
DL = SQRT(DX*DX + DY*DY)
C
C      CALCULATE FORCE COMPONENTS:
C
IF ((DX.LT.0.).AND.(DY.GE.0.)) THEN
RX1 = -PRES(JJ)*DY/6.
RX2 = -PRES(LL)*DY/6.
RY1 = -PRES(JJ)*DX/6.
RY2 = -PRES(LL)*DX/6.
ELSE
IF ((DX.LT.0.).AND.(DY.LT.0.)) THEN
RX1 = PRES(JJ)*DY/6.
RX2 = PRES(LL)*DY/6.
RY1 = -PRES(JJ)*DX/6.
RY2 = -PRES(LL)*DX/6.
ELSE
IF ((DX.GE.0.).AND.(DY.LT.0.)) THEN

```

```

      RX1 = PRES(JJ)*DY/6.
      RX2 = PRES(LL)*DY/6.
      RY1 = PRES(JJ)*DX/6.
      RY2 = PRES(LL)*DX/6.
      ELSE
      IF ((DX.GE.0.).AND.(DY.GE.0.)) THEN
        RX1 = -PRES(JJ)*DY/6.
        RX2 = -PRES(LL)*DY/6.
        RY1 = PRES(JJ)*DX/6.
        RY2 = PRES(LL)*DX/6.
      ENDIF
    ENDIF
  ENDIF
ENDIF
C
C ASSEMBLING FORCE COMPONENTS INTO SYSTEM LOAD VECTOR:
C
      B(JJ) = B(JJ) + RX1/DEN
      B(KK) = B(KK) + 2.*RX1/DEN
      B(KK) = B(KK) + 2.*RX2/DEN
      B(LL) = B(LL) + RX2/DEN
      B(MXPOIV+JJ) = B(MXPOIV+JJ) + RY1/DEN
      B(MXPOIV+KK) = B(MXPOIV+KK) + 2.*RY1/DEN
      B(MXPOIV+KK) = B(MXPOIV+KK) + 2.*RY2/DEN
      B(MXPOIV+LL) = B(MXPOIV+LL) + RY2/DEN
C
10 CONTINUE
C
      RETURN
      END

```

```

C-----
C
      SUBROUTINE HEATFLUX( B, COORD,INTFLUX, FLUX, MXPOIV, MXNEQ,
      * MXFLUX, DEN, CV )
C
      IMPLICIT REAL*8 (A-H,O-Z)
C
      DIMENSION B(MXNEQ),FLUX(MXPOIV)
      DIMENSION COORD(MXPOIV,2),INTFLUX(MXFLUX,4)
C
      DO 10 J=1,MXFLUX
C
C FIND BOUNDARY LOCAL COORDINATES:
C
      JJ = INTFLUX(1,2)
      KK = INTFLUX(1,3)
      LL = INTFLUX(1,4)
      X1 = COORD(JJ,1)
      X2 = COORD(LL,1)
      Y1 = COORD(JJ,2)
      Y2 = COORD(LL,2)
C
C CALCULATE LENGTH OF BOUNDARY:
C
      DX = X2 - X1
      DY = Y2 - Y1
      DL = SQRT(DX*DX + DY*DY)
C
C CALCULATE HEAT FLUX THAT FLOW INTO DOMAIN:
C
      Q1 = (FLUX(JJ)*DL/6.)/(DEN*CV)
      Q2 = (FLUX(LL)*DL/6.)/(DEN*CV)
C
C ASSEMBLING HEAT FLUX INTO SYSTEM LOAD VECTOR:
C
      B(2*MXPOIV+JJ) = B(2*MXPOIV+JJ) + Q1
      B(2*MXPOIV+KK) = B(2*MXPOIV+KK) + 2.*Q1
      B(2*MXPOIV+KK) = B(2*MXPOIV+KK) + 2.*Q2
      B(2*MXPOIV+LL) = B(2*MXPOIV+LL) + Q2
C
10 CONTINUE
C
      RETURN
      END
C-----
C

```

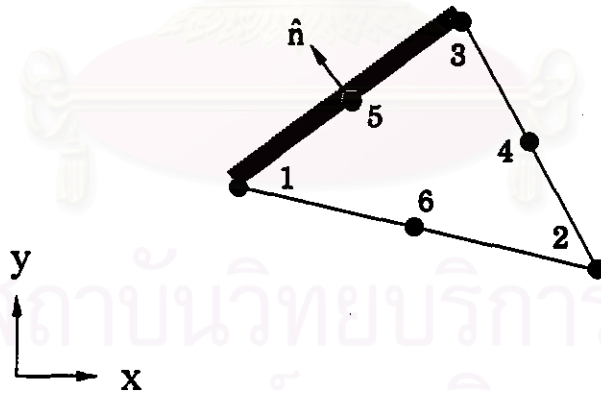
ภาคผนวก ข

การคำนวณหาฟลักซ์ความร้อนที่ผนัง

สิ่งที่สำคัญที่สุดที่ต้องกระทำหลังจากการประดิษฐ์โปรแกรมคอมพิวเตอร์ก็คือ การตรวจสอบความถูกต้องของโปรแกรมคอมพิวเตอร์ที่ประดิษฐ์ขึ้น วิธีการตรวจสอบความถูกต้องนี้กระทำได้โดย ทำการวิเคราะห์การไหลในกรณีที่มีพารามิเตอร์ไร้มิติเท่ากัน แล้วนำผลลัพธ์ที่ได้มาคำนวณหาคูณสมบัติไร้มิติของของไหล เพื่อนำไปเปรียบเทียบกับผลลัพธ์ของนักวิจัยคนอื่นๆ ที่ได้รับการตีพิมพ์ในวารสารทางวิชาการระดับนานาชาติ ซึ่งโดยมากจะเกี่ยวข้องกับการคำนวณหาฟลักซ์ความร้อนที่ผนัง ดังนั้นในภาคผนวก ข นี้จึงนำเสนอวิธีการคำนวณหาฟลักซ์ความร้อนที่ผนัง ซึ่งมีรายละเอียดดังต่อไปนี้

พิจารณาเอลิเมนต์ที่มีด้าน 13 อยู่บนผนังดังแสดงในรูปที่ ข.1 ฟลักซ์ความร้อนที่ถ่ายเทออกจากโดเมนของการไหลผ่านด้านดังกล่าวหาได้จากสมการ

$$q = -k \left(\frac{\partial T}{\partial x} l + \frac{\partial T}{\partial y} m \right) \quad (\text{ข.1})$$



รูปที่ ข.1 เอลิเมนต์ที่มีด้านอยู่บนขอบเขตที่เป็นผนัง

โดย	q	แทนฟลักซ์ความร้อนที่ถ่ายเทออกจากโดเมนของการไหล
	k	แทนสัมประสิทธิ์การนำความร้อนของของไหล
	T	แทนอุณหภูมิของของไหล
	l, m	แทนทิศทางโคซายน์ของเวกเตอร์หนึ่งหน่วยที่ตั้งฉากผนังดังแสดงในรูปที่ ข.1

นำค่า T ที่ได้จากสมการในบทที่ 4 มาหาอนุพันธ์ย่อยเทียบกับตัวแปร x และ y ได้ดังนี้

$$\frac{\partial T}{\partial x} = [H][B]^T [A]^T \{T\} \quad (\text{ข.2})$$

$$\frac{\partial T}{\partial y} = [H][C]^T [A]^T \{T\} \quad (\text{ข.3})$$

เมื่อแทนพิกัดและอุณหภูมิจากไฟล์ผลลัพธ์ของจุดต่อต่าง ๆ ลงไปในสมการ (ข.2) และ (ข.3) แล้วนำค่าที่ได้ไปแทนในสมการ (ข.1) ก็จะคำนวณพลักซ์ความร้อนที่จุดต่อหมายเลข 1, 3 และ 5 ออกมาได้ แต่เนื่องจากจุดต่อที่มุมของเอลิเมนต์จะเชื่อมต่อกับเอลิเมนต์อื่น ๆ อีก ทำให้การคำนวณพลักซ์ความร้อนที่จุดต่อดังกล่าวมีความยุ่งยากมากขึ้น ดังนั้นการคำนวณพลักซ์ความร้อนทั้งหมดที่น่าผลมาแสดงในวิทยานิพนธ์นี้ จึงเป็นการคำนวณที่จุดต่อที่อยู่กลางด้านของเอลิเมนต์เท่านั้น เนื่องจากคำนวณได้สะดวกกว่า และเมื่อใช้จำนวนเอลิเมนต์ที่ผนังมากขึ้น การละทิ้งการคำนวณพลักซ์ความร้อนที่จุดต่อที่มุมของเอลิเมนต์แทบจะไม่ส่งผลกระทบต่อภาพรวมของผลลัพธ์เลย ดังจะเห็นได้จากผลลัพธ์ในหัวข้อ 7.3

การคำนวณค่าการนำความร้อนสมมูล

การนำความร้อนสมมูลที่กล่าวถึงในหัวข้อ 7.3 นั้น เป็นอัตราส่วนของพลักซ์ความร้อนที่หาได้จากสมการ (ข.1) กับพลักซ์ความร้อนของการนำความร้อนเมื่อพิจารณาให้ของไหลในช่องว่างระหว่างทรงกระบอกไม่เคลื่อนที่ [22] ซึ่งหาค่าได้ดังนี้

$$\text{สำหรับทรงกระบอกด้านใน; } \frac{k_{\text{eq}}}{k} = \frac{\left(\frac{\partial T}{\partial x} l + \frac{\partial T}{\partial y} m \right)}{\frac{\Delta T}{r_i \ln(r_o/r_i)}} \quad (\text{ข.4})$$

$$\text{สำหรับทรงกระบอกด้านนอก; } \frac{k_{\text{eq}}}{k} = - \frac{\left(\frac{\partial T}{\partial x} l + \frac{\partial T}{\partial y} m \right)}{\frac{\Delta T}{r_o \ln(r_o/r_i)}} \quad (\text{ข.5})$$

โดย ΔT แทนผลต่างของอุณหภูมิของทรงกระบอกทั้งสองอัน
 r_i แทนรัศมีของทรงกระบอกด้านใน
 r_o แทนรัศมีของทรงกระบอกด้านนอก
 k_{eq} แทนสัมประสิทธิ์การนำความร้อนสมมูล ซึ่งเมื่อนำไปแทนในสมการพลักซ์ความร้อนของการนำความร้อนแล้วจะคำนวณพลักซ์ความร้อนได้เท่ากับผลที่ได้จากสมการ (ข.1)

การคำนวณค่าตัวเลขเชลท์นัมเบอร์

ค่าตัวเลขเชลท์นัมเบอร์ที่นำมาหาค่าเฉลี่ยในหัวข้อ 7.4 นั้น สามารถคำนวณได้โดยแทนค่าฟลักซ์ความร้อนจากสมการของการพาความร้อนลงในสมการ (ข.1) แล้วจัดรูปใหม่ จะได้ค่าตัวเลขเชลท์นัมเบอร์ดังสมการ

$$Nu = \frac{hd}{k} = - \frac{d \left(\frac{\partial T}{\partial x} l + \frac{\partial T}{\partial y} m \right)}{\Delta T} \quad (\text{ข.6})$$

โดย h แทนสัมประสิทธิ์การพาความร้อนของของไหล

d แทนความยาวของเส้นผ่านศูนย์กลางของทรงกระบอก ซึ่งถือว่าเป็นความยาวเฉพาะในโดเมนของการไหลในหัวข้อ 7.4

ΔT แทนผลต่างของอุณหภูมิที่ผิวทรงกระบอกกับอุณหภูมิของของไหลที่ทางเข้า

ภาคผนวก ค

ตัวอย่างไฟล์ข้อมูลนำเข้าและไฟล์ผลลัพธ์

ตัวอย่างของไฟล์ข้อมูลนำเข้าและไฟล์ผลลัพธ์ที่นำมาแสดงไว้ในภาคผนวก ค นี้ เป็นไฟล์ข้อมูลของปัญหาการพาความร้อนแบบอิสระในช่องปิดที่หน้าตัดรูปสี่เหลี่ยมจัตุรัส ในกรณีที่เรย์เลห์นัมเบอร์มีค่า 10^5 ซึ่งมีรายละเอียดดังนี้

ไฟล์ข้อมูลนำเข้า

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2
FREE CONVECTION IN SQUARE ENCLOSURE AT RA = 100000 WITH PR = 0.7
THE MODEL CONSISTS OF 441 NODES AND 200 ELEMENTS
NPOIV  NPOIP  NELEM  NFREE  NFLUX  NITER  TOL
 441    121    200     0       20      20      0.1
DENSITY  VISCOSITY  THERM EXP  SPEC CV  THERM CON  REF TEMP  GRAVITY
1.00000  3.46400   3.00000   .00866   .08000   40.00000  10.00000
NODAL BOUNDARY CONDITIONS AND COORDINATES [441]:
 1 1 1 1 0 .00000 .00000 .00000 .00000 20.00000 .00000 .00000
 2 1 1 0 0 .10000 .00000 .00000 .00000 40.00000 .00000 .00000
 3 1 1 0 0 .20000 .00000 .00000 .00000 40.00000 .00000 .00000
 4 1 1 0 0 .30000 .00000 .00000 .00000 40.00000 .00000 .00000
 5 1 1 0 0 .40000 .00000 .00000 .00000 40.00000 .00000 .00000
 6 1 1 0 0 .50000 .00000 .00000 .00000 40.00000 .00000 .00000
 7 1 1 0 0 .60000 .00000 .00000 .00000 40.00000 .00000 .00000
 8 1 1 0 0 .70000 .00000 .00000 .00000 40.00000 .00000 .00000
 9 1 1 0 0 .80000 .00000 .00000 .00000 40.00000 .00000 .00000
10 1 1 0 0 .90000 .00000 .00000 .00000 40.00000 .00000 .00000
11 1 1 1 0 1.00000 .00000 .00000 .00000 60.00000 .00000 .00000
12 1 1 1 0 .00000 .10000 .00000 .00000 20.00000 .00000 .00000
13 0 0 0 0 .10000 .10000 .10000 .10000 40.00000 .00000 .00000
14 0 0 0 0 .20000 .10000 .10000 .10000 40.00000 .00000 .00000
15 0 0 0 0 .30000 .10000 .10000 .10000 40.00000 .00000 .00000
16 0 0 0 0 .40000 .10000 .10000 .10000 40.00000 .00000 .00000
17 0 0 0 0 .50000 .10000 .10000 .10000 40.00000 .00000 .00000
18 0 0 0 0 .60000 .10000 .10000 .10000 40.00000 .00000 .00000
19 0 0 0 0 .70000 .10000 .10000 .10000 40.00000 .00000 .00000
20 0 0 0 0 .80000 .10000 .10000 .10000 40.00000 .00000 .00000
21 0 0 0 0 .90000 .10000 .10000 .10000 40.00000 .00000 .00000
22 1 1 1 0 1.00000 .10000 .00000 .00000 60.00000 .00000 .00000
23 1 1 1 0 .00000 .20000 .00000 .00000 20.00000 .00000 .00000
24 0 0 0 0 .10000 .20000 .10000 .10000 40.00000 .00000 .00000
25 0 0 0 0 .20000 .20000 .10000 .10000 40.00000 .00000 .00000
26 0 0 0 0 .30000 .20000 .10000 .10000 40.00000 .00000 .00000
27 0 0 0 0 .40000 .20000 .10000 .10000 40.00000 .00000 .00000
28 0 0 0 0 .50000 .20000 .10000 .10000 40.00000 .00000 .00000
29 0 0 0 0 .60000 .20000 .10000 .10000 40.00000 .00000 .00000
30 0 0 0 0 .70000 .20000 .10000 .10000 40.00000 .00000 .00000
31 0 0 0 0 .80000 .20000 .10000 .10000 40.00000 .00000 .00000
32 0 0 0 0 .90000 .20000 .10000 .10000 40.00000 .00000 .00000
33 1 1 1 0 1.00000 .20000 .00000 .00000 60.00000 .00000 .00000
34 1 1 1 0 .00000 .30000 .00000 .00000 20.00000 .00000 .00000
35 0 0 0 0 .10000 .30000 .10000 .10000 40.00000 .00000 .00000
36 0 0 0 0 .20000 .30000 .10000 .10000 40.00000 .00000 .00000
37 0 0 0 0 .30000 .30000 .10000 .10000 40.00000 .00000 .00000
38 0 0 0 0 .40000 .30000 .10000 .10000 40.00000 .00000 .00000
39 0 0 0 0 .50000 .30000 .10000 .10000 40.00000 .00000 .00000
40 0 0 0 0 .60000 .30000 .10000 .10000 40.00000 .00000 .00000
41 0 0 0 0 .70000 .30000 .10000 .10000 40.00000 .00000 .00000
42 0 0 0 0 .80000 .30000 .10000 .10000 40.00000 .00000 .00000
43 0 0 0 0 .90000 .30000 .10000 .10000 40.00000 .00000 .00000
44 1 1 1 0 1.00000 .30000 .00000 .00000 60.00000 .00000 .00000
    
```


430	0	0	0	-1	.65000	.95000	.10000	.10000	40.00000	.00000	.00000
431	0	0	0	-1	.70000	.95000	.10000	.10000	40.00000	.00000	.00000
432	1	1	0	-1	.65000	1.00000	.00000	.00000	40.00000	.00000	.00000
433	0	0	0	-1	.75000	.95000	.10000	.10000	40.00000	.00000	.00000
434	1	1	0	-1	.75000	1.00000	.00000	.00000	40.00000	.00000	.00000
435	0	0	0	-1	.80000	.95000	.10000	.10000	40.00000	.00000	.00000
436	0	0	0	-1	.85000	.95000	.10000	.10000	40.00000	.00000	.00000
437	0	0	0	-1	.90000	.95000	.10000	.10000	40.00000	.00000	.00000
438	1	1	0	-1	.85000	1.00000	.00000	.00000	40.00000	.00000	.00000
439	0	0	0	-1	.95000	.95000	.10000	.10000	40.00000	.00000	.00000
440	1	1	0	-1	.95000	1.00000	.00000	.00000	40.00000	.00000	.00000
441	1	1	1	-1	1.00000	.95000	.00000	.00000	60.00000	.00000	.00000

ELEMENT NODAL CONNECTION [200]:

1	1	13	12	123	124	122
2	1	2	13	126	122	125
3	2	3	13	128	126	127
4	3	14	13	130	126	129
5	3	15	14	132	129	131
6	3	4	15	134	131	133
7	4	5	15	136	134	135
8	5	16	15	138	136	137
9	5	17	16	140	137	139
10	6	6	17	142	139	141
11	6	7	17	144	142	143
12	7	18	17	146	144	145
13	7	19	18	148	145	147
14	7	8	19	150	147	149
15	8	9	19	152	150	151
16	9	20	19	154	152	153
17	9	21	20	156	153	155
18	9	10	21	158	155	157
19	10	11	21	160	158	159
20	11	22	21	162	160	161
21	12	13	23	163	164	123
22	13	24	23	166	163	165
23	13	25	24	168	165	167
24	13	14	25	169	167	130
25	14	15	25	170	169	132
26	15	26	25	172	170	171
27	15	27	26	174	171	173
28	15	16	27	175	173	138
29	16	17	27	176	175	140
30	17	28	27	178	176	177
31	17	29	28	180	177	179
32	17	18	29	181	179	146
33	18	19	29	182	181	148
34	19	30	29	184	182	183
35	19	31	30	186	183	185
36	19	20	31	187	185	154
37	20	21	31	188	187	156
38	21	32	31	190	188	189
39	21	33	32	192	189	191
40	21	22	33	193	191	162
41	23	35	34	195	196	194
42	23	24	35	197	194	166
43	24	25	35	198	197	168
44	25	36	35	200	198	199
45	25	37	36	202	199	201
46	25	26	37	203	201	172
47	26	27	37	204	203	174
48	27	38	37	206	204	205
49	27	39	38	208	205	207
50	27	28	39	209	207	178
51	28	29	39	210	209	180
52	29	40	39	212	210	211
53	29	41	40	214	211	213
54	29	30	41	215	213	184
55	30	31	41	216	215	186
56	31	42	41	218	216	217
57	31	43	42	220	217	219
58	31	32	43	221	219	190
59	32	33	43	222	221	192
60	33	44	43	224	222	223
61	34	35	45	225	226	195
62	35	46	45	228	225	227
63	35	47	46	230	227	229
64	35	36	47	231	229	200

66	36	37	47	232	231	202
66	37	48	47	234	232	233
67	37	49	48	236	233	235
68	37	38	49	237	235	208
69	38	39	49	238	237	208
70	39	50	49	240	238	239
71	39	51	50	242	239	241
72	39	40	51	243	241	212
73	40	41	51	244	243	214
74	41	52	51	246	244	245
75	41	53	52	248	245	247
76	41	42	53	249	247	218
77	42	43	53	250	249	220
78	43	54	53	252	250	251
79	43	55	54	254	251	253
80	43	44	55	255	253	224
81	45	57	56	257	258	256
82	45	46	57	259	256	228
83	46	47	57	260	259	230
84	47	58	57	262	260	261
85	47	59	58	264	261	263
86	47	48	59	265	263	234
87	48	49	59	266	265	236
88	49	60	59	268	266	267
89	49	61	60	270	267	269
90	49	50	61	271	269	240
91	50	51	61	272	271	242
92	51	62	61	274	272	273
93	51	63	62	276	273	275
94	51	52	63	277	275	246
95	52	53	63	278	277	248
96	53	64	63	280	278	279
97	53	65	64	282	279	281
98	53	54	65	283	281	252
99	54	55	65	284	283	254
100	55	66	66	286	284	285
101	56	67	67	287	286	287
102	57	68	67	290	287	289
103	57	69	68	292	289	291
104	57	58	69	293	291	282
105	58	59	69	294	293	284
106	59	70	69	296	294	295
107	59	71	70	298	295	297
108	59	60	71	299	297	288
109	60	61	71	300	299	270
110	61	72	71	302	300	301
111	61	73	72	304	301	303
112	61	62	73	305	303	274
113	62	63	73	306	305	276
114	63	74	73	308	306	307
115	63	75	74	310	307	309
116	63	64	75	311	309	280
117	64	65	75	312	311	282
118	65	76	75	314	312	313
119	65	77	76	316	313	315
120	65	66	77	317	315	286
121	67	79	78	319	320	318
122	67	68	79	321	318	290
123	68	69	79	322	321	292
124	69	80	79	324	322	323
125	69	81	80	326	323	325
126	69	70	81	327	325	296
127	70	71	81	328	327	298
128	71	82	81	330	328	329
129	71	83	82	332	329	331
130	71	72	83	333	331	302
131	72	73	83	334	333	304
132	73	84	83	336	334	335
133	73	85	84	338	335	337
134	73	74	85	339	337	308
135	74	75	85	340	339	310
136	75	86	85	342	340	341
137	75	87	86	344	341	343
138	75	76	87	345	343	314
139	76	77	87	346	345	316
140	77	88	87	348	346	347
141	78	79	89	349	350	319



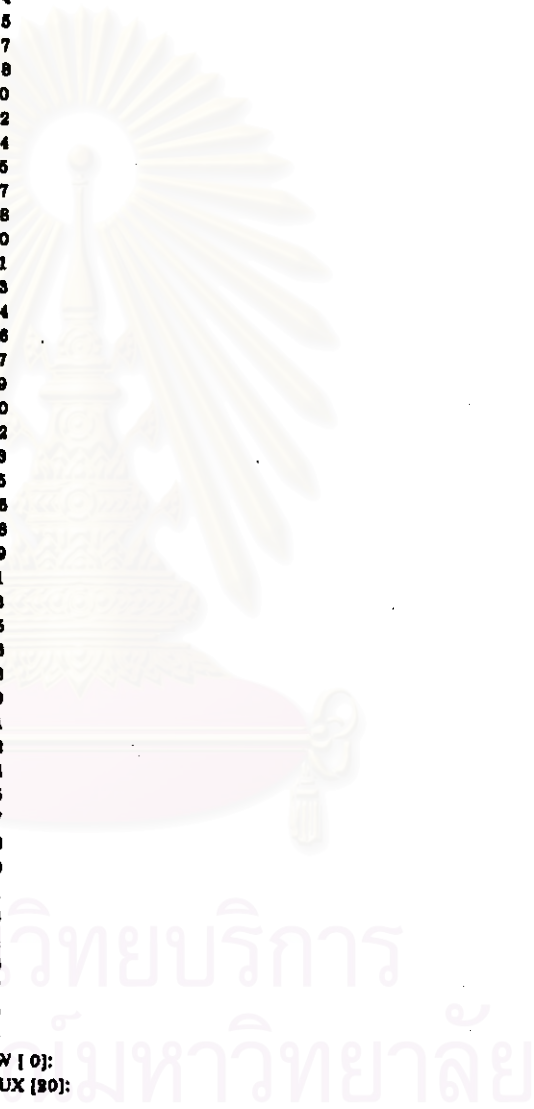
วิทยาลัยบริการ
นันทนาวิทยาลัย

142	79	90	89	352	349	351
143	79	91	90	354	351	353
144	79	80	91	355	353	324
145	80	81	91	356	355	326
146	81	92	91	358	356	357
147	81	93	92	360	357	359
148	81	82	93	361	359	330
149	82	83	93	362	361	332
150	83	94	93	364	362	363
151	83	95	94	366	363	365
152	83	84	95	367	365	336
153	84	85	95	368	367	338
154	85	96	95	370	368	369
155	85	97	96	372	369	371
156	85	86	97	373	371	342
157	86	87	97	374	373	344
158	87	98	97	376	374	375
159	87	99	98	378	375	377
160	87	88	99	379	377	348
161	89	101	100	381	382	380
162	89	90	101	383	380	352
163	90	91	101	384	383	354
164	91	102	101	386	384	385
165	91	103	102	388	385	387
166	91	92	103	389	387	358
167	92	93	103	390	389	360
168	93	104	103	392	390	391
169	93	105	104	394	391	393
170	93	94	105	395	393	364
171	94	95	105	396	395	366
172	95	106	105	398	396	397
173	95	107	106	400	397	399
174	95	96	107	401	399	370
175	96	97	107	402	401	372
176	97	108	107	404	402	403
177	97	109	108	406	403	406
178	97	98	109	407	405	376
179	98	99	109	408	407	378
180	99	110	109	410	408	409
181	100	101	111	411	412	381
182	101	112	111	414	411	413
183	101	113	112	416	413	415
184	101	102	113	417	415	386
185	102	103	113	418	417	388
186	103	114	113	420	418	419
187	103	115	114	422	419	421
188	103	104	115	423	421	392
189	104	105	115	424	423	394
190	105	116	115	426	424	425
191	105	117	116	428	425	427
192	105	106	117	429	427	398
193	106	107	117	430	429	400
194	107	118	117	432	430	431
195	107	119	118	434	431	433
196	107	108	119	435	433	404
197	108	109	119	436	435	406
198	109	120	119	438	436	437
199	109	121	120	440	437	439
200	109	110	121	441	439	410

ELEMENT NODAL CONNECTION FOR OUTFLOW [0]:

ELEMENT NODAL CONNECTION FOR HEAT FLUX [30]:

1	1	125	2
2	2	127	3
3	3	133	4
4	4	135	5
5	5	141	6
6	6	143	7
7	7	149	8
8	8	151	9
9	9	157	10
10	10	159	11
11	121	440	120
12	120	438	119
13	119	434	118
14	118	432	117
15	117	428	116
16	116	426	115



17 115 422 114
 18 114 420 113
 19 113 416 112
 20 112 414 111

ไฟล์ผลลัพธ์ (Conjugate gradient method)

NODAL SOLUTIONS [441]:

NODE	U-VELOCITY	V-VELOCITY	TEMPERATURE	PRESSURE
1	.000000E+00	.000000E+00	.200000E+02	.512180E+01
2	.000000E+00	.000000E+00	.228212E+02	.511971E+01
3	.000000E+00	.000000E+00	.246106E+02	.510273E+01
4	.000000E+00	.000000E+00	.269273E+02	.508673E+01
5	.000000E+00	.000000E+00	.288870E+02	.508016E+01
6	.000000E+00	.000000E+00	.275693E+02	.507448E+01
7	.000000E+00	.000000E+00	.262046E+02	.507161E+01
8	.000000E+00	.000000E+00	.288460E+02	.508778E+01
9	.000000E+00	.000000E+00	.303702E+02	.506044E+01
10	.000000E+00	.000000E+00	.367266E+02	.503988E+01
11	.000000E+00	.000000E+00	.600000E+02	.502047E+01
12	.000000E+00	.000000E+00	.200000E+02	.409155E+01
13	.582736E-01	-.617794E-01	.240060E+02	.406440E+01
14	.126879E+00	-.253860E-01	.262892E+02	.405402E+01
15	.143926E+00	.985295E-02	.270841E+02	.404445E+01
16	.121636E+00	.166148E-01	.275867E+02	.404102E+01
17	.102933E+00	.986122E-02	.280009E+02	.403856E+01
18	.928306E-01	.116394E-02	.265098E+02	.403661E+01
19	.936209E-01	-.560831E-02	.290993E+02	.403406E+01
20	.980713E-01	-.103077E-01	.300488E+02	.403042E+01
21	.846053E-01	.142626E-01	.348004E+02	.402882E+01
22	.000000E+00	.000000E+00	.600000E+02	.403991E+01
23	.000000E+00	.000000E+00	.200000E+02	.302060E+01
24	.542418E-01	-.140092E+00	.275608E+02	.301813E+01
25	.101861E+00	-.615197E-01	.311735E+02	.300766E+01
26	.116127E+00	.126763E-01	.309929E+02	.300487E+01
27	.114252E+00	.324197E-01	.302019E+02	.300509E+01
28	.107427E+00	.208963E-01	.298794E+02	.300615E+01
29	.106236E+00	.536844E-02	.300548E+02	.300494E+01
30	.101603E+00	-.529139E-02	.305167E+02	.300417E+01
31	.919732E-01	-.204255E-02	.314267E+02	.300340E+01
32	.498749E-01	.103464E+00	.367304E+02	.300658E+01
33	.000000E+00	.000000E+00	.600000E+02	.300994E+01
34	.000000E+00	.000000E+00	.200000E+02	.198329E+01
35	.357031E-01	-.199479E+00	.310655E+02	.198437E+01
36	.560439E-01	-.736038E-01	.352633E+02	.197782E+01
37	.571265E-01	.127968E-01	.346895E+02	.197691E+01
38	.613873E-01	.288218E-01	.333532E+02	.197997E+01
39	.710423E-01	.182292E-01	.327262E+02	.198014E+01
40	.755689E-01	.533136E-02	.327745E+02	.198044E+01
41	.756322E-01	-.464126E-03	.330813E+02	.197976E+01
42	.643826E-01	.225889E-01	.334559E+02	.198036E+01
43	.327267E-01	.146957E+00	.383475E+02	.198282E+01
44	.000000E+00	.000000E+00	.600000E+02	.198790E+01
45	.000000E+00	.000000E+00	.200000E+02	.970001E+00
46	.189219E-01	-.219495E+00	.337544E+02	.966086E+00
47	.146779E-01	-.639620E-01	.384539E+02	.961120E+00
48	.108361E-01	.732222E-02	.376821E+02	.963095E+00
49	.206897E-01	.164289E-01	.365438E+02	.963730E+00
50	.323889E-01	.925188E-02	.362120E+02	.964481E+00
51	.401549E-01	.160192E-02	.362853E+02	.963867E+00
52	.442039E-01	.567321E-03	.361879E+02	.964340E+00
53	.363187E-01	.376345E-01	.361461E+02	.963563E+00
54	.107363E-01	.199284E+00	.411770E+02	.967201E+00
55	.000000E+00	.000000E+00	.600000E+02	.870849E+00
56	.000000E+00	.000000E+00	.200000E+02	-.389928E-01
57	.236656E-02	-.215149E+00	.365844E+02	-.394926E-01
58	-.117495E-01	-.581530E-01	.412199E+02	-.415740E-01
59	-.163287E-01	.243078E-02	.406177E+02	-.418585E-01
60	-.914207E-02	.626652E-02	.400815E+02	-.410544E-01
61	-.578489E-03	-.109391E-03	.400183E+02	-.414941E-01
62	.920666E-02	-.650141E-02	.399250E+02	-.410095E-01

83	.175894E-01	-.251022E-02	.393838E+02	-.417967E-01
84	.124228E-01	.565355E-01	.387987E+02	-.415052E-01
85	-.221409E-02	.214987E+00	.434207E+02	-.394436E-01
86	.000000E+00	.000000E+00	.600000E+02	-.389502E-01
87	.000000E+00	.000000E+00	.200000E+02	-.102915E+01
88	-.107487E-01	-.199653E+00	.388330E+02	-.103282E+01
89	-.382303E-01	-.376813E-01	.438649E+02	-.103851E+01
90	-.441097E-01	-.296024E-03	.438443E+02	-.103866E+01
91	-.404493E-01	-.556556E-03	.438245E+02	-.103806E+01
92	-.324259E-01	-.958484E-02	.438413E+02	-.103551E+01
93	-.203546E-01	-.178451E-01	.433800E+02	-.103640E+01
94	-.104531E-01	-.743333E-02	.422931E+02	-.103703E+01
95	-.143806E-01	.648333E-01	.415875E+02	-.103892E+01
96	-.188238E-01	.219702E+00	.462622E+02	-.103391E+01
97	.000000E+00	.000000E+00	.600000E+02	-.102998E+01
98	.000000E+00	.000000E+00	.200000E+02	-.201301E+01
99	-.328894E-01	-.146018E+00	.416685E+02	-.201729E+01
80	-.847795E-01	-.226866E-01	.465624E+02	-.201955E+01
81	-.761142E-01	.959400E-03	.469456E+02	-.202006E+01
82	-.756716E-01	-.505051E-02	.472634E+02	-.201938E+01
83	-.705198E-01	-.191110E-01	.472640E+02	-.201975E+01
84	-.611587E-01	-.296703E-01	.466378E+02	-.202012E+01
85	-.573865E-01	-.126077E-01	.463260E+02	-.202323E+01
86	-.562421E-01	.743709E-01	.447826E+02	-.202221E+01
87	-.357567E-01	.199773E+00	.489437E+02	-.201560E+01
88	.000000E+00	.000000E+00	.600000E+02	-.201667E+01
89	.000000E+00	.000000E+00	.200000E+02	-.298994E+01
90	-.499400E-01	-.103417E+00	.432655E+02	-.299330E+01
91	-.921122E-01	.214419E-02	.485677E+02	-.299647E+01
92	-.101603E+00	.544891E-02	.494764E+02	-.299566E+01
93	-.104957E+00	-.568142E-02	.499265E+02	-.299492E+01
94	-.107300E+00	-.214890E-01	.501006E+02	-.299379E+01
95	-.114607E+00	-.327077E-01	.497932E+02	-.299490E+01
96	-.115639E+00	-.124712E-01	.490088E+02	-.299612E+01
97	-.102117E+00	.619879E-01	.488334E+02	-.299226E+01
98	-.542941E-01	.140230E+00	.524466E+02	-.298177E+01
99	.000000E+00	.000000E+00	.600000E+02	-.297932E+01
100	.000000E+00	.000000E+00	.200000E+02	-.396001E+01
101	-.845624E-01	-.142261E-01	.451896E+02	-.397109E+01
102	-.979468E-01	.103726E-01	.499422E+02	-.396948E+01
103	-.934134E-01	.583425E-02	.508927E+02	-.396586E+01
104	-.926884E-01	-.128630E-02	.514633E+02	-.396334E+01
105	-.103076E+00	-.100729E-01	.519972E+02	-.396139E+01
106	-.122050E+00	-.167076E-01	.524140E+02	-.395893E+01
107	-.144351E+00	-.976834E-02	.529165E+02	-.395548E+01
108	-.127056E+00	.255467E-01	.537123E+02	-.394687E+01
109	-.582821E-01	.618056E-01	.559968E+02	-.393548E+01
110	.000000E+00	.000000E+00	.600000E+02	-.393833E+01
111	.000000E+00	.000000E+00	.200000E+02	-.497947E+01
112	.000000E+00	.000000E+00	.432645E+02	-.496006E+01
113	.000000E+00	.000000E+00	.499213E+02	-.493949E+01
114	.000000E+00	.000000E+00	.511465E+02	-.493216E+01
115	.000000E+00	.000000E+00	.517919E+02	-.492635E+01
116	.000000E+00	.000000E+00	.524306E+02	-.492551E+01
117	.000000E+00	.000000E+00	.531153E+02	-.491978E+01
118	.000000E+00	.000000E+00	.540755E+02	-.491818E+01
119	.000000E+00	.000000E+00	.553918E+02	-.489715E+01
120	.000000E+00	.000000E+00	.573801E+02	-.488016E+01
121	.000000E+00	.000000E+00	.600000E+02	-.487809E+01
122	.156541E-01	-.160649E-01	.215676E+02	
123	.157892E-01	-.507407E-01	.221673E+02	
124	.000000E+00	.000000E+00	.200000E+02	
125	.000000E+00	.000000E+00	.213810E+02	
126	.511513E-01	-.169294E-01	.229196E+02	
127	.000000E+00	.000000E+00	.237142E+02	
128	.804570E-01	-.148794E-01	.240338E+02	
129	.951197E-01	-.809338E-02	.249140E+02	
130	.995913E-01	-.476109E-01	.253958E+02	
131	.106104E+00	.140878E-02	.266023E+02	
132	.141003E+00	-.198913E-02	.268094E+02	
133	.000000E+00	.000000E+00	.253355E+02	
134	.104761E+00	.351015E-02	.261494E+02	
135	.000000E+00	.000000E+00	.264269E+02	
136	.917161E-01	.595819E-02	.265917E+02	
137	.797637E-01	.761896E-02	.269784E+02	
138	.132719E+00	.143261E-01	.273560E+02	
139	.724242E-01	.600178E-02	.273274E+02	

140	.111634E+00	.158143E-01	.277864E+02
141	.000000E+00	.000000E+00	.272411E+02
142	.667126E-01	.231437E-02	.276490E+02
143	.000000E+00	.000000E+00	.278845E+02
144	.608939E-01	.119966E-02	.279415E+02
145	.578187E-01	.366683E-03	.282290E+02
146	.962328E-01	.472007E-02	.282500E+02
147	.590322E-01	-.576518E-03	.285317E+02
148	.923497E-01	-.143842E-02	.287831E+02
149	.000000E+00	.000000E+00	.284960E+02
150	.638362E-01	-.143975E-02	.288805E+02
151	.000000E+00	.000000E+00	.294026E+02
152	.667286E-01	-.424045E-02	.293120E+02
153	.692979E-01	-.638632E-02	.300367E+02
154	.971349E-01	-.107084E-01	.294362E+02
155	.801619E-01	-.660189E-02	.315407E+02
156	.940773E-01	.684056E-04	.313726E+02
157	.000000E+00	.000000E+00	.320204E+02
158	.844579E-01	.445761E-02	.358757E+02
159	.000000E+00	.000000E+00	.458284E+02
160	.421163E-01	.357320E-01	.452951E+02
161	.000000E+00	.000000E+00	.600000E+02
162	.203764E-01	.908400E-01	.458756E+02
163	.219834E-01	-.852811E-01	.230817E+02
164	.000000E+00	.000000E+00	.200000E+02
165	.602126E-01	-.101648E+00	.257222E+02
166	.230080E-01	-.114992E+00	.241024E+02
167	.977762E-01	-.793520E-01	.275820E+02
168	.855468E-01	-.108687E+00	.299507E+02
169	.123463E+00	-.434094E-01	.285445E+02
170	.135373E+00	-.955154E-02	.288926E+02
171	.136226E+00	.137228E-01	.289203E+02
172	.110756E+00	-.177268E-01	.312699E+02
173	.134667E+00	.252522E-01	.287893E+02
174	.115236E+00	.291666E-01	.305677E+02
175	.130303E+00	.264697E-01	.287075E+02
176	.121293E+00	.238426E-01	.287070E+02
177	.113666E+00	.176616E-01	.287740E+02
178	.109582E+00	.275503E-01	.299702E+02
179	.109973E+00	.103321E-01	.289128E+02
180	.106726E+00	.134719E-01	.299169E+02
181	.107509E+00	.326666E-02	.291131E+02
182	.105316E+00	-.152429E-02	.293556E+02
183	.103874E+00	-.572849E-02	.296422E+02
184	.103250E+00	-.125069E-02	.302668E+02
185	.104516E+00	-.997851E-02	.299673E+02
186	.986076E-01	-.801020E-02	.308371E+02
187	.102088E+00	-.892565E-02	.305197E+02
188	.906640E-01	.107282E-01	.317266E+02
189	.623156E-01	.630180E-01	.357902E+02
190	.762499E-01	.300608E-01	.324180E+02
191	.202363E-01	.138836E+00	.456304E+02
192	.205138E-01	.159876E+00	.460910E+02
193	.000000E+00	.000000E+00	.600000E+02
194	.160647E-01	-.146538E+00	.250756E+02
195	.105710E-01	-.178735E+00	.259682E+02
196	.000000E+00	.000000E+00	.200000E+02
197	.449746E-01	-.172834E+00	.293701E+02
198	.886826E-01	-.129093E+00	.321264E+02
199	.776185E-01	-.690349E-01	.333651E+02
200	.507513E-01	-.140281E+00	.340267E+02
201	.832339E-01	-.196558E-01	.334416E+02
202	.563165E-01	-.192521E-01	.352806E+02
203	.873081E-01	.114094E-01	.329769E+02
204	.967324E-01	.282304E-01	.323407E+02
205	.875014E-01	.325812E-01	.317918E+02
206	.569759E-01	.258647E-01	.339521E+02
207	.898633E-01	.284433E-01	.314161E+02
208	.672613E-01	.250613E-01	.329447E+02
209	.911531E-01	.209516E-01	.312256E+02
210	.923282E-01	.134796E-01	.312017E+02
211	.923556E-01	.671931E-02	.312978E+02
212	.733256E-01	.112388E-01	.326997E+02
213	.934710E-01	.588316E-03	.314739E+02
214	.768151E-01	.122140E-02	.329153E+02
215	.909877E-01	-.328549E-02	.316827E+02
216	.870471E-01	-.146847E-02	.319017E+02

217	.778653E-01	.114861E-01	.323335E+02
218	.723358E-01	.320144E-02	.331576E+02
219	.626094E-01	.521629E-01	.335203E+02
220	.515441E-01	.692402E-01	.346841E+02
221	.416801E-01	.130536E+00	.375828E+02
222	.152294E-01	.191661E+00	.467959E+02
223	.000000E+00	.000000E+00	.600000E+02
224	.740924E-02	.218604E+00	.476909E+02
225	.138161E-01	-.197560E+00	.268012E+02
226	.000000E+00	.000000E+00	.200000E+02
227	.273776E-01	-.210278E+00	.323798E+02
228	.125185E-01	-.207213E+00	.276947E+02
229	.356711E-01	-.144180E+00	.357016E+02
230	.206782E-01	-.143218E+00	.373061E+02
231	.354162E-01	-.723326E-01	.369312E+02
232	.308621E-01	-.187661E-01	.368336E+02
233	.308797E-01	.103339E-01	.362074E+02
234	.938351E-02	-.172727E-01	.382624E+02
235	.335340E-01	.213746E-01	.354966E+02
236	.154884E-01	.161012E-01	.370429E+02
237	.385718E-01	.227275E-01	.349238E+02
238	.454308E-01	.196088E-01	.345594E+02
239	.508892E-01	.148308E-01	.343972E+02
240	.263331E-01	.135787E-01	.362961E+02
241	.550326E-01	.868496E-02	.343893E+02
242	.375464E-01	.501409E-02	.362329E+02
243	.576222E-01	.334298E-02	.344642E+02
244	.591403E-01	.906030E-03	.345382E+02
245	.595998E-01	.153947E-02	.346675E+02
246	.419806E-01	-.792210E-03	.362805E+02
247	.579386E-01	.804287E-02	.345723E+02
248	.442571E-01	.105423E-01	.360668E+02
249	.512071E-01	.313278E-01	.347476E+02
250	.394455E-01	.874820E-01	.358571E+02
251	.204090E-01	.177098E+00	.398306E+02
252	.251283E-01	.106709E+00	.371101E+02
253	.325660E-02	.224968E+00	.484430E+02
254	-.527056E-03	.223185E+00	.491289E+02
255	.000000E+00	.000000E+00	.600000E+02
256	.570571E-02	-.222748E+00	.284660E+02
257	.108478E-02	-.235637E+00	.291905E+02
258	.000000E+00	.000000E+00	.200000E+02
259	.101539E-01	-.220717E+00	.351587E+02
260	.623351E-02	-.136816E+00	.387430E+02
261	-.850587E-04	-.613583E-01	.398575E+02
262	-.504623E-02	-.127383E+00	.400884E+02
263	-.457109E-02	-.163653E-01	.397007E+02
264	-.161829E-01	-.144889E-01	.411152E+02
265	-.426225E-02	.425067E-02	.391506E+02
266	.498725E-04	.113777E-01	.386303E+02
267	.559095E-02	.118241E-01	.382842E+02
268	-.138280E-01	.707103E-02	.402776E+02
269	.106094E-01	.808594E-02	.381323E+02
270	-.414204E-02	.332709E-02	.400115E+02
271	.154371E-01	.371976E-02	.381112E+02
272	.199655E-01	.104547E-02	.381440E+02
273	.241409E-01	-.114794E-02	.381413E+02
274	.346867E-02	-.352827E-02	.400141E+02
275	.277732E-01	-.340118E-02	.380361E+02
276	.146130E-01	-.729986E-02	.397171E+02
277	.301595E-01	-.137885E-02	.378089E+02
278	.304058E-01	.122030E-01	.375083E+02
279	.242579E-01	.482059E-01	.374622E+02
280	.171760E-01	.147888E-01	.389006E+02
281	.139568E-01	.118457E+00	.385503E+02
282	.543509E-02	.127552E+00	.399233E+02
283	.378428E-02	.209597E+00	.424014E+02
284	-.196569E-02	.232408E+00	.500064E+02
285	.000000E+00	.000000E+00	.600000E+02
286	-.103139E-02	.235492E+00	.508124E+02
287	.200607E-02	-.232629E+00	.299983E+02
288	.000000E+00	.000000E+00	.200000E+02
289	-.367529E-02	-.209827E+00	.376065E+02
290	.517043E-03	-.223439E+00	.308771E+02
291	-.137001E-01	-.118514E+00	.414599E+02
292	-.250950E-01	-.105889E+00	.429009E+02
293	-.237785E-01	-.480899E-01	.425500E+02



294	-.297132E-01	-.121132E-01	.425028E+02
295	-.294631E-01	.148802E-02	.422098E+02
296	-.441055E-01	-.104768E-01	.439463E+02
297	-.273660E-01	.371206E-02	.430100E+02
298	-.421031E-01	.143304E-02	.437878E+02
299	-.242526E-01	.163822E-02	.419353E+02
300	-.205356E-01	-.637518E-03	.419375E+02
301	-.160307E-01	-.389907E-02	.419352E+02
302	-.377833E-01	-.448241E-02	.438672E+02
303	-.109622E-01	-.886464E-02	.418606E+02
304	-.261132E-01	-.147108E-01	.438874E+02
305	-.536629E-02	-.127276E-01	.418540E+02
306	.634431E-03	-.120249E-01	.413098E+02
307	.510313E-02	-.433738E-02	.408276E+02
308	-.150972E-01	-.168913E-01	.428921E+02
309	.536207E-02	.168887E-01	.403195E+02
310	-.901177E-02	.178341E-01	.417587E+02
311	.694831E-03	.620580E-01	.401725E+02
312	-.587590E-02	.137239E+00	.412741E+02
313	-.100030E-01	.220785E+00	.448467E+02
314	-.204831E-01	.143760E+00	.427161E+02
315	-.585949E-02	.222720E+00	.515456E+02
316	-.124857E-01	.207264E+00	.523060E+02
317	.000000E+00	.000000E+00	.600000E+02
318	-.329092E-02	-.225194E+00	.315621E+02
319	-.746013E-02	-.218629E+00	.323122E+02
320	.000000E+00	.000000E+00	.200000E+02
321	-.205180E-01	-.177322E+00	.401887E+02
322	-.396278E-01	-.876907E-01	.441536E+02
323	-.514781E-01	-.314148E-01	.452651E+02
324	-.518160E-01	-.693422E-01	.453224E+02
325	-.582521E-01	-.792971E-02	.454486E+02
326	-.728236E-01	-.299064E-02	.468677E+02
327	-.599641E-01	-.114415E-02	.454513E+02
328	-.595852E-01	-.227326E-03	.455254E+02
329	-.577930E-01	-.269665E-02	.456227E+02
330	-.771715E-01	-.692734E-03	.471170E+02
331	-.548890E-01	-.851371E-02	.456778E+02
332	-.729798E-01	-.114749E-01	.473134E+02
333	-.505109E-01	-.154570E-01	.456347E+02
334	-.448452E-01	-.208304E-01	.454298E+02
335	-.381697E-01	-.238994E-01	.450439E+02
336	-.667455E-01	-.261316E-01	.470411E+02
337	-.333824E-01	-.220504E-01	.444744E+02
338	-.570466E-01	-.262472E-01	.460484E+02
339	-.308511E-01	-.103558E-01	.437875E+02
340	-.308958E-01	.193638E-01	.431909E+02
341	-.354035E-01	.731870E-01	.431040E+02
342	-.566088E-01	.198669E-01	.447421E+02
343	-.356270E-01	.144799E+00	.443225E+02
344	-.508502E-01	.140887E+00	.459942E+02
345	-.273611E-01	.210543E+00	.476290E+02
346	-.138129E-01	.197620E+00	.532007E+02
347	.000000E+00	.000000E+00	.600000E+02
348	-.105913E-01	.178785E+00	.540448E+02
349	-.152866E-01	-.191898E+00	.332043E+02
350	.000000E+00	.000000E+00	.200000E+02
351	-.418199E-01	-.130543E+00	.424182E+02
352	-.205397E-01	-.159654E+00	.339057E+02
353	-.828373E-01	-.521599E-01	.484508E+02
354	-.763574E-01	-.299894E-01	.475777E+02
355	-.781961E-01	-.113985E-01	.476678E+02
356	-.873926E-01	.170366E-02	.481017E+02
357	-.912125E-01	.359948E-02	.483223E+02
358	-.987157E-01	.618887E-02	.491570E+02
359	-.925573E-01	-.332234E-03	.485289E+02
360	-.103111E+00	.124954E-02	.497201E+02
361	-.921862E-01	-.675520E-02	.486945E+02
362	-.919605E-01	-.139684E-01	.487792E+02
363	-.908505E-01	-.217271E-01	.487505E+02
364	-.108440E+00	-.139852E-01	.500594E+02
365	-.894691E-01	-.292523E-01	.485655E+02
366	-.109672E+00	-.280544E-01	.500159E+02
367	-.875508E-01	-.331453E-01	.482028E+02
368	-.870550E-01	-.284121E-01	.476636E+02
369	-.877507E-01	-.112163E-01	.470320E+02
370	-.115707E+00	-.292352E-01	.494316E+02

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371	-.836654E-01	.201554E-01	.466720E+02
372	-.111201E+00	.181238E-01	.487345E+02
373	-.779238E-01	.696443E-01	.466515E+02
374	-.687271E-01	.129568E+00	.478880E+02
375	-.450377E-01	.173043E+00	.606361E+02
376	-.856641E-01	.109043E+00	.500675E+02
377	-.160807E-01	.146544E+00	.549277E+02
378	-.230062E-01	.114974E+00	.559006E+02
379	.000000E+00	.000000E+00	.600000E+02
380	-.202348E-01	-.138787E+00	.341641E+02
381	-.203628E-01	-.908082E-01	.344180E+02
382	.000000E+00	.000000E+00	.200000E+02
383	-.623092E-01	-.629490E-01	.442019E+02
384	-.906665E-01	-.108398E-01	.482654E+02
385	-.102039E+00	.902590E-02	.494718E+02
386	-.940030E-01	-.118793E-04	.486182E+02
387	-.104438E+00	.101031E-01	.500236E+02
388	-.969666E-01	.107685E-01	.505551E+02
389	-.103730E+00	.560609E-02	.503479E+02
390	-.103099E+00	.147049E-02	.506332E+02
391	-.107308E+00	-.347436E-02	.508744E+02
392	-.921386E-01	.139612E-02	.512092E+02
393	-.109834E+00	-.106878E-01	.510748E+02
394	-.962149E-01	-.489531E-02	.517451E+02
395	-.113609E+00	-.180594E-01	.512162E+02
396	-.121567E+00	-.241638E-01	.512874E+02
397	-.130747E+00	-.266588E-01	.512909E+02
398	-.111944E+00	-.159927E-01	.522138E+02
399	-.136169E+00	-.252666E-01	.512092E+02
400	-.133176E+00	-.143277E-01	.526430E+02
401	-.136715E+00	-.135453E-01	.510784E+02
402	-.135748E+00	.984138E-02	.511078E+02
403	-.123692E+00	.437210E-01	.514679E+02
404	-.141312E+00	.215027E-02	.531914E+02
405	-.978763E-01	.795842E-01	.524220E+02
406	-.996601E-01	.477213E-01	.546064E+02
407	-.602428E-01	.101726E+00	.542816E+02
408	-.219765E-01	.852553E-01	.569404E+02
409	.000000E+00	.000000E+00	.600000E+02
410	-.157864E-01	.507238E-01	.578340E+02
411	-.421031E-01	-.357225E-01	.346982E+02
412	.000000E+00	.000000E+00	.200000E+02
413	-.844282E-01	-.445183E-02	.443148E+02
414	.000000E+00	.000000E+00	.341664E+02
415	-.801104E-01	.661898E-02	.484500E+02
416	.000000E+00	.000000E+00	.479703E+02
417	-.692031E-01	.640979E-02	.499546E+02
418	-.668971E-01	.426017E-02	.508802E+02
419	-.634662E-01	.145011E-02	.511128E+02
420	.000000E+00	.000000E+00	.505898E+02
421	-.588641E-01	.552596E-02	.514628E+02
422	.000000E+00	.000000E+00	.514989E+02
423	-.577285E-01	-.427814E-02	.517670E+02
424	-.606014E-01	-.125785E-02	.520565E+02
425	-.668287E-01	-.236356E-02	.523508E+02
426	.000000E+00	.000000E+00	.521139E+02
427	-.726369E-01	-.605084E-02	.526740E+02
428	.000000E+00	.000000E+00	.527604E+02
429	-.800378E-01	-.764170E-02	.530239E+02
430	-.920240E-01	-.596011E-02	.534107E+02
431	-.108066E+00	-.349584E-02	.538529E+02
432	.000000E+00	.000000E+00	.535758E+02
433	-.106334E+00	-.135852E-02	.544000E+02
434	.000000E+00	.000000E+00	.548871E+02
435	-.952496E-01	.815349E-02	.550862E+02
436	-.806029E-01	.149151E-01	.559692E+02
437	-.511507E-01	.169401E-01	.570821E+02
438	.000000E+00	.000000E+00	.562877E+02
439	-.156404E-01	.160664E-01	.584231E+02
440	.000000E+00	.000000E+00	.586198E+02
441	.000000E+00	.000000E+00	.600000E+02

ไฟล์ผลลัพธ์ (Gauss elimination method)

NODAL SOLUTIONS (441):

NODE	U-VELOCITY	V-VELOCITY	TEMPERATURE	PRESSURE
1	.000000E+00	.000000E+00	.200000E+02	.512933E+01
2	.000000E+00	.000000E+00	.226236E+02	.512725E+01
3	.000000E+00	.000000E+00	.246145E+02	.511026E+01
4	.000000E+00	.000000E+00	.269316E+02	.509425E+01
5	.000000E+00	.000000E+00	.288892E+02	.508766E+01
6	.000000E+00	.000000E+00	.275667E+02	.508193E+01
7	.000000E+00	.000000E+00	.282052E+02	.507908E+01
8	.000000E+00	.000000E+00	.288514E+02	.507525E+01
9	.000000E+00	.000000E+00	.303842E+02	.506793E+01
10	.000000E+00	.000000E+00	.367427E+02	.504736E+01
11	.000000E+00	.000000E+00	.600000E+02	.502795E+01
12	.000000E+00	.000000E+00	.200000E+02	.406909E+01
13	.584220E-01	-.619676E-01	.240111E+02	.407193E+01
14	.127425E+00	-.256339E-01	.262996E+02	.406154E+01
15	.144780E+00	.989663E-02	.270935E+02	.405195E+01
16	.122222E+00	.168611E-01	.275896E+02	.404850E+01
17	.103051E+00	.100729E-01	.279978E+02	.404604E+01
18	.926674E-01	.122643E-02	.285098E+02	.404407E+01
19	.933573E-01	-.584070E-02	.291096E+02	.404152E+01
20	.978915E-01	-.103666E-01	.300701E+02	.403790E+01
21	.845426E-01	.142727E-01	.348246E+02	.403630E+01
22	.000000E+00	.000000E+00	.600000E+02	.404739E+01
23	.000000E+00	.000000E+00	.200000E+02	.302811E+01
24	.544847E-01	-.140676E+00	.275662E+02	.302665E+01
25	.102560E+00	-.622989E-01	.311923E+02	.301519E+01
26	.118259E+00	.126339E-01	.310115E+02	.301234E+01
27	.115202E+00	.331106E-01	.301996E+02	.301253E+01
28	.107493E+00	.217503E-01	.298876E+02	.301360E+01
29	.104398E+00	.594770E-02	.300675E+02	.301240E+01
30	.100648E+00	-.540067E-02	.305828E+02	.301164E+01
31	.914179E-01	-.241111E-02	.314684E+02	.301087E+01
32	.497177E-01	.103311E+00	.367676E+02	.301405E+01
33	.000000E+00	.000000E+00	.600000E+02	.301741E+01
34	.000000E+00	.000000E+00	.200000E+02	.199078E+01
35	.358782E-01	-.200502E+00	.310718E+02	.199187E+01
36	.565662E-01	-.749119E-01	.352665E+02	.198533E+01
37	.581536E-01	.126876E-01	.346930E+02	.198435E+01
38	.620031E-01	.303217E-01	.333293E+02	.198737E+01
39	.702448E-01	.202664E-01	.327099E+02	.198756E+01
40	.739382E-01	.627301E-02	.327911E+02	.198791E+01
41	.746730E-01	-.102043E-02	.331106E+02	.198721E+01
42	.642064E-01	.217423E-01	.334942E+02	.198778E+01
43	.327119E-01	.145626E+00	.363891E+02	.199005E+01
44	.000000E+00	.000000E+00	.600000E+02	.199533E+01
45	.000000E+00	.000000E+00	.200000E+02	.977435E+00
46	.186548E-01	-.220347E+00	.337876E+02	.973525E+00
47	.140103E-01	-.666770E-01	.384346E+02	.968535E+00
48	.106711E-01	.682866E-02	.377151E+02	.970424E+00
49	.203275E-01	.190983E-01	.366912E+02	.971043E+00
50	.315827E-01	.123290E-01	.363008E+02	.971841E+00
51	.397349E-01	.163593E-02	.361645E+02	.971266E+00
52	.441340E-01	-.109841E-02	.360710E+02	.971670E+00
53	.386776E-01	.363645E-01	.361350E+02	.970867E+00
54	.110025E-01	.199013E+00	.412014E+02	.974539E+00
55	.000000E+00	.000000E+00	.600000E+02	.978211E+00
56	.000000E+00	.000000E+00	.200000E+02	-.316084E-01
57	.174377E-02	-.214985E+00	.365726E+02	-.321181E-01
58	-.135780E-01	-.571747E-01	.412044E+02	-.342396E-01
59	-.191107E-01	.216739E-02	.406761E+02	-.346241E-01
60	-.106861E-01	.788908E-02	.402568E+02	-.338225E-01
61	.885550E-03	.255451E-02	.402008E+02	-.342650E-01
62	.112356E-01	-.572416E-02	.399372E+02	-.338255E-01
63	.180108E-01	-.364253E-02	.393169E+02	-.346354E-01
64	.125082E-01	.552118E-01	.387632E+02	-.342825E-01
65	-.198324E-02	.214949E+00	.434229E+02	-.321254E-01
66	.000000E+00	.000000E+00	.600000E+02	-.316135E-01
67	.000000E+00	.000000E+00	.200000E+02	-.102178E+01
68	-.110159E-01	-.198773E+00	.387926E+02	-.102546E+01
69	-.392150E-01	-.373910E-01	.438272E+02	-.102914E+01

70	-.458586E-01	-.739906E-03	.437546E+02	-.102833E+01
71	-.412775E-01	-.217553E-02	.436016E+02	-.102874E+01
72	-.314503E-01	-.100863E-01	.436899E+02	-.102817E+01
73	-.187210E-01	-.166580E-01	.433292E+02	-.102900E+01
74	-.940529E-02	-.724503E-02	.423302E+02	-.102961E+01
75	-.142436E-01	.637245E-01	.415596E+02	-.103148E+01
76	-.187831E-01	.219746E+00	.462385E+02	-.102648E+01
77	.000000E+00	.000000E+00	.600000E+02	-.102257E+01
78	.000000E+00	.000000E+00	.200000E+02	-.200466E+01
79	-.325893E-01	-.145465E+00	.416086E+02	-.200994E+01
80	-.840991E-01	-.219740E-01	.465054E+02	-.201221E+01
81	-.753136E-01	.308354E-03	.466634E+02	-.201277E+01
82	-.749718E-01	-.644323E-02	.471186E+02	-.201206E+01
83	-.707623E-01	-.194015E-01	.471592E+02	-.201240E+01
84	-.814953E-01	-.287281E-01	.465968E+02	-.201264E+01
85	-.569648E-01	-.124217E-01	.462966E+02	-.201566E+01
86	-.559113E-01	.737542E-01	.447202E+02	-.201466E+01
87	-.357178E-01	.199909E+00	.489211E+02	-.200811E+01
88	.000000E+00	.000000E+00	.600000E+02	-.200921E+01
89	.000000E+00	.000000E+00	.200000E+02	-.298257E+01
90	-.496575E-01	-.103237E+00	.432373E+02	-.298593E+01
91	-.913457E-01	.241276E-02	.485493E+02	-.298912E+01
92	-.100891E+00	.513123E-02	.494674E+02	-.298835E+01
93	-.105015E+00	-.595301E-02	.499443E+02	-.298759E+01
94	-.107883E+00	-.213234E-01	.501301E+02	-.298640E+01
95	-.114864E+00	-.324887E-01	.497978E+02	-.298747E+01
96	-.115495E+00	-.126567E-01	.489895E+02	-.298765E+01
97	-.102088E+00	.616652E-01	.488000E+02	-.298478E+01
98	-.543536E-01	.140474E+00	.524225E+02	-.297432E+01
99	.000000E+00	.000000E+00	.600000E+02	-.297187E+01
100	.000000E+00	.000000E+00	.200000E+02	-.395281E+01
101	-.845207E-01	-.142396E-01	.461825E+02	-.396369E+01
102	-.978290E-01	.104173E-01	.499412E+02	-.396210E+01
103	-.932885E-01	.581085E-02	.508997E+02	-.395848E+01
104	-.927224E-01	-.128497E-02	.514948E+02	-.395594E+01
105	-.103106E+00	-.998884E-02	.520003E+02	-.395397E+01
106	-.121944E+00	-.167267E-01	.524089E+02	-.395150E+01
107	-.144316E+00	-.992733E-02	.529045E+02	-.394804E+01
108	-.127248E+00	.254421E-01	.536973E+02	-.393843E+01
109	-.584300E-01	.619842E-01	.569842E+02	-.392804E+01
110	.000000E+00	.000000E+00	.600000E+02	-.393088E+01
111	.000000E+00	.000000E+00	.200000E+02	-.497205E+01
112	.000000E+00	.000000E+00	.433641E+02	-.495264E+01
113	.000000E+00	.000000E+00	.496234E+02	-.493208E+01
114	.000000E+00	.000000E+00	.511528E+02	-.492476E+01
115	.000000E+00	.000000E+00	.517958E+02	-.492099E+01
116	.000000E+00	.000000E+00	.524283E+02	-.491807E+01
117	.000000E+00	.000000E+00	.531065E+02	-.491234E+01
118	.000000E+00	.000000E+00	.540640E+02	-.490574E+01
119	.000000E+00	.000000E+00	.553815E+02	-.489971E+01
120	.000000E+00	.000000E+00	.573741E+02	-.487272E+01
121	.000000E+00	.000000E+00	.600000E+02	-.487064E+01
122	.156664E-01	-.161001E-01	.215694E+02	
123	.158186E-01	-.508238E-01	.221698E+02	
124	.000000E+00	.000000E+00	.200000E+02	
125	.000000E+00	.000000E+00	.213822E+02	
126	.512585E-01	-.169881E-01	.229225E+02	
127	.000000E+00	.000000E+00	.237175E+02	
128	.807062E-01	-.149635E-01	.240370E+02	
129	.955047E-01	-.818215E-02	.249192E+02	
130	.999375E-01	-.478622E-01	.254040E+02	
131	.106613E+00	.138408E-02	.256081E+02	
132	.141733E+00	-.212051E-02	.266206E+02	
133	.000000E+00	.000000E+00	.253400E+02	
134	.105277E+00	.354083E-02	.261548E+02	
135	.000000E+00	.000000E+00	.264305E+02	
136	.921262E-01	.602079E-02	.265959E+02	
137	.800405E-01	.769576E-02	.269608E+02	
138	.133474E+00	.144923E-01	.273646E+02	
139	.725720E-01	.807711E-02	.273276E+02	
140	.112008E+00	.160919E-01	.277853E+02	
141	.000000E+00	.000000E+00	.272417E+02	
142	.667580E-01	.235054E-02	.276478E+02	
143	.000000E+00	.000000E+00	.278837E+02	
144	.605786E-01	.121510E-02	.279401E+02	
145	.577631E-01	.370827E-03	.282290E+02	
146	.861983E-01	.483672E-02	.282470E+02	

147	.589629E-01	-.579425E-03	.285347E+02
148	.921012E-01	-.142399E-02	.287581E+02
149	.000000E+00	.000000E+00	.284990E+02
150	.835837E-01	-.144970E-02	.288876E+02
151	.000000E+00	.000000E+00	.294130E+02
152	.866931E-01	-.425135E-02	.293234E+02
153	.892755E-01	-.838473E-02	.300521E+02
154	.966953E-01	-.107718E-01	.294528E+02
155	.801752E-01	-.858890E-02	.315589E+02
156	.939747E-01	.330496E-04	.313967E+02
157	.000000E+00	.000000E+00	.320370E+02
158	.844501E-01	.446943E-02	.356942E+02
159	.000000E+00	.000000E+00	.458397E+02
160	.420874E-01	.357379E-01	.453080E+02
161	.000000E+00	.000000E+00	.600000E+02
162	.203547E-01	.907995E-01	.455905E+02
163	.220344E-01	-.854370E-01	.230660E+02
164	.000000E+00	.000000E+00	.200000E+02
165	.804335E-01	-.102025E+00	.257294E+02
166	.230724E-01	-.115267E+00	.241061E+02
167	.982029E-01	-.798724E-01	.275941E+02
168	.860237E-01	-.109494E+00	.299631E+02
169	.124120E+00	-.438976E-01	.285610E+02
170	.136267E+00	-.983723E-02	.289109E+02
171	.137248E+00	.137215E-01	.289370E+02
172	.111773E+00	-.181842E-01	.312915E+02
173	.135640E+00	.255555E-01	.287994E+02
174	.116310E+00	.295782E-01	.305769E+02
175	.131145E+00	.269418E-01	.287096E+02
176	.121828E+00	.243481E-01	.287025E+02
177	.113762E+00	.181000E-01	.287668E+02
178	.110084E+00	.283662E-01	.299578E+02
179	.109849E+00	.106963E-01	.289090E+02
180	.106345E+00	.142766E-01	.299175E+02
181	.107119E+00	.350357E-02	.291166E+02
182	.104748E+00	-.141321E-02	.293680E+02
183	.103261E+00	-.572614E-02	.296631E+02
184	.102258E+00	-.104383E-02	.302957E+02
185	.103980E+00	-.101157E-01	.299945E+02
186	.978168E-01	-.834249E-02	.308777E+02
187	.101893E+00	-.910473E-02	.305505E+02
188	.904356E-01	.106195E-01	.317600E+02
189	.821936E-01	.829784E-01	.358209E+02
190	.759097E-01	.298020E-01	.324607E+02
191	.202017E-01	.138736E+00	.458486E+02
192	.204686E-01	.159503E+00	.461133E+02
193	.000000E+00	.000000E+00	.600000E+02
194	.161469E-01	-.146935E+00	.250795E+02
195	.106426E-01	-.179299E+00	.259626E+02
196	.000000E+00	.000000E+00	.200000E+02
197	.452139E-01	-.173633E+00	.293772E+02
198	.690437E-01	-.130126E+00	.321352E+02
199	.783514E-01	-.700510E-01	.333774E+02
200	.510559E-01	-.141532E+00	.340295E+02
201	.842373E-01	-.203206E-01	.334575E+02
202	.571126E-01	-.202066E-01	.352646E+02
203	.884429E-01	.113238E-01	.329905E+02
204	.878433E-01	.287808E-01	.323399E+02
205	.883492E-01	.336349E-01	.317733E+02
206	.579762E-01	.265789E-01	.339413E+02
207	.899708E-01	.298049E-01	.313919E+02
208	.871925E-01	.270991E-01	.329200E+02
209	.909036E-01	.223708E-01	.312102E+02
210	.914106E-01	.147152E-01	.312069E+02
211	.909479E-01	.753924E-02	.313253E+02
212	.718749E-01	.128703E-01	.327024E+02
213	.910917E-01	.819682E-03	.315123E+02
214	.753999E-01	.134846E-02	.329374E+02
215	.898688E-01	-.361620E-02	.317269E+02
216	.862682E-01	-.209485E-02	.319487E+02
217	.774192E-01	.106291E-01	.323808E+02
218	.718620E-01	.230234E-02	.331899E+02
219	.623539E-01	.518968E-01	.335676E+02
220	.515105E-01	.686663E-01	.347282E+02
221	.415359E-01	.130253E+00	.376244E+02
222	.151998E-01	.191381E+00	.468208E+02
223	.000000E+00	.000000E+00	.600000E+02

224	.743113E-02	.218223E+00	.477145E+02
225	.138166E-01	-.198184E+00	.268060E+02
226	.000000E+00	.000000E+00	.200000E+02
227	.273601E-01	-.211262E+00	.323850E+02
228	.124232E-01	-.207789E+00	.276985E+02
229	.356380E-01	-.145495E+00	.356993E+02
230	.202197E-01	-.144458E+00	.373006E+02
231	.354758E-01	-.738719E-01	.369212E+02
232	.309868E-01	-.199680E-01	.368288E+02
233	.314654E-01	.100374E-01	.362130E+02
234	.888615E-02	-.187830E-01	.382557E+02
235	.341362E-01	.223171E-01	.355151E+02
236	.152881E-01	.170789E-01	.371328E+02
237	.387575E-01	.248260E-01	.349503E+02
238	.449569E-01	.228056E-01	.345874E+02
239	.497893E-01	.177045E-01	.344084E+02
240	.258969E-01	.169905E-01	.364451E+02
241	.535739E-01	.108326E-01	.343711E+02
242	.367800E-01	.680491E-02	.362196E+02
243	.582994E-01	.406900E-02	.344110E+02
244	.582028E-01	.483277E-03	.344832E+02
245	.590966E-01	.301546E-03	.345428E+02
246	.418733E-01	-.181830E-02	.361389E+02
247	.578723E-01	.869668E-02	.345602E+02
248	.444879E-01	.884278E-02	.360035E+02
249	.513565E-01	.302766E-01	.347844E+02
250	.396498E-01	.868504E-01	.358901E+02
251	.205828E-01	.178749E+00	.398550E+02
252	.255033E-01	.105034E+00	.371271E+02
253	.332492E-02	.224767E+00	.484631E+02
254	-.391892E-03	.223152E+00	.491442E+02
255	.000000E+00	.000000E+00	.600000E+02
256	.558405E-02	-.223115E+00	.284546E+02
257	.905814E-03	-.235631E+00	.291826E+02
258	.000000E+00	.000000E+00	.200000E+02
259	.967631E-02	-.221191E+00	.361563E+02
260	.527874E-02	-.137833E+00	.387340E+02
261	-.150741E-02	-.629235E-01	.398420E+02
262	-.622895E-02	-.127897E+00	.400729E+02
263	-.614184E-02	-.178649E-01	.397040E+02
264	-.186091E-01	-.154530E-01	.411230E+02
265	-.574206E-02	.387448E-02	.392123E+02
266	-.141918E-02	.122838E-01	.387821E+02
267	.445760E-02	.141498E-01	.385202E+02
268	-.163347E-01	.777388E-02	.404029E+02
269	.102712E-01	.112854E-01	.383829E+02
270	-.427361E-02	.556882E-02	.402047E+02
271	.155766E-01	.664037E-02	.382870E+02
272	.207158E-01	.279304E-02	.381963E+02
273	.251816E-01	-.880112E-03	.360738E+02
274	.563710E-02	-.167041E-02	.401051E+02
275	.283244E-01	-.442251E-02	.378986E+02
276	.159696E-01	-.764024E-02	.396749E+02
277	.303782E-01	-.296672E-02	.378762E+02
278	.306464E-01	.105581E-01	.374241E+02
279	.244989E-01	.469269E-01	.374274E+02
280	.173513E-01	.133154E-01	.388462E+02
281	.142897E-01	.117835E+00	.385501E+02
282	.558440E-02	.128838E+00	.399098E+02
283	.408947E-02	.209484E+00	.424137E+02
284	-.184918E-02	.232586E+00	.500151E+02
285	.000000E+00	.000000E+00	.600000E+02
286	-.993452E-03	.235766E+00	.508160E+02
287	.179715E-02	-.232288E+00	.299820E+02
288	.000000E+00	.000000E+00	.200000E+02
289	-.425620E-02	-.209352E+00	.375807E+02
290	.422188E-03	-.222829E+00	.308517E+02
291	-.147544E-01	-.118412E+00	.414330E+02
292	-.257004E-01	-.105247E+00	.428592E+02
293	-.254861E-01	-.484547E-01	.425276E+02
294	-.320941E-01	-.128393E-01	.424968E+02
295	-.321834E-01	.104075E-02	.422151E+02
296	-.456233E-01	-.105384E-01	.439081E+02
297	-.298834E-01	.354942E-02	.420111E+02
298	-.436217E-01	.481497E-03	.438634E+02
299	-.258042E-01	.178866E-02	.419202E+02
300	-.205939E-01	-.379860E-03	.418922E+02

301	-.146655E-01	-.325523E-02	.416797E+02
302	-.375950E-01	-.574568E-02	.436024E+02
303	-.667984E-02	-.767361E-02	.418352E+02
304	-.246869E-01	-.141613E-01	.435190E+02
305	-.308255E-02	-.116587E-01	.416615E+02
306	.228732E-02	-.116390E-01	.413479E+02
307	.605676E-02	-.477577E-02	.408485E+02
308	-.136454E-01	-.160370E-01	.429173E+02
309	.569951E-02	.157083E-01	.403071E+02
310	-.841909E-02	.171654E-01	.417612E+02
311	.702677E-03	.607359E-01	.401460E+02
312	-.581624E-02	.136473E+00	.412553E+02
313	-.990210E-02	.220760E+00	.448400E+02
314	-.203827E-01	.143144E+00	.426909E+02
315	-.564363E-02	.223087E+00	.515453E+02
316	-.126083E-01	.207615E+00	.523023E+02
317	.000000E+00	.000000E+00	.600000E+02
318	-.329519E-02	-.224496E+00	.315334E+02
319	-.738049E-02	-.218039E+00	.322834E+02
320	.000000E+00	.000000E+00	.200000E+02
321	-.204723E-01	-.176499E+00	.401401E+02
322	-.395980E-01	-.868108E-01	.441028E+02
323	-.514660E-01	-.307794E-01	.452146E+02
324	-.513435E-01	-.685675E-01	.452737E+02
325	-.584592E-01	-.771257E-02	.453863E+02
326	-.719984E-01	-.289167E-02	.468002E+02
327	-.603274E-01	-.153774E-02	.463513E+02
328	-.595909E-01	-.130268E-02	.453608E+02
329	-.575700E-01	-.421267E-02	.453931E+02
330	-.763067E-01	-.186637E-02	.470037E+02
331	-.545826E-01	-.990640E-02	.454084E+02
332	-.727824E-01	-.126422E-01	.471770E+02
333	-.500840E-01	-.160431E-01	.452804E+02
334	-.445764E-01	-.203081E-01	.452581E+02
335	-.378070E-01	-.228851E-01	.449663E+02
336	-.672893E-01	-.256082E-01	.469666E+02
337	-.326701E-01	-.209486E-01	.444585E+02
338	-.570235E-01	-.254280E-01	.460240E+02
339	-.300403E-01	-.994899E-02	.437876E+02
340	-.301027E-01	.189320E-01	.431697E+02
341	-.351242E-01	.723446E-01	.430669E+02
342	-.561510E-01	.194430E-01	.447053E+02
343	-.355101E-01	.144294E+00	.442893E+02
344	-.506865E-01	.140541E+00	.459662E+02
345	-.273244E-01	.210624E+00	.476102E+02
346	-.138362E-01	.197982E+00	.531939E+02
347	.000000E+00	.000000E+00	.600000E+02
348	-.105746E-01	.179148E+00	.540350E+02
349	-.151517E-01	-.191988E+00	.331792E+02
350	.000000E+00	.000000E+00	.200000E+02
351	-.414408E-01	-.130142E+00	.423780E+02
352	-.204385E-01	-.159464E+00	.338683E+02
353	-.622075E-01	-.516076E-01	.464407E+02
354	-.758317E-01	-.297089E-01	.475501E+02
355	-.772763E-01	-.109970E-01	.476333E+02
356	-.863472E-01	.171047E-02	.480666E+02
357	-.902689E-01	.309223E-02	.482836E+02
358	-.978970E-01	.615465E-02	.491433E+02
359	-.917553E-01	-.125226E-02	.484881E+02
360	-.102693E+00	.836804E-03	.497214E+02
361	-.917977E-01	-.777010E-02	.485599E+02
362	-.921439E-01	-.145103E-01	.487616E+02
363	-.914064E-01	-.217255E-01	.487485E+02
364	-.106864E+00	-.140730E-01	.500858E+02
365	-.901933E-01	-.288276E-01	.485690E+02
366	-.110192E+00	-.277874E-01	.500375E+02
367	-.880824E-01	-.326030E-01	.482009E+02
368	-.871701E-01	-.280561E-01	.476487E+02
369	-.875206E-01	-.112254E-01	.470062E+02
370	-.118742E+00	-.291490E-01	.494223E+02
371	-.833220E-01	.198152E-01	.465361E+02
372	-.111013E+00	.177889E-01	.487069E+02
373	-.776581E-01	.692341E-01	.466098E+02
374	-.686123E-01	.129401E+00	.478609E+02
375	-.450345E-01	.173255E+00	.506135E+02
376	-.857154E-01	.108960E+00	.500261E+02
377	-.160903E-01	.146907E+00	.549163E+02

378	-.230584E-01	.115304E+00	.558890E+02
379	.000000E+00	.000000E+00	.600000E+02
380	-.201832E-01	-.138728E+00	.341544E+02
381	-.203615E-01	-.908029E-01	.344136E+02
382	.000000E+00	.000000E+00	.200000E+02
383	-.621447E-01	-.629366E-01	.441854E+02
384	-.903809E-01	-.105391E-01	.482509E+02
385	-.101645E+00	.915888E-02	.494645E+02
386	-.939268E-01	.236250E-04	.486128E+02
387	-.103980E+00	.100775E-01	.500226E+02
388	-.966204E-01	.107871E-01	.505584E+02
389	-.103341E+00	.562945E-02	.503534E+02
390	-.104958E+00	.128534E-02	.506458E+02
391	-.107414E+00	-.359244E-02	.508932E+02
392	-.921177E-01	.135459E-02	.512193E+02
393	-.110129E+00	-.106613E-01	.510969E+02
394	-.962891E-01	-.463894E-02	.517544E+02
395	-.113969E+00	-.178994E-01	.512357E+02
396	-.121751E+00	-.240114E-01	.512963E+02
397	-.130780E+00	-.265973E-01	.512883E+02
398	-.111883E+00	-.159129E-01	.522114E+02
399	-.136124E+00	-.253446E-01	.512001E+02
400	-.133073E+00	-.144301E-01	.526324E+02
401	-.136638E+00	-.137928E-01	.510643E+02
402	-.135748E+00	.955705E-02	.510886E+02
403	-.123810E+00	.436126E-01	.514351E+02
404	-.141399E+00	.198658E-02	.531776E+02
405	-.980182E-01	.795710E-01	.523988E+02
406	-.998792E-01	.477479E-01	.545916E+02
407	-.603578E-01	.101951E+00	.542634E+02
408	-.220393E-01	.855287E-01	.569309E+02
409	.000000E+00	.000000E+00	.600000E+02
410	-.158877E-01	.508885E-01	.578275E+02
411	-.420999E-01	-.357418E-01	.346967E+02
412	.000000E+00	.000000E+00	.200000E+02
413	-.844449E-01	-.446048E-02	.443128E+02
414	.000000E+00	.000000E+00	.341648E+02
415	-.801480E-01	.661506E-02	.484492E+02
416	.000000E+00	.000000E+00	.479707E+02
417	-.692248E-01	.640824E-02	.499663E+02
418	-.666040E-01	.426262E-02	.508843E+02
419	-.634841E-01	.144362E-02	.511185E+02
420	.000000E+00	.000000E+00	.505938E+02
421	-.588805E-01	.573621E-03	.514692E+02
422	.000000E+00	.000000E+00	.515043E+02
423	-.577156E-01	-.384186E-03	.517724E+02
424	-.605417E-01	-.122116E-02	.520590E+02
425	-.687229E-01	-.234944E-02	.523493E+02
426	.000000E+00	.000000E+00	.521150E+02
427	-.725029E-01	-.604108E-02	.526684E+02
428	.000000E+00	.000000E+00	.527543E+02
429	-.799200E-01	-.787086E-02	.530148E+02
430	-.919231E-01	-.599444E-02	.533998E+02
431	-.105022E+00	-.382519E-02	.538413E+02
432	.000000E+00	.000000E+00	.535651E+02
433	-.106389E+00	-.142099E-02	.543883E+02
434	.000000E+00	.000000E+00	.546559E+02
435	-.953952E-01	.809756E-02	.550771E+02
436	-.867008E-01	.149212E-01	.559594E+02
437	-.513005E-01	.169827E-01	.570747E+02
438	.000000E+00	.000000E+00	.582792E+02
439	-.157011E-01	.161130E-01	.584290E+02
440	.000000E+00	.000000E+00	.586165E+02
441	.000000E+00	.000000E+00	.600000E+02

ประวัติผู้วิจัย

นายวรสิทธิ์ กาญจนกิจเกษม เกิดเมื่อวันที่ 4 เดือนมีนาคม พุทธศักราช 2518 ที่ จังหวัดกรุงเทพมหานคร สำเร็จการศึกษาปริญญาวิศวกรรมศาสตรบัณฑิตจากภาควิชาวิศวกรรม เครื่องกล คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เมื่อปีการศึกษา 2538 เข้าศึกษาต่อ ในหลักสูตรวิศวกรรมศาสตรมหาบัณฑิต ภาควิชาวิศวกรรมเครื่องกล คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เมื่อปีการศึกษา 2539



สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย