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      PROGRAM FRF2

C THIS PROGRAM WILL CALCULATE THE FREQUENCY RESPONSE OF A SYSTEM USING THE
C SUBROUTINE FFT2F.F WRITTEN BY STEARNS AND DAVID.  IT WILL INCLUDE TWO INPUT
C FILES AND AN OUTPUT FILE.

      integer nmax
      real*8 pi

      parameter (nmax = 8192)
      parameter (pi = 3.14159265358979323846d0)
      integer n


      real a(0 : nmax)
      real b(0:nmax), WW(0:NMAX), WD(0:NMAX), PT(0:NMAX)
      REAL T(0:NMAX), AOA(0:NMAX), JD(0:NMAX), JW(0:NMAX)
      REAL PTREL(0:NMAX),U,UTIP,RHO,PAMB, AVGOUT, AVGIN
      REAL MAGRR(0:NMAX), MAGF(0:NMAX), PHASERR(0:NMAX), PHASEF(0:NMAX)
      COMPLEX  HH(0:NMAX), AA(0:NMAX), BB(0:NMAX), CC(0:NMAX)
      REAL MAG(0:NMAX), PHASE(0:NMAX), RE(0:NMAX), IM(0:NMAX)
      REAL MAGR(0:NMAX), PHASER(0:NMAX), C(0:NMAX), H(0:NMAX)
      REAL RER(0:NMAX), IMR(0:NMAX)
c     OPEN(UNIT=2,FILE='C:\joe\thesis\shaun_data\s3d12ww.DAT')!response function
      OPEN(UNIT=1,FILE='C:\myfiles\shaun_thesis\shaun_two\s3c12.dat')!forcing function
      OPEN(UNIT=3,FILE='C:\msdev\projects\FRF2\ww\RESPFUNCs3c12ww')
      OPEN(UNIT=4,FILE='C:\msdev\projects\FRF2\ww\READIMs3c12ww')
      OPEN(UNIT=5,FILE='C:\msdev\projects\FRF2\ww\RESPONSEs3c12ww')
      OPEN(UNIT=6,FILE='C:\msdev\projects\FRF2\ww\MAG&PHASEs3c12ww')
      open(Unit=8,file='c:\msdev\projects\frf2\ww\PLOTs3c12ww.DAT')
      N=13
      NN=N/2.
      RHO =.0738 !LBM/FT^3
      RHO=RHO/.062428 !KG/M^3
      U=2100.  !MACHINE SPEED IN RPM
      U=U*2.*PI/60. !RAD/S
      UTIP=U*.228346 !m/s
      PAMB=30.22*3386.388 !PASCALS

C DETERMINE WHICH OUTPUT PARAMETER WILL BE A FUNCTION OF THE FORCING FUNCTION
C IN THE BOLLER DATA SET THE FORCING FUNCTION IS AOA AND THE RESPONSE FUNCTIONS
C ARE WAKE DEPTH, WAKE WIDTH, JET DEPTH, JET WIDTH, AND TOTAL PRESSURE (POOR RESPONSE).
      PRINT *, 'ENTER THE NUMBER FOR WHICH RESPONSE IS TO BE USED TO CAL
     1CULATE THE FRF OF THE BLADE. THE HIGHEST CORRELATION OCCURRED WITH
     2 THE SEMI WAKE WIDTH AND AOA.'
      PRINT *,'  '
      PRINT *,'WAKE SEMI-WIDTH  =  1'
      PRINT *,'WAKE DEFECT MAG  =  2'
      PRINT *,'SS JET MAG       =  3'
      PRINT *,'SS JET SEMI-WIDTH=  4'
      PRINT *,'EXT MED PT       =  5'
      READ *,K
      PRINT *,'ENTER THE NUMBER FOR THE FORCING FUNCTION THAT IS TO BE U
     1SED IN THE FRF CALCULATION'
      PRINT *,'AOA = 6'
      PRINT *,'PT REL = 7'
      READ *, KK

      DO 2 J=0,N-1
      READ(1,1) T(J), PTREL(J),AOA(J), JW(J), JD(J), WW(J), WD(J), PT(J)
1     FORMAT(E9.2,1X,E9.2,1X,E8.2,1X,E8.2,1X,E8.2,1X,E8.2,1X,E9.2,1X,E8.
     12)
      PTREL(J)=PTREL(J)+(PAMB/(.5*RHO*UTIP**2))
      PT(J)=PT(J)+(PAMB/(.5*RHO*UTIP**2))
      PRINT *, ptrel(J), pt(J)
2     CONTINUE
      PRINT *,'   '
      DO 3 J=0,N-1
      IF(K .EQ. 1) B(J)=WW(J)
      IF(K .EQ. 2) B(J)=WD(J)
      IF(K .EQ. 3) B(J)=JD(J)
      IF(K .EQ. 4) B(J)=JW(J)
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      IF(K .EQ. 5) B(J)=PT(J)
      IF(KK .EQ. 6) A(J)=AOA(J)
      IF(KK .EQ. 7) A(J)=PTREL(J)
3     CONTINUE

C NORMALIZE AOA AND WAKE SEMI-WIDTH TO MAKE A RESPONSE THAT HAS A HIGHER
C RELATIONSHIP TO THE ACTUAL BLADE LIFT RESPONSE.
C ALSO NORMALIZE PT/PT.

      DO 20 J=0,N-1
      AVGOUT=AVGOUT+B(J)
      AVGIN=AVGIN+A(J)
20    CONTINUE
      AVGOUT=AVGOUT/N
      AVGIN=AVGIN/N
      DO 25 J=0,N-1
      A(J)=A(J)/AVGIN
      B(J)=B(J)/AVGOUT
25    CONTINUE


c     DO 20 J=0,N-1
c     READ(2,'(F12.6)') B(J)
c20   CONTINUE

      CALL SPDFTR(A,AA,N)
      CALL SPDFTR(B,BB,N)
C CALCULATE THE MAG AND PHASE OF THE FRF
      DO 30 I=0,(N-1)/2
      MAGF(I)=((AIMAG(AA(I))**2+REAL(AA(I))**2)**.5)
      MAGRR(I)=((AIMAG(BB(I))**2+REAL(BB(I))**2)**.5)
      MAG(I)=MAGRR(I)/MAGF(I)
      PHASERR(I)=ATAN2(AIMAG(BB(I)),REAL(BB(I)))
      PHASEF(I)=ATAN2(AIMAG(AA(I)),REAL(AA(I)))
      PHASE(I)=PHASERR(I)-PHASEF(I)
30    CONTINUE

C CALCUATE THE FRF IN THE FREQUENCY DOMAIN (REAL AND IMAGINARY PARTS)
      DO 35 I=0,(N-1)/2
C HAND CHECKED THE FOLLOWING TWO CALCULATIONS
      RE(I)=MAG(I)*COS(PHASE(I))
      IM(I)=MAG(I)*SIN(PHASE(I))
      WRITE(4,'(2F15.7)') RE(I), IM(I)
      HH(I)=CMPLX(RE(I),IM(I))
35    CONTINUE

      CALL SPIDTR(HH,H,N)
      DO 36 I=0,N-1
      H(I)=H(I)/N
36    CONTINUE

      DO 37 I=0,N-1
      WRITE(3,'(E15.7)') H(I)
37    CONTINUE

      DO 50 I=0,(N-1)/2
      WRITE(6,'(2E15.7)') MAG(I), PHASE(I)
50    CONTINUE

      DO 60 I=0,(N-1)/2
      MAGR(I)=MAG(I)*((AIMAG(AA(I))**2+REAL(AA(I))**2)**.5)
      PHASER(I)=PHASE(I)+ATAN2(AIMAG(AA(I)),REAL(AA(I)))
60    CONTINUE
c CHECK TO SEE IF THE FRF GIVES THE SAME RESPONSE AS THE GIVEN RESPONSE
      DO 70 I=0,(N-1)/2
      RER(I)=MAGR(I)*COS(PHASER(I))
      IMR(I)=MAGR(I)*SIN(PHASER(I))
      CC(I)=CMPLX(RER(I),IMR(I))
70    CONTINUE
      CALL SPIDTR(CC,C,N)
      DO 75 I=0,N-1
      C(I)=C(I)/N
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75    CONTINUE
      DO 80 I=0,N-1
      WRITE(5,'(2E15.7)') B(I), C(I)
80    CONTINUE

      IF(K .EQ. 1) THEN
      WRITE (8,81)
81    FORMAT(1X,'TITLE="FRF WW/AOA"',/,1X,'VARIABLES= "HARMONICS" "AOA"
     1"WAKE SEMI-WIDTH" "AOA MAG" "AOA PHASE" "WAKE SEMI-WIDTH MAG" "WAK
     2E SEMI-WIDTH PHASE" "FRF MAG" "FRF PHASE" "THETA"',/)
      END IF

      IF (K .EQ. 5) THEN
      WRITE (8,85)
85    FORMAT (1X,'TITLE="FRF OF BLADE"',/,1X,'VARIABLES= "HARMONICS" "PT
     1 INLET" "PT EXIT" "PT INLET MAG" "PT INLET PHASE" "PT EXIT MAG" "P
     2T EXIT PHASE" "FRF MAG" "FRF PHASE" "THETA"',/)
      END IF

      WRITE (8,86)
86    FORMAT (1X,'ZONE I=13',' J=1','  F=POINT')

      DO 100 I=0,N+1
      WRITE (8,90) I,A(I),B(I),MAGF(I),PHASEF(I),MAGRR(I),PHASERR(I),
     1MAG(I),PHASE(I), T(I)
90    FORMAT (2X,I4,2X,F11.6,2X,F11.6,2X,F11.6,2X,F11.6,2X,F11.6,2X,F11.
     16,2X,F11.6,2X,F11.6,2X,F9.3)
100   CONTINUE


      END



            SUBROUTINE SPDFTR(X,Y,N)
C-LATEST DATE: 10/26/90
C-COMPUTES THE DFT OF A REAL VECTOR X CONTAINING N DATA SAMPLES.
C-X IS DIMENSIONED X(0:N-1) OR LARGER.
C-Y IS COMPLEX Y(0:N/2) IF N EVEN, OR Y(0:(N-1)/2) IF N ODD.
C-INPUTS ARE X(0),X(1),...,X(N-1) AND N=NUMBER OF DATA SAMPLES.
C-OUTPUTS Y(0),Y(1),...,Y(N/2) IF N EVEN, OR Y(0),Y(1),...,
C-  Y((N-1)/2) IF N ODD, ARE THE COMPLEX DFT COMPONENTS, WITH
C-  COSINE COMPONENT=REAL PART AND SINE COMPONENT=IMAGINARY PART.
C-Y AND X CANNOT BE THE SAME ARRAY.
      REAL X
      DIMENSION X(0:N-1)
      COMPLEX Y(0:N/2),TPJN
      TPJN=CMPLX(0.,-8.*ATAN(1.)/N)
      DO 2 M=0,N/2
        Y(M)=X(0)
        DO 1 K=1,N-1
          Y(M)=Y(M)+X(K)*EXP(TPJN*K*M)
    1   CONTINUE
    2 CONTINUE
      RETURN
      END


C-*****************************************************************
C-
      SUBROUTINE SPIDTR(Y,X,N)
C-LATEST DATE: 11/12/85
C-SAME AS SPDFTR EXCEPT REVERSED; Y=SPECTRUM, X=OUTPUT TIME SERIES.
C-SPECTRAL DATA IS ASSUMED TO BE IN COMPLEX Y(0) THRU Y(N/2).
C-N=TIME SERIES LENGTH SHOULD BE EVEN.  TIME SERIES (SCALED BY N)
C-IS COMPUTED IN X(0) THRU X(N-1).  COMPLEX Y(0:N/2) AND DIMENSION
C-X(0:N-1) ARE ASSUMED, ALTHOUGH THE ARRAYS MAY BE LARGER.
      DIMENSION X(0:N-1)
      COMPLEX Y(0:N/2),TPJN
      TPJN=CMPLX(0.,8.*ATAN(1.)/N)
      DO 2 K=0,N-1
        X(K)=Y(0)+Y(N/2)*(-1)**K
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          DO 1 M=1,N/2-1
            X(K)=X(K)+2.*REAL(Y(M)*EXP(TPJN*K*M))
    1     CONTINUE
    2   CONTINUE
        RETURN
        END
C-
C-*********************************************************************
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