```
!***************** ********************************************
!           3-D Numerical Wave Basin Program by BEM
!           Warning !! only for PC Cluster with 4 CPUs
!           2005/7/28 winnt
!*************************************************************************
*
        include 'mpif.h'
        integer stat(mpi_status_size),rank,cpu_num
        integer c(4)
      character(len=*) path
      parameter(path='\\3dwave09\chou\3dwave4\5x20\')
!=============================================================
        parameter(ni1=161,nj1=11,ni2=3,nj2=21,ni3=3,nj3=41,
       &          ni4=3,nj4=41,ni5=3,nj5=11,ni6=21,nj6=11,b6=1)
        parameter(ni11=ni1-1,nj11=nj1-1,ni21=ni2-1,nj21=nj2-1,ni31=ni3-1,
       &          nj31=nj3-1,ni41=ni4-1,nj41=nj4-1,ni51=ni5-1,nj51=nj5-1,
       &          ni61=ni6-1,nj61=nj6-1)
        parameter(nt1=ni1*nj1,nt2=ni2*nj2,nt3=ni3*nj3,
       &          nt4=ni4*nj4,nt5=ni5*nj5,nt6=ni6*nj6)
        parameter(nt=nt1+nt2+nt3+nt4+nt5+nt6,nt26=nt-nt1)

!       select large one between nt1 and nt26
        parameter(n1=ni1/2*nj1,n2=(ni1-ni1/2)*nj1)
        parameter(n3=nt2+nt3+nt4+nt5,n4=nt6)
        parameter(nt0=n2)
        real x(nt),y(nt),z(nt),fxx(nt1),fyy(nt1),fzz(nt1)
        real hh(nt0,nt0),gg(nt0,nt0),xp(3,3),xpkj(3,3,nj1)
      real f1(nt1),f1b(nt1),f2(nt2),f2b(nt2),f3(nt3),f3b(nt3)
      real f4(nt4),f4b(nt4),f5(nt5),f5b(nt5),f6(nt6),f6b(nt6)
        real u(nj2),xx(4),yy(4),zz(4),tmp(nt)

!========================
!       change case by case
        parameter(i_dis=11)
!========================

!
        parameter(nspec=2048)
```

```
      real rnum(nspec),s0(nspec),hkk(nspec),re(nspec),ss(nspec),
     &         e25(25),f25(25),theta(nspec)

!       residual correction
        parameter(icor_ch=10,icorr=2)
      real mas,maso,kin
      character*8 systime
!=================================================================
====
        call mpi_init(ierror)
        call mpi_comm_size(mpi_comm_world,cpu_num,ierror)
        call mpi_comm_rank(mpi_comm_world,rank,ierror)
!       ********************************************
!       in   processor   1   (n0,server.cluster)
!       ********************************************
        if(rank.eq.0)then
        c(1)=0
      if(cpu_num.ne.4)then
        write(*,*) 'Error !! Not have enough CPUs !'
        pause
      end if
!=================================================================
        open(27,file=path//'hw.dat',status='replace')
        open(26,file=path//'surface.dat',status='replace')
        open(24,file=path//'mass.dat',status='replace')
        write(24,"(5a8)") 'ttx','mas','eng','ek','ep'
!=================================================================
        open(25,file=path//'3dwave.in')
        read(25,*) icase
        read(25,*) start
        read(25,*) eend
        read(25,*) wave
        close(25)
!=================================================================
        write(*,*)
        write(*,*) 'n1=',n1,' n2=',n2,' n3=',n3,' n4=',n4
      write(*,*)
      write(*,*) 'nt0=',nt0
```

```
      write(*,*)
      write(*,*) 'CHECK DIMENSION'
      write(*,*)
         pa2i=1.570796327
         pai =3.141592654
         pai2=6.283185308
         gro=9.81
         ho=1.
         nch=nj2
         itype=1
         umu=2.0
      mu=3
      nu0=nj2/8
      if(ho.eq.100) gr=gro*ho
      if(ho.ne.100) gr=gro
!======================= ============================
         if(icase.eq.1) then
         open(34,file=path//'xyz.dat')
         read(34,4) (x(i),y(i),z(i),i=1,nt)
         close(34)
         do i=1,nt
         x(i)=x(i)*ho
         y(i)=y(i)*ho
         z(i)=z(i)*ho
         end do
!-------------------------------------------------------------
         do i=1,nt1
         f1(i)=0
         f1b(i)=0
      fxx(i)=0
      fyy(i)=0
      fzz(i)=0
         end do
         do i=1,nt2
         f2b(i)=0
         end do
         do i=1,nt3
         f3b(i)=0
```

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```
      end do
      do i=1,nt4
      f4b(i)=0
      end do
      do i=1,nt5
      f5b(i)=0
      end do
      do i=1,nt6
      f6b(i)=0
      end do
      end if
!=============================================
      if(icase.ne.1) then
      open(28,file=path//'3dwave.old',form='unformatted',status='old')
      read(28) (f1(i),i=1,nt1)
      read(28) (z(i),x(i),y(i),i=1,nt)
      close(28)
      end if
!-------------------------------------
      blod=x(nj2+nt1)/nj21
!=============================================
      if(wave.eq.1) then
      open(25,file=path//'regular.dat')
!      read(25,*) t31
      read(25,*) shg
      read(25,*) h31
      read(25,*) teta0
      read(25,*) depth
      read(25,*) ntt
      close(25)
      h31=h31*ho
      depth=depth*ho
!      shg=4*pai**2*depth/t31**2/gr
      t31=sqrt(4*pai**2*depth/shg/gr)
      call kh(shg,hk)
      ddt=t31/ntt
      rteta0=teta0*pai/180.0
      df=2*pai/t31
```

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```
      write(27,*) 'shg=',shg,'    t31=',t31,'    kh=',hk,'    l/h=',pai2/hk
      write(26,*) 'shg=',shg,'    t31=',t31,'    kh=',hk,'    l/h=',pai2/hk
      write(*,*)   'shg=',shg,'    t31=',t31,'    kh=',hk,'    l/h=',pai2/hk
      e=df*h31/2*(sinh(hk)*cosh(hk)+hk)/2./sinh(hk)**2
      end if
!=====================================
      if(wave.eq.2) then
      open(25,file=path//'cross.dat')
      read(25,*) shg1
      read(25,*) h31
      read(25,*) teta01
      read(25,*) shg2
      read(25,*) h32
      read(25,*) teta02
      read(25,*) depth
      read(25,*) ntt
      close(25)
      depth=depth*ho
      h31=h31*ho
      t31=sqrt(4*pai**2*depth/shg1/gr)
      call kh(shg1,hk1)
      ddt=t31/ntt
      rteta01=teta01*pai/180.0
      df1=2*pai/t31
      write(*,*) 't31=',t31
      h32=h32*ho
      t32=sqrt(4*pai**2*depth/shg2/gr)
      call kh(shg2,hk2)
      rteta02=teta02*pai/180.0
      df2=2*pai/t32
      e1=df1*h31/2*(sinh(hk1)*cosh(hk1)+hk1)/2./sinh(hk1)**2
      e2=df2*h32/2*(sinh(hk2)*cosh(hk2)+hk2)/2./sinh(hk2)**2
      end if
!=========================================
      if(wave.eq.3) then
      open(25,file=path//'soliton.dat')
      read(25,*) h
      read(25,*) teta0
```

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```
      read(25,*) depth
      read(25,*) ntt
      close(25)
      dt=ntt
      h=h*ho
      depth=depth*ho
      gr1=gr*depth
      h=h/depth
      rteta0=teta0*pai/180.0
      ce=sqrt(gr1*(1+h))
      xo=sqrt(4.*h/3./(1+h))
      omega=sqrt(gr1)*sqrt(.75*h*(1+h))
      tc=pai/omega
      xleff=9.5766/sqrt(h)
      teff=xleff/ce
      ddt=tc/dt
      end if
!==================================
      if(wave.eq.4) then
      open(25,file=path//'freq.dat')
      read(25,*) itpspc
      read(25,*) shg31
      read(25,*) h31
      read(25,*) teta0
      read(25,*) deptho
      read(25,*) ntt
      if(itpspc.eq.4) then
      read(25,*) fpeak
      read(25,*) speak
      read(25,*) (e25(i),i=2,25)
      end if
      close(25)
      dtt=ntt
      h31=h31*ho
      depth=deptho*ho
      t31=sqrt(4*pai**2*depth/shg31/gr)
      write(*,*) 't31=',t31
!==================================
```

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```
tmin=0.5
tmax=2.5
rteta0=teta0*pai/180.0
ixy=7
fmax=1./tmin
fmin=1./tmax
df=(fmax-fmin)/nspec
dt=1./(2.*nspec*df)
ddt=tmin/dtt
if(itpspc.eq.1) call bm0(s0,nspec,nspec,h31,t31,dt)
if(itpspc.eq.2) call bms(s0,nspec,nspec,h31,t31,dt)
if(itpspc.eq.3) call jonswap(s0,nspec,nspec,h31,t31,dt)
if(itpspc.eq.4) call specin(s0,nspec,nspec,dt,e25,f25,fpeak,speak)
do i=1,nspec
s0(i)=s0(i)*ho**2
end do
call wvmod(re,nspec,nspec,deptho,dt,tmax,tmin,itype,hkk)
do j=1,nspec
call randu(ixy,iy,fl)
ixy=iy
rnum(j)=pai2*fl+hkk(j)*i*blod*(cos(rteta0))
end do
end if
!=========================================
if(wave.eq.5) then
open(25,file=path//'muti.dat')
read(25,*) itpspc
read(25,*) shg31
read(25,*) h31
read(25,*) teta0
read(25,*) deptho
read(25,*) smax
read(25,*) ntt
if(itpspc.eq.4) then
read(25,*) fpeak
read(25,*) speak
read(25,*) (e25(i),i=2,25)
end if
```

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```
      close(25)
      dtt=ntt
      h31=h31*ho
      depth=deptho*ho
      t31=sqrt(4*pai**2*depth/shg31/gr)
      write(*,*) 't31=',t31
!=============================================
      tmin=0.5
      tmax=2.5
      rteta0=teta0*pai/180.0
      ixy=7
      fmax=1./tmin
      fmin=1./tmax
      df=(fmax-fmin)/nspec
      dt=1./(2.*nspec*df)
      ddt=tmin/dtt
      if(itpspc.eq.1) call bm0(s0,nspec,nspec,h31,t31,dt)
      if(itpspc.eq.2) call bms(s0,nspec,nspec,h31,t31,dt)
      if(itpspc.eq.3) call jonswap(s0,nspec,nspec,h31,t31,dt)
      if(itpspc.eq.4) call specin(s0,nspec,nspec,dt,e25,f25,fpeak,speak)
      do i=1,nspec
      s0(i)=s0(i)*ho**2
      end do
      call wvmod(re,nspec,nspec,deptho,dt,tmax,tmin,itype,hkk)
!================ direction ============================
      l=int(0.11*smax+0.55)
      l2=2*l
      kq=1
      kk=1
      ll2=l2
100   kq=kq*ll2
      kk=kk*(ll2-1)
      ll2=ll2-2
      if (ll2.gt.0) go to 100
      expr=pai*float(kk)/float(kq)
      irx=ixy
      do    j=1,nspec
210   call randu(irx,iry,fl)
```

```
        irx=iry
        rcon=fl*expr
        thetal=0.0
        thetar=pai
200     thetam=(thetal+thetar)/2.0
        thetad=(thetar-thetal)
        qi=thetam
        alfa=thetam-pa2i
        do n=1,l
        qi=((sin(alfa)*(cos(alfa))**(2*n-1))+(2*n-1)*qi)/(2*n)
        end do
        def=qi-rcon
        if(def .eq. 0.0) go to 300
        if(def .gt. 0.0) thetar=thetam
        if(def .lt. 0.0) thetal=thetam
        if(thetad .ge.    0.0017) go to 200
300     if (teta0 .lt. 90.0) then
        thetam=thetam-(pa2i-teta0)
        if (thetam.le.0.0 .or. thetam.ge.pa2i+teta0) goto 210
        else if (teta0 .gt. 90.0) then
        thetam=thetam-(pa2i-teta0)
        if (thetam.le.teta0-pa2i .or. thetam.ge.pai) goto 210
        end if
        theta(j)=thetam
        end do
        do j=1,nspec
        call randu(ixy,iy,fl)
        ixy=iy
        rnum(j)=pai2*fl+hkk(j)*i*blod*(cos(theta(j)))
        end do
        end if
!-----------------------------------
        maso=depth*x(nt1)*y(nt1)
      engo=9.81*depth*ni1*nj1
!===================================
!=              begin to repeat                =
!===================================
        istart=start*100
```

```
      iend=eend*100
      istart1=istart+1
      iend1=iend
      if(icase.ne.1) istart1=istart-istart+1
      if(icase.ne.1) iend1=iend-istart
      do itt=istart1,iend1
      it1=1+float(ntt)/100*(itt-1)
      it2=float(ntt)/100*itt
      do it=it1,it2
      ttx=start+it/float(ntt)
    call time(systime)
      write(*,"('it= ',f8.5,' (system time: ',a8,' )')") ttx,systime
    t=ttx*t31
      if(wave.eq.1) call regular(u,e,df,t,hk,rteta0,nch,blod)
      if(wave.eq.2) call
     &cross(u,e1,e2,t,hk1,hk2,rteta01,rteta02,df1,df2,nch,blod)
      if(wave.eq.3) call soliton(it,u,xo,omega,tc,rteta0,ddt,nch,blod)
      if(wave.eq.4) call freq_wave(it,u,s0,df,nspec,re,ddt,rnum,nch)
      if(wave.eq.5) call muti_wave(it,u,s0,df,nspec,re,ddt,rnum,nch)
!=====================================================
    if(umu.ne.0.and.teta0.ne.90.and.wave.ne.5) then
      do ki=1,ni2
      do kj=1,nu0
      i=kj+nj2*(ki-1)
      u(kj)=0
      end do
      do kj=nj1-nu0+1,nj1
      i=kj+nj2*(ki-1)
      u(kj)=0
      end do
      end do
    end if
!=====================================================
      do ki=1,ni2
      do kj=1,nj2
      i=kj+nj2*(ki-1)
      f2b(i)=-u(kj)
      end do
```

```
        end do
!=======================================================
        open(11,file=path//'tmp/xyz.old',form='unformatted'
       &   ,status='replace')
        write(11) (z(i),x(i),y(i),i=1,nt)
        close(11)
        call openfilen(11,10)
        write(11) (f1(i),i=1,nt1)
        close(11)
        call openfilen(11,12)
        write(11) (f2b(i),i=1,nt2)
        close(11)
        call openfilen(11,13)
        write(11) (f3b(i),i=1,nt3)
        close(11)
        call openfilen(11,14)
        write(11) (f4b(i),i=1,nt4)
        close(11)
        call openfilen(11,15)
        write(11) (f5b(i),i=1,nt5)
        close(11)
        call openfilen(11,16)
        write(11) (f6b(i),i=1,nt6)
        close(11)
!#######################################################
        do iy=1,3
        call mpi_send(9,1,mpi_integer,iy,1,mpi_comm_world,ierror)
        end do
        call h1(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &          nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call g3(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &          nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call mpi_recv(c(2),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mpi_recv(c(3),1,mpi_integer,2,13,mpi_comm_world,stat,ierror)
        call mpi_recv(c(4),1,mpi_integer,3,14,mpi_comm_world,stat,ierror)

! B11^ (with n1)
        call mpi_send(9,1,mpi_integer,2,13,mpi_comm_world,ierror)
```

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```
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call mir2_1(hh,gg,nt0,n1,n2,81,71,1)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mir2_3(hh,nt0,n1,n2,71,72,91)

! B11^ *B12 (with n1)
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n1,n2,n1,n2,n3,n4,91,82,71,1,61)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n1,n2,n3,n4,71,72,90)

! B21 * [B11^ *B12] (with n1)
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n3,n4,n1,n2,n3,n4,83,90,71,1,61)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n3,n4,n3,n4,71,72,91)

! B22 - [B21 * B11^ *B12] (with n1)
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call sa2_1(hh,gg,nt0,n3,n4,n3,n4,84,91,71)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call sa2_3(hh,nt0,n3,n4,n3,n4,71,72,93)

! [B22 - B21 * B11^ *B12]^ (with n1)
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call mir2_1(hh,gg,nt0,n3,n4,93,71,1)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mir2_3(hh,nt0,n3,n4,71,72,78)

! [- B11^ * B12][B22 - B21 * B11^ * B12]^ (with n1)
        call mpi_send(7,1,mpi_integer,1,12,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n1,n2,n3,n4,n3,n4,90,78,71,2,61)
        call mpi_recv(c(1),1,mpi_integer,1,12,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n1,n2,n3,n4,71,72,76)
        call mpi_recv(c(3),1,mpi_integer,2,13,mpi_comm_world,stat,ierror)

!=====================================================
        do iy=1,3
```

```
      call mpi_send(9,1,mpi_integer,iy,1,mpi_comm_world,ierror)
      end do
      call solf1b1(gg,f1,f1b,f2b,f3b,f4b,f5b,f6b,nt0,nt1,nt2,nt3,
     &                  nt4,nt5,nt6,n1,n2,n3,n4,1,85,86,51)
      call mpi_recv(c(2),1,mpi_integer,1,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(3),1,mpi_integer,2,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(4),1,mpi_integer,3,1,mpi_comm_world,stat,ierror)
      do iy=1,3
      call mpi_send(9,1,mpi_integer,iy,1,mpi_comm_world,ierror)
      end do
      call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,1,51,52,53,54,75,76,55)
      call mpi_recv(c(2),1,mpi_integer,1,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(3),1,mpi_integer,2,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(4),1,mpi_integer,3,1,mpi_comm_world,stat,ierror)
!     ..... residual correction .. start .....
    if(icor_ch.eq.1)then
      do icor=1,icorr
      do iy=1,3
      call mpi_send(9,1,mpi_integer,iy,1,mpi_comm_world,ierror)
      end do
      call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,1,55,56,57,58,81,82,41)
      call solwsa(f1,f1b,nt1,n1,51,41,45,1)
      call mpi_recv(c(2),1,mpi_integer,1,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(3),1,mpi_integer,2,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(4),1,mpi_integer,3,1,mpi_comm_world,stat,ierror)
      do iy=1,3
      call mpi_send(9,1,mpi_integer,iy,1,mpi_comm_world,ierror)
      end do
      call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,1,45,46,47,48,75,76,35)
      call solwsa(f1,f1b,nt1,n1,55,35,55,2)
      call mpi_recv(c(2),1,mpi_integer,1,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(3),1,mpi_integer,2,1,mpi_comm_world,stat,ierror)
      call mpi_recv(c(4),1,mpi_integer,3,1,mpi_comm_world,stat,ierror)
      end do
      end if
!     ..... residual correction .. end .....
      do iy=1,3
      call mpi_send(88,1,mpi_integer,iy,1,mpi_comm_world,ierror)
```

```
      end do
!#############################################################
      call openfileo(11,10)
      read(11) (f1(i),i=1,nt1)
      close(11)

      call openfileo(11,57)
      read(11) (f1b(ki),ki=1,n3)
    close(11)
      do i=1,nt2
      f2(i)=f1b(i)
      end do
      do i=1,nt3
      f3(i)=f1b(nt2+i)
      end do
      do i=1,nt4
      f4(i)=f1b(nt2+nt3+i)
      end do
      do i=1,nt5
      f5(i)=f1b(nt2+nt3+nt4+i)
      end do

      call openfileo(11,58)
      read(11) (f6b(i),i=1,nt6)
      close(11)
!
      call openfileo(41,55)
      call openfileo(42,56)
      read(41) (f1b(ki),ki=1,n1)
      read(42) (f1b(ki),ki=n1+1,n1+n2)
      close(41)
    close(42)
      call openfileo(11,12)
      read(11) (f2b(i),i=1,nt2)
      close(11)

      call openfileo(11,13)
```

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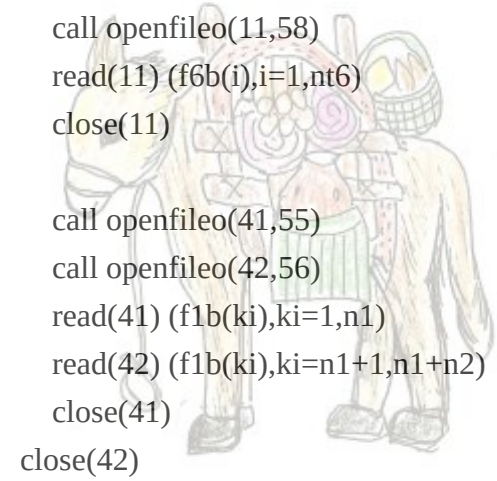


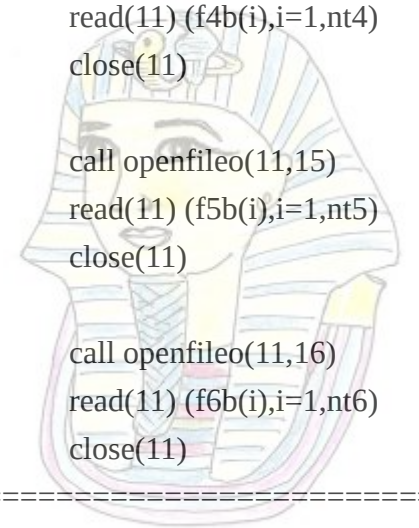
載滿貨品的驢子

```
      read(11) (f3b(i),i=1,nt3)
      close(11)

      call openfileo(11,14)
      read(11) (f4b(i),i=1,nt4)
      close(11)

      call openfileo(11,15)
      read(11) (f5b(i),i=1,nt5)
      close(11)

      call openfileo(11,16)
      read(11) (f6b(i),i=1,nt6)
      close(11)
!=================================================
      do kj=1,nj1
    f1b(kj+ni11*nj1)=f1b(kj+(ni11-1)*nj1)
    end do
!=======================2011-埃及尼羅河之旅=================
      do ki=1,ni1
      do kj=1,nj1
      nstart=0
      i=kj+nj1*(ki-1)
      if(ki.ne.ni1.and.kj.ne.nj1) then
      call xx_x_6(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
      call normal(xx,yy,zz,xn,yn,zn,a)
      xt1=xx(1)
      xt2=xx(2)
      xt3=xx(3)
      xt4=xx(4)
      yt1=yy(1)
      yt2=yy(2)
      yt3=yy(3)
      yt4=yy(4)
      zt1=zz(1)
      zt2=zz(2)
      zt3=zz(3)
      zt4=zz(4)
```



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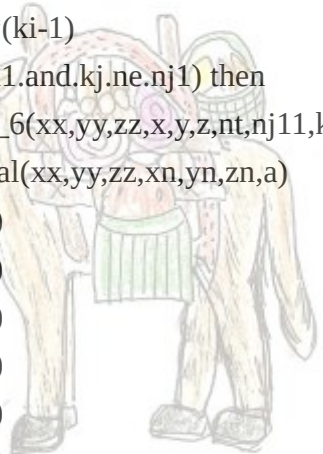

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```
p1=-1
p2=-1
xp(1,1)=.25*((-1+p2)*xt1+( 1-p2)*xt2+(1+p2)*xt3+(-1-p2)*xt4)
xp(2,1)=.25*((-1+p1)*xt1+(-1-p1)*xt2+(1+p1)*xt3+( 1-p1)*xt4)
xp(3,1)=xn
xp(1,2)=.25*((-1+p2)*yt1+( 1-p2)*yt2+(1+p2)*yt3+(-1-p2)*yt4)
xp(2,2)=.25*((-1+p1)*yt1+(-1-p1)*yt2+(1+p1)*yt3+( 1-p1)*yt4)
xp(3,2)=-yn
xp(1,3)=.25*((-1+p2)*zt1+( 1-p2)*zt2+(1+p2)*zt3+(-1-p2)*zt4)
xp(2,3)=.25*((-1+p1)*zt1+(-1-p1)*zt2+(1+p1)*zt3+( 1-p1)*zt4)
xp(3,3)=-zn
call minvs(xp,3,3,0.000001,ill)
if(ill.ne.0) write(*,11) ill
if(ki.eq.ni11) then
do ii=1,3
do jj=1,3
xpkj(ii,jj,kj)=xp(ii,jj)
end do
end do
end if
end if
if(kj.ne.nj1) fp1=(f1(i+1)-f1(i))/2.
if(kj.eq.nj1) fp1=-(f1(i)-f1(i-1))/2.
if(ki.ne.ni1) fp2=(f1(i+nj1)-f1(i))/2.
if(ki.eq.ni1) fp2=-(f1(i)-f1(i-nj1))/2.
fp3=f1b(i)
if(ki.eq.ni1) then
do ii=1,3
do jj=1,3
xp(ii,jj)=xpkj(ii,jj,kj)
end do
end do
end if
fx=xp(1,1)*fp1 +xp(1,2)*fp2 +xp(1,3)*fp3
fy=xp(2,1)*fp1 +xp(2,2)*fp2 +xp(2,3)*fp3
fz=xp(3,1)*fp1 +xp(3,2)*fp2 +xp(3,3)*fp3
if(ki.eq.1)                    fx=0
if(ki.eq.ni1)                  fy=0
```

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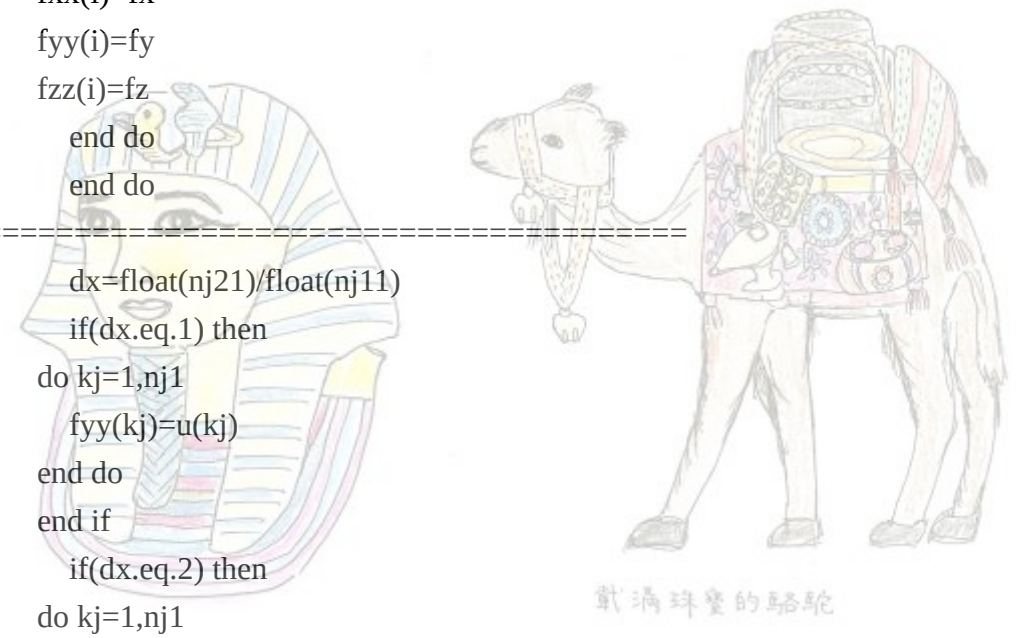
```
        if(kj.eq.1.or.kj.eq.nj1) fx=0
        if(teta0.eq.90) fx=0
      fxx(i)=fx
      fyy(i)=fy
      fzz(i)=fz
        end do
        end do
!=======================================
        dx=float(nj21)/float(nj11)
        if(dx.eq.1) then
      do kj=1,nj1
        fyy(kj)=u(kj)
      end do
      end if
        if(dx.eq.2) then
      do kj=1,nj1
      fyy(kj)=u(1+(kj-1)*2)
      end do
      end if
        if(dx.eq.3) then
      do kj=1,nj1
      fyy(kj)=u(1+(kj-1)*3)
      end do
      end if
        if(dx.eq.4) then
      do kj=1,nj1
      fyy(kj)=u(1+(kj-1)*4)
      end do
      end if
!=========================================
        do ki=1,ni1
      fxx((ki-1)*nj1+1)=0
        fxx(ki*nj1)=0
      end do
!=========================================
        do ki=1,ni1
      fyy((ki-1)*nj1+1)=fyy((ki-1)*nj1+2)
        fyy(ki*nj1)=fyy(ki*nj1-1)
```



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```
      end do
!=========================================
         do kj=1,nj1
      fyy(ni11*nj1+kj)=0
      end do
!================================
         do ki=i_dis,i_dis
         do kj=1,nj1
      fyy(kj+(ki-1)*nj1)=(fyy(kj+(ki-2)*nj1)+fyy(kj+ki*nj1))/2
      end do
      end do
!=======================================
!          go to 124
         do kij=1,20
      do ki=1,ni1
      ii=(ki-1)*nj1
      do kj=nj1/2,nj11
      fzz(ii+kj)=(fzz(ii+kj-1)+fzz(ii+kj)+fzz(ii+kj+1))/3
      end do
         fzz(ki*nj1)=(fzz(ki*nj1)+fzz(ki*nj1-1)+fzz(ki*nj1-2))/3
      do kj=nj1/2-1,2,-1
      fzz(ii+kj)=(fzz(ii+kj-1)+fzz(ii+kj)+fzz(ii+kj+1))/3
      end do
         fzz(ii+1)=(fzz(ii+1)+fzz(ii+2)+fzz(ii+3))/3
         end do
      end do
!=======================================
         do kij=1,20
      do ki=1,ni1
      ii=(ki-1)*nj1
      do kj=nj1/2,nj11
      fyy(ii+kj)=(fyy(ii+kj-1)+fyy(ii+kj)+fyy(ii+kj+1))/3
      end do
         fyy(ki*nj1)=(fyy(ki*nj1)+fyy(ki*nj1-1)+fyy(ki*nj1-2))/3
      do kj=nj1/2-1,2,-1
      fyy(ii+kj)=(fyy(ii+kj-1)+fyy(ii+kj)+fyy(ii+kj+1))/3
      end do
         fyy(ii+1)=(fyy(ii+1)+fyy(ii+2)+fyy(ii+3))/3
```

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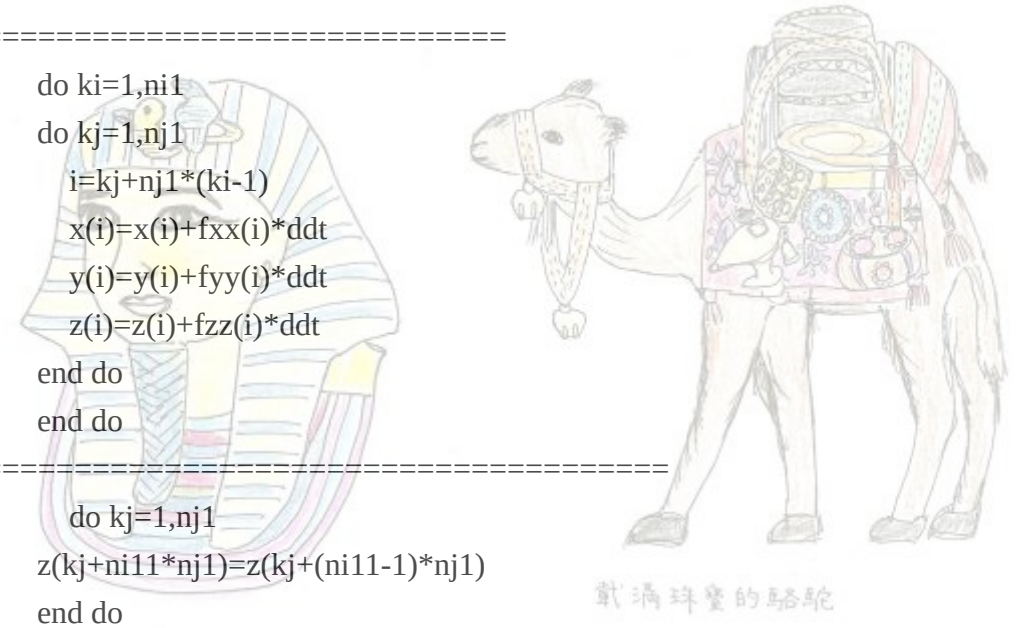
```
        end do
      end do
124   continue
!============================
      do ki=1,ni1
      do kj=1,nj1
        i=kj+nj1*(ki-1)
        x(i)=x(i)+fxx(i)*ddt
        y(i)=y(i)+fyy(i)*ddt
        z(i)=z(i)+fzz(i)*ddt
      end do
      end do
!=======================================
        do kj=1,nj1
      z(kj+ni11*nj1)=z(kj+(ni11-1)*nj1)
      end do
!=====================================
        do ki=1,ni2
      do kj=1,nj2
        i=nt1+kj+nj2*(ki-1)
      y(i)=y(i)+u(kj)*ddt
      end do
      end do
!====================================
        dx=float(nj21)/float(nj11)
        if(dx.eq.1) then
      do kj=1,nj1
        y(kj)=y(nt1+kj)
      end do
      end if
        if(dx.eq.2) then
      do kj=1,nj1
      y(kj)=y(nt1+1+(kj-1)*2)
      end do
      end if
        if(dx.eq.3) then
      do kj=1,nj1
      y(kj)=y(nt1+1+(kj-1)*3)
```



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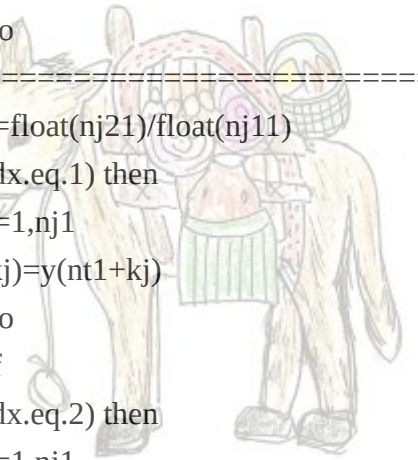
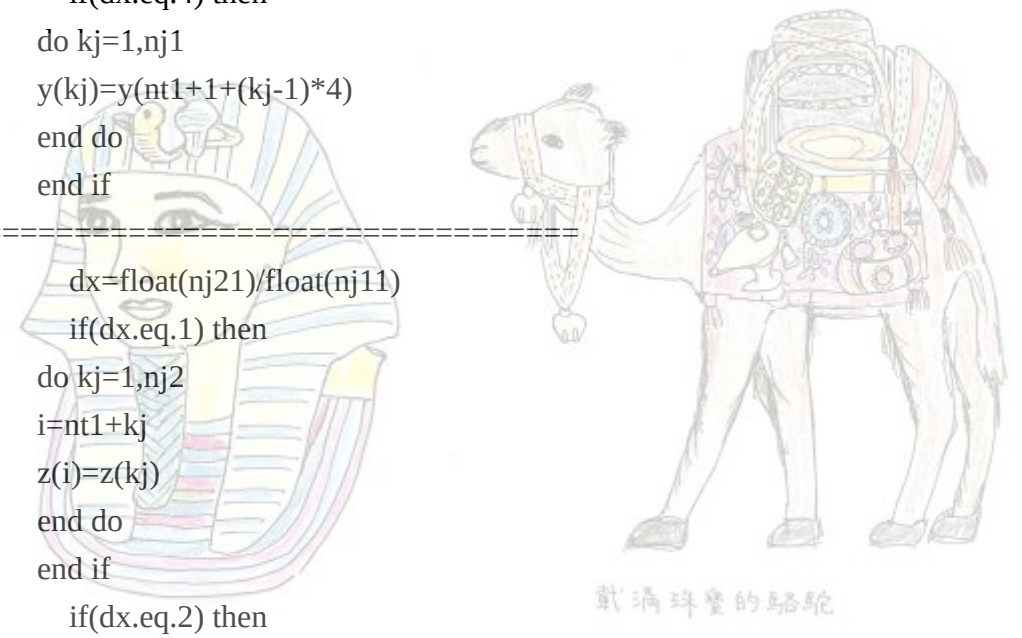


```
end do
end if
   if(dx.eq.4) then
do kj=1,nj1
y(kj)=y(nt1+1+(kj-1)*4)
end do
end if
!==================================
   dx=float(nj21)/float(nj11)
   if(dx.eq.1) then
do kj=1,nj2
i=nt1+kj
z(i)=z(kj)
end do
end if
   if(dx.eq.2) then
do kj=1,nj2,2
i=nt1+kj
j=1+(kj-1)/2
z(i)=z(j)
end do
do kj=2,nj21,2
i=nt1+kj
z(i)=0.5*(z(kj-1)+z(kj+1))
end do
end if
   if(dx.eq.3) then
do kj=1,nj2,3
i=nt1+kj
j=1+(kj-1)/3
z(i)=z(j)
end do
do kj=2,nj21-1,3
i=nt1+kj
z(i)=z((kj+1)/3)+(z((kj+4)/3)-z((kj+1)/3))/3
end do
do kj=3,nj21-2,3
i=nt1+kj
```



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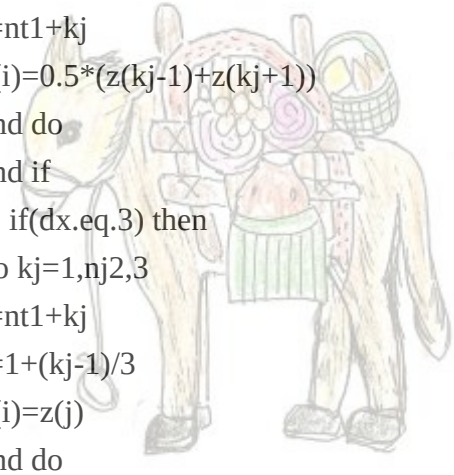

```
z(i)=z(kj/3)+2*(z((kj+3)/3)-z(kj/3))/3
end do
end if
   if(dx.eq.4) then
do kj=1,nj2,4
i=nt1+kj
j=1+(kj-1)/4
z(i)=z(j)
end do
do kj=2,nj21-2,4
i=nt1+kj
z(i)=z((kj+2)/4)+(z((kj+6)/4)-z((kj+2)/4))/4
end do
do kj=3,nj21-3,4
i=nt1+kj
z(i)=z((kj+1)/4)+2*(z((kj+5)/4)-z((kj+1)/4))/4
end do
do kj=4,nj21-4,4
i=nt1+kj
z(i)=z(kj/4)+3*(z((kj+4)/4)-z(kj/4))/4
end do
end if
!=================================================
   dx=float(ni11)/float(nj31)
   if(dx.eq.1) then
   do ki=1,ni3
do kj=1,nj3
i=nt1+nt2+kj+nj3*(ki-1)
y(i)=y(nj1*kj)
end do
end do
do kj=1,nj3
z(nt1+nt2+kj)=z(nj1*kj)
end do
end if
   if(dx.eq.2) then
   do ki=1,ni3
do kj=1,nj3
```

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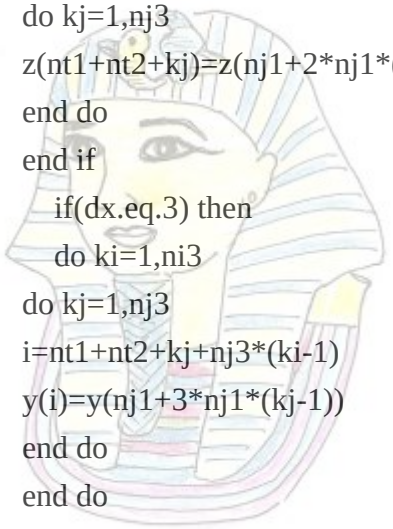
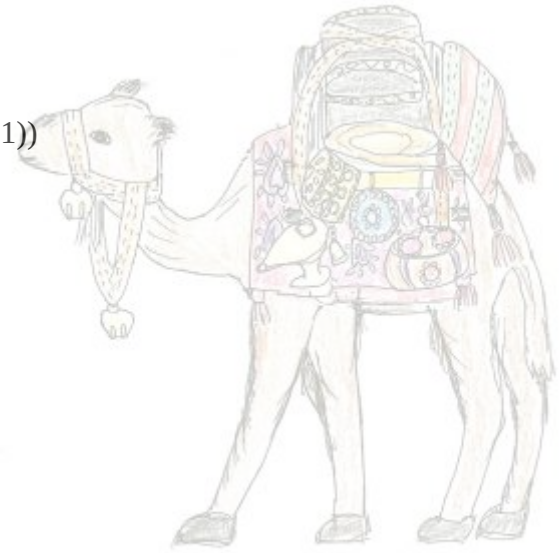
```
i=nt1+nt2+kj+nj3*(ki-1)
y(i)=y(nj1+2*nj1*(kj-1))
end do
end do
do kj=1,nj3
z(nt1+nt2+kj)=z(nj1+2*nj1*(kj-1))
end do
end if
  if(dx.eq.3) then
  do ki=1,ni3
do kj=1,nj3
i=nt1+nt2+kj+nj3*(ki-1)
y(i)=y(nj1+3*nj1*(kj-1))
end do
end do
do kj=1,nj3
z(nt1+nt2+kj)=z(nj1+3*nj1*(kj-1))
end do
end if
  if(dx.eq.4) then
  do ki=1,ni3
do kj=1,nj3
i=nt1+nt2+kj+nj3*(ki-1)
y(i)=y(nj1+4*nj1*(kj-1))
end do
end do
do kj=1,nj3
z(nt1+nt2+kj)=z(nj1+4*nj1*(kj-1))
end do
end if
!=============================================
  dx=float(ni11)/float(nj41)
  if(dx.eq.1) then
  do ki=1,ni4
do kj=1,nj4
i=nt1+nt2+nt3+kj+nj4*(ki-1)
y(i)=y(1+nj1*(kj-1))
end do
```





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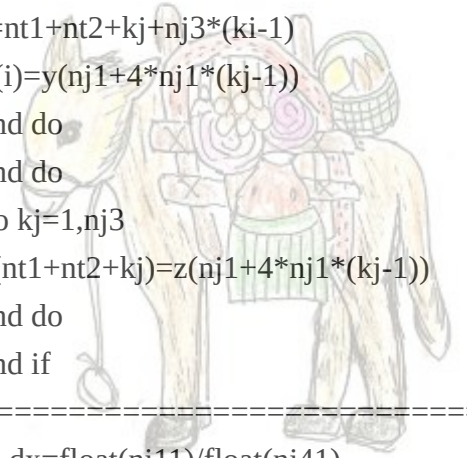

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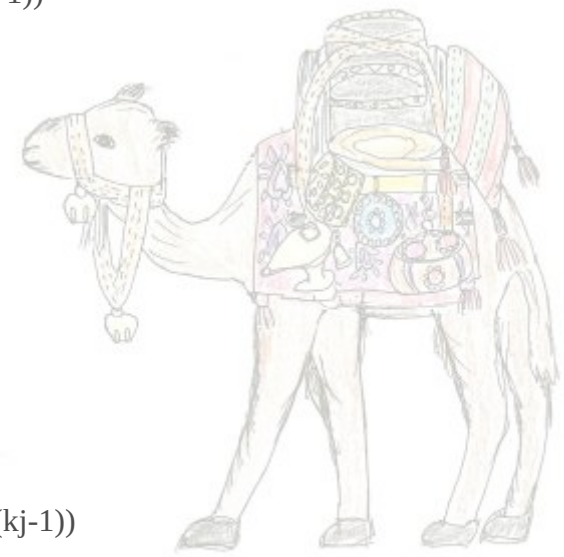
```
end do
do kj=1,nj4
z(nt1+nt2+nt3+kj)=z(1+nj1*(kj-1))
end do
end if
   if(dx.eq.2) then
   do ki=1,ni4
do kj=1,nj4
i=nt1+nt2+nt3+nj4*(ki-1)+kj
y(i)=y(1+2*nj1*(kj-1))
end do
end do
do kj=1,nj4
z(nt1+nt2+nt3+kj)=z(1+2*nj1*(kj-1))
end do
end if
   if(dx.eq.3) then
   do ki=1,ni4
do kj=1,nj4
i=nt1+nt2+nt3+nj4*(ki-1)+kj
y(i)=y(1+3*nj1*(kj-1))
end do
end do
do kj=1,nj4
z(nt1+nt2+nt3+kj)=z(1+3*nj1*(kj-1))
end do
end if
   if(dx.eq.4) then
   do ki=1,ni4
do kj=1,nj4
i=nt1+nt2+nt3+nj4*(ki-1)+kj
y(i)=y(1+4*nj1*(kj-1))
end do
end do
do kj=1,nj4
z(nt1+nt2+nt3+kj)=z(1+4*nj1*(kj-1))
end do
end if
```



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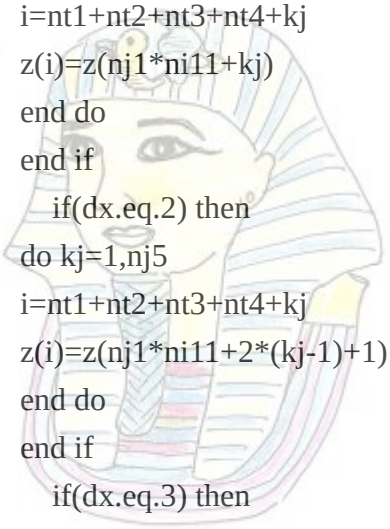
```
!=========================================
      dx=float(nj11)/float(nj51)
      if(dx.eq.1) then
    do kj=1,nj5
    i=nt1+nt2+nt3+nt4+kj
    z(i)=z(nj1*ni11+kj)
    end do
    end if
      if(dx.eq.2) then
    do kj=1,nj5
    i=nt1+nt2+nt3+nt4+kj
    z(i)=z(nj1*ni11+2*(kj-1)+1)
    end do
    end if
      if(dx.eq.3) then
    do kj=1,nj5
    i=nt1+nt2+nt3+nt4+kj
    z(i)=z(nj1*ni11+3*(kj-1)+1)
    end do
    end if
      if(dx.eq.4) then
    do kj=1,nj5
    i=nt1+nt2+nt3+nt4+kj
    z(i)=z(nj1*ni11+4*(kj-1)+1)
    end do
    end if
!=========================================
      dx=float(nj21)/float(nj61)
      if(dx.eq.1) then
      do kj=1,nj6
    i=nt1+nt2+nt3+nt4+nt5+kj
    y(i)=y(kj)
    end do
      end if
      if(dx.eq.2) then
      do kj=1,nj6
    i=nt1+nt2+nt3+nt4+nt5+kj
      y(i)=y(2*(kj-1)+1)
```



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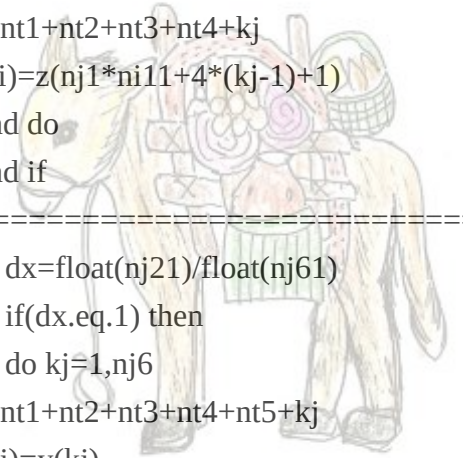

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```
      end do
      end if
      if(dx.eq.3) then
      do kj=1,nj6
    i=nt1+nt2+nt3+nt4+nt5+kj
      y(i)=y(3*(kj-1)+1)
      end do
      end if
      if(dx.eq.4) then
      do kj=1,nj6
    i=nt1+nt2+nt3+nt4+nt5+kj
      y(i)=y(4*(kj-1)+1)
      end do
      end if
!=================================================
      call check(x,y,z,nt,f1,f1b,nt1,ni1,nj1,f2,f2b,nt2,ni2,nj2,
     &           f3,f3b,nt3,ni3,nj3,f4,f4b,nt4,ni4,nj4,f5,f5b,nt5,ni5,nj5,
     &          f6,f6b,nt6,ni6,nj6,mas,eng,ek,ep)
!=========================================================
    do ki=1,ni1
    do kj=1,nj1
      i=kj+nj1*(ki-1)
      za=z(i)
    if(kj.eq.1.or.kj.eq.nj1.or.ki.eq.1.or.ki.eq.ni1)          za=z(i)/2
    if(i.eq.1.or.i.eq.nj1.or.i.eq.nt1.or.i.eq.ni11*nj1+1) za=z(i)/4
      f1(i)=f1(i)+ddt*(.5*(fxx(i)**2+fyy(i)**2+fzz(i)**2)-gr*za)
    if(umu.ne.0) then
      if(teta0.eq.90) then
      if(ki.ge.ni1-5) f1(i)=f1(i)-umu*f1(i)*ddt
    else
      if(ki.ge.ni1-5.or.kj.le.mu.or.kj.ge.nj1-mu+1)
     /     f1(i)=f1(i)-umu*f1(i)*ddt
    end if
    end if
    end do
    end do
!=========================================
    write(*,*) 'z'
```

```
      do ki=1,ni1
      i1=nj1*(ki-1)+1
      i2=nj1*ki
      if(wave.ne.3)        write(*,88) (z(i)/(h31/2.),i=i1,i2)
      if(wave.eq.3)        write(*,88) (z(i)/(h*depth),i=i1,i2)
      end do

      iwrite=ntt/100
      wd=float(it)/float(iwrite)-it/iwrite
      if(wd.eq.0) then
      write(24,"(5f8.3)") ttx,mas,eng,ek,ep
    write(26,"('ttx=',f8.3)") ttx
      do ki=1,ni1
      i1=nj1*(ki-1)+1
      i2=nj1*ki
      if(wave.ne.3)        write(26,88) (z(i)/(h31/2.),i=i1,i2)
      if(wave.eq.3)        write(26,88) (z(i)/(h*depth),i=i1,i2)
      end do
      write(27,"('ttx=',f8.3)") ttx
      write(27,7) (z(i)*ho,x(i)*ho,y(i)*ho,i=1,nt1)
      end if
    if(itt.eq.iend1.and.it.eq.it2) then
      open(28,file=path//'3dwave.old',form='unformatted'
     &   ,status='replace')
      rewind 28
      write(28) (f1(i),i=1,nt1)
      write(28) (z(i),x(i),y(i),i=1,nt)
      close(28)
    end if
      end do
      end do
      close(27)
!=====================================
7       format( 3f7.3)
6       format(21f5.2)
5       format(8f16.8)
4       format(3f10.4)
3       format(3f10.4)
```

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```
2       format(4f10.4)
10      format('    ill = ',i7)
11      format('    ill11 = ',i7)
89      format(21f8.4)
88      format(101f5.2)
90      format(101f7.3)
!#################################################################
!       stop    all    nodes
        do iy=1,cpu_num-1
        c(iy+1)=99
        call mpi_send(c(iy+1),1,mpi_integer,iy,1,mpi_comm_world,ierror)
        end do
!#################################################################
        end if
!       ************************************************
!        in    processor    2    (n1,node1.cluster)
!       ************************************************
        if(rank.eq.1)then
902     c(2)=0
        call mpi_recv(c(2),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(2).eq.99) goto 992

        open(12,file=path//'tmp/xyz.old',form='unformatted',status='old'
       &   ,action='read')
        read(12) (z(i),x(i),y(i),i=1,nt)
        close(12)

        call h2(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call g4(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call mpi_send(1,1,mpi_integer,0,12,mpi_comm_world,ierror)

! B11^ (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call mir2_2(hh,gg,nt0,n1,n2,81,72,2)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)
```

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```
! B11^ *B12 (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call mtr2_2(hh,gg,nt0,n1,n2,n1,n2,n3,n4,91,82,72,1,62)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)

! B21 * [B11^ *B12] (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call mtr2_2(hh,gg,nt0,n3,n4,n1,n2,n3,n4,83,90,72,1,62)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)

! B22 - [B21 * B1^ *B12] (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call sa2_2(hh,gg,nt0,n3,n4,n3,n4,84,91,72)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)

! [B22 - B21 * B11^ *B12]^ (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call mir2_2(hh,gg,nt0,n3,n4,93,72,2)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)

! [- B11^ *B12] * [B22 - B21 * B11^ *B12]^    (with n0)
        call mpi_recv(c(2),1,mpi_integer,0,12,mpi_comm_world,stat,ierror)
        call mtr2_2(hh,gg,nt0,n1,n2,n3,n4,n3,n4,90,78,72,2,62)
        call mpi_send(3,1,mpi_integer,0,12,mpi_comm_world,ierror)

!       ==========================================
        call mpi_recv(c(2),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b1(gg,f1,f1b,f2b,f3b,f4b,f5b,f6b,nt0,nt1,nt2,nt3,
       &             nt4,nt5,nt6,n1,n2,n3,n4,2,85,86,52)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        call mpi_recv(c(2),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,2,51,52,53,54,75,76,56)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
!       ..........................................................
972     continue
        call mpi_recv(c(2),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(2).eq.88) goto 982
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,2,55,56,57,58,81,82,42)
```

```
        call solwsa(f1,f1b,nt1,n2,52,42,46,1)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        call mpi_recv(c(2),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,2,45,46,47,48,75,76,36)
        call solwsa(f1,f1b,nt1,n2,56,36,56,2)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        goto 972
!       .....................................................
982     continue
        goto 902
992     continue
        end if
!       ******************************************
!       in   processor   3   (n2,node2.cluster)
!       ******************************************
        if(rank.eq.2)then
903     c(3)=0
        call mpi_recv(c(3),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(3).eq.99) goto 993

        open(13,file=path//'tmp/xyz.old',form='unformatted',status='old'
       &   ,action='read')
        read(13) (z(i),x(i),y(i),i=1,nt)
        close(13)

        call h3(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &             nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call g1(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &             nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call mpi_send(1,1,mpi_integer,0,13,mpi_comm_world,ierror)

! b22^ (with n3)
        call mpi_recv(c(3),1,mpi_integer,0,13,mpi_comm_world,stat,ierror)
        call mpi_send(7,1,mpi_integer,3,34,MPI_COMM_WORLD,IERROR)
        call mir2_1(hh,gg,nt0,n3,n4,84,73,3)
        call mpi_recv(c(3),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call mir2_3(hh,nt0,n3,n4,73,74,94)
```

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```
! b22^ *b21 (with n3)
        call mpi_send(7,1,mpi_integer,3,34,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n3,n4,n3,n4,n1,n2,94,83,73,1,63)
        call mpi_recv(c(3),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n3,n4,n1,n2,73,74,89)

! b12 * [b22^ *b21] (with n3)
        call mpi_send(7,1,mpi_integer,3,34,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n1,n2,n3,n4,n1,n2,82,89,73,1,63)
        call mpi_recv(c(2),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n1,n2,n1,n2,73,74,94)

! b11 - [b12 * b22^ *b21] (with n3)
        call mpi_send(7,1,mpi_integer,3,34,mpi_comm_world,ierror)
        call sa2_1(hh,gg,nt0,n1,n2,n1,n2,81,94,73)
        call mpi_recv(c(3),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call sa2_3(hh,nt0,n1,n2,n1,n2,73,74,92)

! [b11 - b12 * b22^ *b21]^ (with n3)
        call mpi_send(7,1,mpi_integer,3,34,mpi_comm_world,ierror)
        call mir2_1(hh,gg,nt0,n1,n2,92,73,3)
        call mpi_recv(c(3),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call mir2_3(hh,nt0,n1,n2,73,74,75)

! [- b22^ * b21][b11 - b12 * b22^ * b21]^ (with n3)
        call mpi_send(7,1,mpi_integer,3,34,mpi_comm_world,ierror)
        call mtr2_1(hh,gg,nt0,n3,n4,n1,n2,n1,n2,89,75,73,2,63)
        call mpi_recv(c(3),1,mpi_integer,3,34,mpi_comm_world,stat,ierror)
        call mtr2_3(hh,nt0,n3,n4,n1,n2,73,74,77)
        call mpi_send(1,1,mpi_integer,0,13,mpi_comm_world,ierror)

!       ================================================
        call mpi_recv(c(3),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b1(gg,f1,f1b,f2b,f3b,f4b,f5b,f6b,nt0,nt1,nt2,nt3,
       &             nt4,nt5,nt6,n1,n2,n3,n4,3,87,88,53)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        call mpi_recv(c(3),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,3,51,52,53,54,77,78,57)
```

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```
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
!       .....................................................................
973     continue
        call mpi_recv(c(3),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(3).eq.88) goto 983
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,3,55,56,57,58,83,84,43)
        call solwsa(f1,f1b,nt1,n3,53,43,47,1)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        call mpi_recv(c(3),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,3,45,46,47,48,77,78,37)
        call solwsa(f1,f1b,nt1,n3,57,37,57,2)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        goto 973
!       .....................................................................
983     continue
        goto 903
993     continue
        end if
!       ********************************************
!       in    processor4    (n3,node3.cluster)
!       ****************************
        if(rank.eq.3)then
904     c(4)=0
        call mpi_recv(c(4),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(4).eq.99) goto 994

        open(14,file=path//'tmp/xyz.old',form='unformatted',status='old'
       &   ,action='read')
        read(14) (z(i),x(i),y(i),i=1,nt)
        close(14)

        call h4(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &        nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call g2(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        call mpi_send(1,1,mpi_integer,0,14,mpi_comm_world,ierror)

! B22^ (with n2)
```

```
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call mir2_2(hh,gg,nt0,n3,n4,84,74,4)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)

! B22^ *B21 (with n2)
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call mtr2_2(hh,gg,nt0,n3,n4,n3,n4,n1,n2,94,83,74,1,64)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)

! B12 * [B22^ *B21] (with n2)
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call mtr2_2(hh,gg,nt0,n1,n2,n3,n4,n1,n2,82,89,74,1,64)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)

! B11 - [B12 * B22^ *B21] (with n2)
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call sa2_2(hh,gg,nt0,n1,n2,n1,n2,81,94,74)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)
```

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```
! [B11 - B12 * B22^ *B21]^ (with n2)
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call mir2_2(hh,gg,nt0,n1,n2,92,74,4)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)


! [- B22^ *B21] * [B11 - B12 * B22^ *B21]^    (with n2)
      call mpi_recv(c(4),1,mpi_integer,2,34,mpi_comm_world,stat,ierror)
      call mtr2_2(hh,gg,nt0,n3,n4,n1,n2,n1,n2,89,75,74,2,64)
      call mpi_send(3,1,mpi_integer,2,34,mpi_comm_world,ierror)

!       ================================================
      call mpi_recv(c(4),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
      call solf1b1(gg,f1,f1b,f2b,f3b,f4b,f5b,f6b,nt0,nt1,nt2,nt3,
     &             nt4,nt5,nt6,n1,n2,n3,n4,4,87,88,54)
      call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
      call mpi_recv(c(4),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
      call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,4,51,52,53,54,77,78,58)
      call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
```

```
!       .....................................................................
974     continue
        call mpi_recv(c(4),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        if(c(4).eq.88) goto 984
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,4,55,56,57,58,83,84,44)
        call solwsa(f1,f1b,nt1,n4,54,44,48,1)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        call mpi_recv(c(4),1,mpi_integer,0,1,mpi_comm_world,stat,ierror)
        call solf1b2(gg,f1,f1b,nt0,nt1,n1,n2,n3,n4,4,45,46,47,48,77,78,38)
        call solwsa(f1,f1b,nt1,n4,58,38,58,2)
        call mpi_send(1,1,mpi_integer,0,1,mpi_comm_world,ierror)
        goto 974
!       ..................................
984     continue
        goto 904
994     continue
        end if
!       ========================================================
        call mpi_finalize(ierror)
        stop
        end
!========== ================================================
        subroutine h1(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &                    nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        character(len=*) path
        real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
        real hh(nt0,nt0)
        real xg(4),yg(4),zg(4),p(2),e(2),h(4)
        call openfilen(85,85)
        ni1=ni11+1
        nj1=nj11+1
        ni2=ni21+1
        nj2=nj21+1
        ni3=ni31+1
        nj3=nj31+1
        ni4=ni41+1
        nj4=nj41+1
        ni5=ni51+1
```

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```
nj5=nj51+1
ni6=ni61+1
nj6=nj61+1
nt1=ni1*nj1
nt2=ni2*nj2
nt3=ni3*nj3
nt4=ni4*nj4
nt5=ni5*nj5
nt6=ni6*nj6
!=====================================
pai=3.1415927
do ii=1,2
if(ii.eq.1) is=1
if(ii.eq.1) ie=n1
if(ii.eq.2) is=n1+1
if(ii.eq.2) ie=n1+n2
do jj=1,2
if(jj.eq.1) js=1
if(jj.eq.1) je=n1
if(jj.eq.2) js=n1+1
if(jj.eq.2) je=n1+n2
do i=is,ie
if(ii.eq.1) ix=i
if(ii.eq.2) ix=i-n1
open(34,file=path//'node_element_n1.dat',action='read')
open(35,file=path//'node_element_n2.dat',action='read')
do j=js,je
if(jj.eq.1) jx=j
if(jj.eq.2) jx=j-n1
do k=1,4
if(jj.eq.1) read(34,201) nojk,ki,kj
if(jj.eq.2) read(35,201) nojk,ki,kj
if(nojk.eq.0) then
h(k)=0
end if
if(nojk.ne.0) then
if(i.eq.j) then
h(k)=0
```

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```
    end if
    if(i.ne.j) then
    if(nojk.eq.1) then
    nstart=0
    call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
    end if
    if(nojk.eq.2) then
    nstart=nt1
    call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
    end if
    if(nojk.eq.3) then
    nstart=nt1+nt2
    call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
    end if
    if(nojk.eq.4) then
    nstart=nt1+nt2+nt3
    call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
    end if
    if(nojk.eq.5) then
    nstart=nt1+nt2+nt3+nt4
    call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
    end if
    if(nojk.eq.6) then
    nstart=nt1+nt2+nt3+nt4+nt5
    call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
    end if

    call normal(xx,yy,zz,xn,yn,zn,a)
    call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
    call hx(h,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

    end if
    end if
    end do
    hh(ix,jx)=h(1)+h(2)+h(3)+h(4)
icheck=0
do ik=1,4
if(h(ik).eq.0) icheck=icheck+1
```

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```
      end do
      if(icheck.eq.2) hh(ix,jx)=hh(ix,jx)*2
      if(icheck.eq.3) hh(ix,jx)=hh(ix,jx)*4
        if(ii.eq.jj.and.i.eq.j) hh(ix,jx)=hh(ix,jx)+1
        end do
        close(34)
        close(35)
        end do
        if(ii.eq.1.and.jj.eq.1) write(85) ((-hh(i,j),j=1,n1),i=1,n1)
        if(ii.eq.1.and.jj.eq.2) write(85) ((-hh(i,j),j=1,n2),i=1,n1)
        if(ii.eq.2.and.jj.eq.1) write(85) ((-hh(i,j),j=1,n1),i=1,n2)
        if(ii.eq.2.and.jj.eq.2) write(85) ((-hh(i,j),j=1,n2),i=1,n2)
        end do
        end do
        close(85)
4       format(3f10.4)
2       format(4f10.4)
201     format(3i5)
        return
        end
!=============================================================
        subroutine h2(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
        character(len=*) path
        real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
        real hh(nt0,nt0)
        real xg(4),yg(4),zg(4),p(2),e(2),h(4)
        call openfilen(82,82)
        ni1=ni11+1
        nj1=nj11+1
        ni2=ni21+1
        nj2=nj21+1
        ni3=ni31+1
        nj3=nj31+1
        ni4=ni41+1
        nj4=nj41+1
        ni5=ni51+1
        nj5=nj51+1
```

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```
ni6=ni61+1
nj6=nj61+1
nt1=ni1*nj1
nt2=ni2*nj2
nt3=ni3*nj3
nt4=ni4*nj4
nt5=ni5*nj5
nt6=ni6*nj6
!=============================================
pai=3.1415927
do ii=1,2
if(ii.eq.1) is=1
if(ii.eq.1) ie=n1
if(ii.eq.2) is=n1+1
if(ii.eq.2) ie=n1+n2
do jj=3,4
if(jj.eq.3) js=n1+n2+1
if(jj.eq.3) je=n1+n2+n3
if(jj.eq.4) js=n1+n2+n3+1
if(jj.eq.4) je=nt
do i=is,ie
if(ii.eq.1) ix=i
if(ii.eq.2) ix=i-n1
open(36,file=path//'node_element_n3.dat',action='read')
open(37,file=path//'node_element_n4.dat',action='read')
do j=js,je
if(jj.eq.3) jx=j-n1-n2
if(jj.eq.4) jx=j-n1-n2-n3
do k=1,4
if(jj.eq.3) read(36,201) nojk,ki,kj
if(jj.eq.4) read(37,201) nojk,ki,kj
if(nojk.eq.0) then
h(k)=0
end if
if(nojk.ne.0) then
if(i.eq.j) then
h(k)=0
end if
```

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```
    if(i.ne.j) then
    if(nojk.eq.1) then
    nstart=0
    call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
    end if
    if(nojk.eq.2) then
    nstart=nt1
    call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
    end if
    if(nojk.eq.3) then
    nstart=nt1+nt2
    call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
    end if
    if(nojk.eq.4) then
    nstart=nt1+nt2+nt3
    call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
    end if
    if(nojk.eq.5) then
    nstart=nt1+nt2+nt3+nt4
    call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
    end if
    if(nojk.eq.6) then
    nstart=nt1+nt2+nt3+nt4+nt5
    call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
    end if

    call normal(xx,yy,zz,xn,yn,zn,a)
    call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
    call hx(h,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

    end if
    end if
    end do
    hh(ix,jx)=h(1)+h(2)+h(3)+h(4)
icheck=0
do ik=1,4
if(h(ik).eq.0) icheck=icheck+1
end do
```

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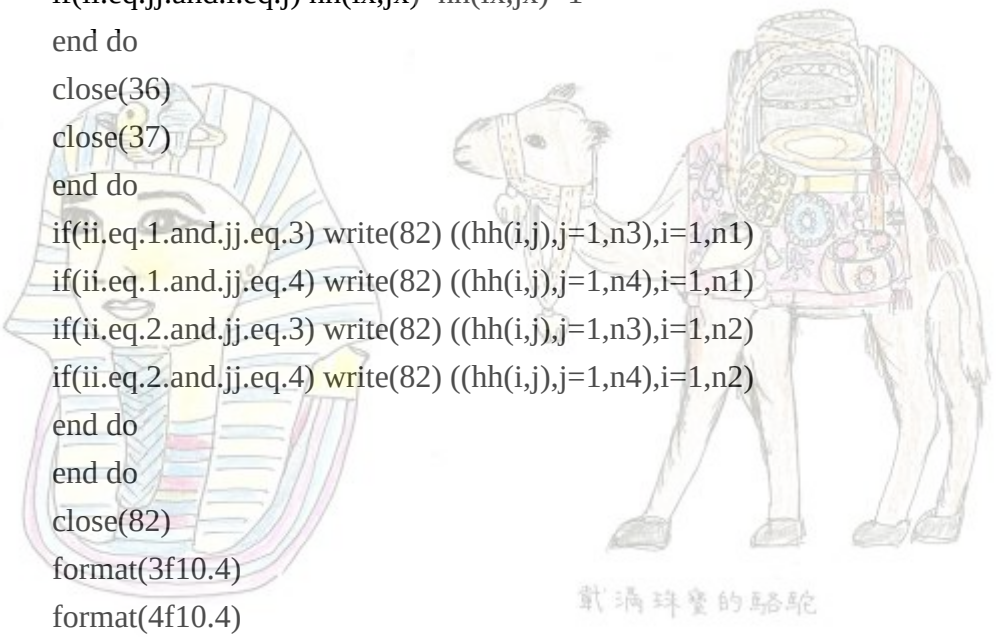
```
      if(icheck.eq.2) hh(ix,jx)=hh(ix,jx)*2
      if(icheck.eq.3) hh(ix,jx)=hh(ix,jx)*4
         if(ii.eq.jj.and.i.eq.j) hh(ix,jx)=hh(ix,jx)+1
         end do
         close(36)
         close(37)
         end do
         if(ii.eq.1.and.jj.eq.3) write(82) ((hh(i,j),j=1,n3),i=1,n1)
         if(ii.eq.1.and.jj.eq.4) write(82) ((hh(i,j),j=1,n4),i=1,n1)
         if(ii.eq.2.and.jj.eq.3) write(82) ((hh(i,j),j=1,n3),i=1,n2)
         if(ii.eq.2.and.jj.eq.4) write(82) ((hh(i,j),j=1,n4),i=1,n2)
         end do
         end do
         close(82)
4        format(3f10.4)
2        format(4f10.4)
201      format(3i5)
         return
         end
!=================================================
         subroutine h3(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
        &                    nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
      character(len=*) path
         real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
         real hh(nt0,nt0)
         real xg(4),yg(4),zg(4),p(2),e(2),h(4)
         call openfilen(87,87)
         ni1=ni11+1
         nj1=nj11+1
         ni2=ni21+1
         nj2=nj21+1
         ni3=ni31+1
         nj3=nj31+1
         ni4=ni41+1
         nj4=nj41+1
         ni5=ni51+1
         nj5=nj51+1
         ni6=ni61+1
```



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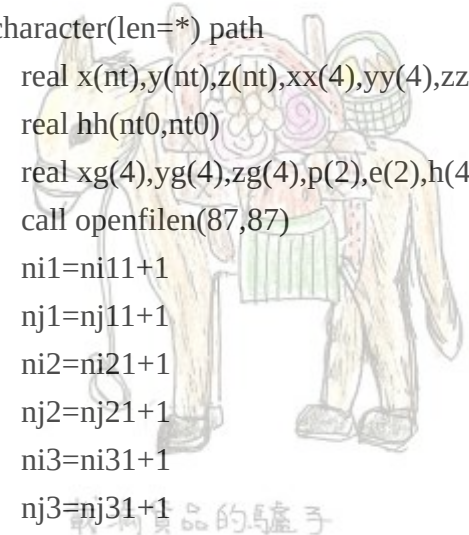
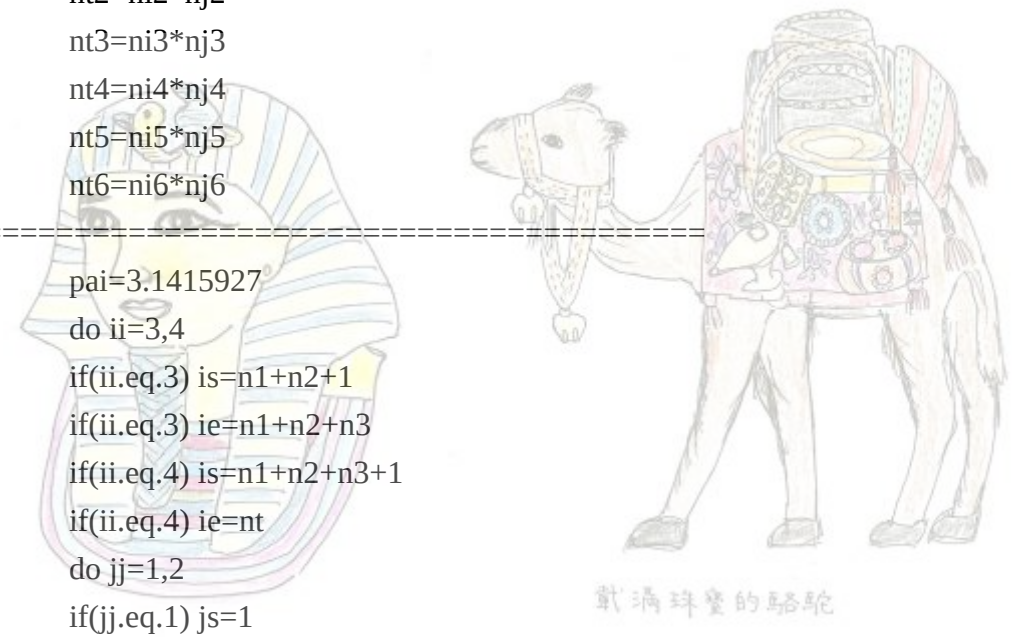


```
nj6=nj61+1
nt1=ni1*nj1
nt2=ni2*nj2
nt3=ni3*nj3
nt4=ni4*nj4
nt5=ni5*nj5
nt6=ni6*nj6
!=========================================
pai=3.1415927
do ii=3,4
if(ii.eq.3) is=n1+n2+1
if(ii.eq.3) ie=n1+n2+n3
if(ii.eq.4) is=n1+n2+n3+1
if(ii.eq.4) ie=nt
do jj=1,2
if(jj.eq.1) js=1
if(jj.eq.1) je=n1
if(jj.eq.2) js=n1+1
if(jj.eq.2) je=n1+n2
do i=is,ie
if(ii.eq.3) ix=i-n1-n2
if(ii.eq.4) ix=i-n1-n2-n3
open(34,file=path//'node_element_n1.dat',action='read')
open(35,file=path//'node_element_n2.dat',action='read')
do j=js,je
if(jj.eq.1) jx=j
if(jj.eq.2) jx=j-n1
do k=1,4
if(jj.eq.1) read(34,201) nojk,ki,kj
if(jj.eq.2) read(35,201) nojk,ki,kj
if(nojk.eq.0) then
h(k)=0
end if
if(nojk.ne.0) then
if(i.eq.j) then
h(k)=0
end if
if(i.ne.j) then
```



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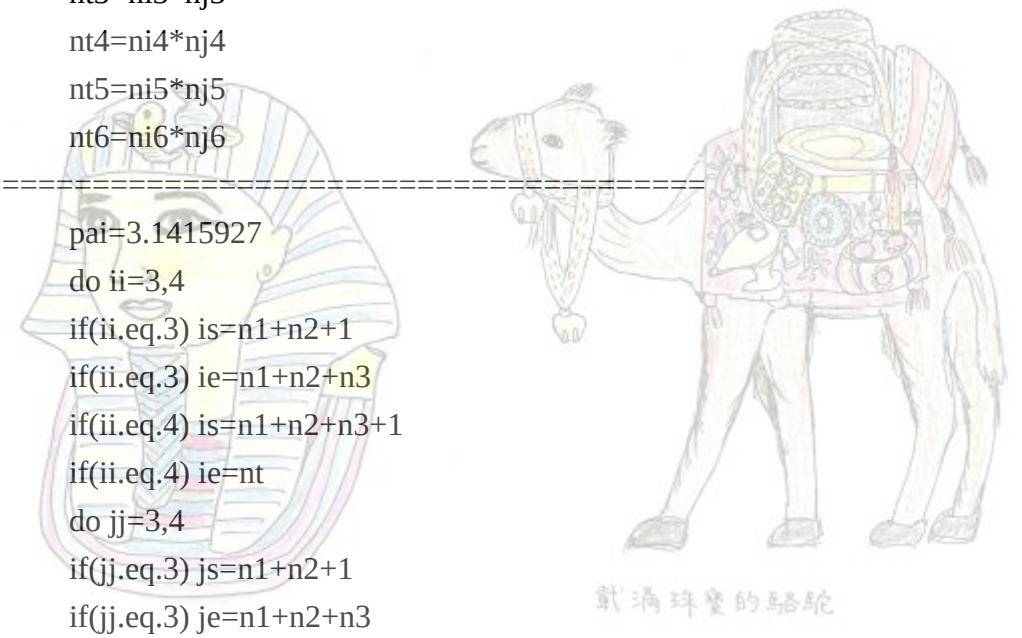
```
    if(nojk.eq.1) then
    nstart=0
    call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
    end if
    if(nojk.eq.2) then
    nstart=nt1
    call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
    end if
    if(nojk.eq.3) then
    nstart=nt1+nt2
    call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
    end if
    if(nojk.eq.4) then
    nstart=nt1+nt2+nt3
    call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
    end if
    if(nojk.eq.5) then
    nstart=nt1+nt2+nt3+nt4
    call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
    end if
    if(nojk.eq.6) then
    nstart=nt1+nt2+nt3+nt4+nt5
    call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
    end if

    call normal(xx,yy,zz,xn,yn,zn,a)
    call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
    call hx(h,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

    end if
    end if
    end do
    hh(ix,jx)=h(1)+h(2)+h(3)+h(4)
icheck=0
do ik=1,4
if(h(ik).eq.0) icheck=icheck+1
end do
if(icheck.eq.2) hh(ix,jx)=hh(ix,jx)*2
```

```
      if(icheck.eq.3) hh(ix,jx)=hh(ix,jx)*4
        if(ii.eq.jj.and.i.eq.j) hh(ix,jx)=hh(ix,jx)+1
        end do
        close(34)
        close(35)
        end do
        if(ii.eq.3.and.jj.eq.1) write(87) ((-hh(i,j),j=1,n1),i=1,n3)
        if(ii.eq.3.and.jj.eq.2) write(87) ((-hh(i,j),j=1,n2),i=1,n3)
        if(ii.eq.4.and.jj.eq.1) write(87) ((-hh(i,j),j=1,n1),i=1,n4)
        if(ii.eq.4.and.jj.eq.2) write(87) ((-hh(i,j),j=1,n2),i=1,n4)
        end do
        end do
        close(87)
4       format(3f10.4)
2       format(4f10.4)
201     format(3i5)
        return
        end
!=======================2011-埃及-尼羅河之旅==============
        subroutine h4(hh,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
       &                    nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
      character(len=*) path
        real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
        real hh(nt0,nt0)
        real xg(4),yg(4),zg(4),p(2),e(2),h(4)
        call openfilen(84,84)
        ni1=ni11+1
        nj1=nj11+1
        ni2=ni21+1
        nj2=nj21+1
        ni3=ni31+1
        nj3=nj31+1
        ni4=ni41+1
        nj4=nj41+1
        ni5=ni51+1
        nj5=nj51+1
        ni6=ni61+1
        nj6=nj61+1
```

```
nt1=ni1*nj1
nt2=ni2*nj2
nt3=ni3*nj3
nt4=ni4*nj4
nt5=ni5*nj5
nt6=ni6*nj6
!=========================================
pai=3.1415927
do ii=3,4
if(ii.eq.3) is=n1+n2+1
if(ii.eq.3) ie=n1+n2+n3
if(ii.eq.4) is=n1+n2+n3+1
if(ii.eq.4) ie=nt
do jj=3,4
if(jj.eq.3) js=n1+n2+1
if(jj.eq.3) je=n1+n2+n3
if(jj.eq.4) js=n1+n2+n3+1
if(jj.eq.4) je=nt
do i=is,ie
if(ii.eq.3) ix=i-n1-n2
if(ii.eq.4) ix=i-n1-n2-n3
open(36,file=path//'node_element_n3.dat',action='read')
open(37,file=path//'node_element_n4.dat',action='read')
do j=js,je
if(jj.eq.3) jx=j-n1-n2
if(jj.eq.4) jx=j-n1-n2-n3
do k=1,4
if(jj.eq.3) read(36,201) nojk,ki,kj
if(jj.eq.4) read(37,201) nojk,ki,kj
if(nojk.eq.0) then
h(k)=0
end if
if(nojk.ne.0) then
if(i.eq.j) then
h(k)=0
end if
if(i.ne.j) then
if(nojk.eq.1) then
```



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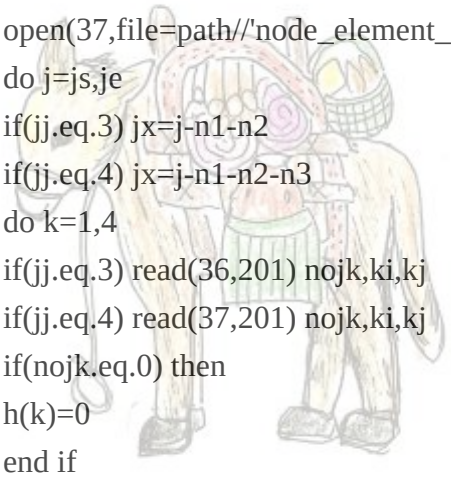

```
    nstart=0
    call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
    end if
    if(nojk.eq.2) then
    nstart=nt1
    call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
    end if
    if(nojk.eq.3) then
    nstart=nt1+nt2
    call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
    end if
    if(nojk.eq.4) then
    nstart=nt1+nt2+nt3
    call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
    end if
    if(nojk.eq.5) then
    nstart=nt1+nt2+nt3+nt4
    call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
    end if
    if(nojk.eq.6) then
    nstart=nt1+nt2+nt3+nt4+nt5
    call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
    end if

    call normal(xx,yy,zz,xn,yn,zn,a)
    call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
    call hx(h,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

    end if
    end if
    end do
    hh(ix,jx)=h(1)+h(2)+h(3)+h(4)
icheck=0
do ik=1,4
if(h(ik).eq.0) icheck=icheck+1
end do
if(icheck.eq.2) hh(ix,jx)=hh(ix,jx)*2
if(icheck.eq.3) hh(ix,jx)=hh(ix,jx)*4
```

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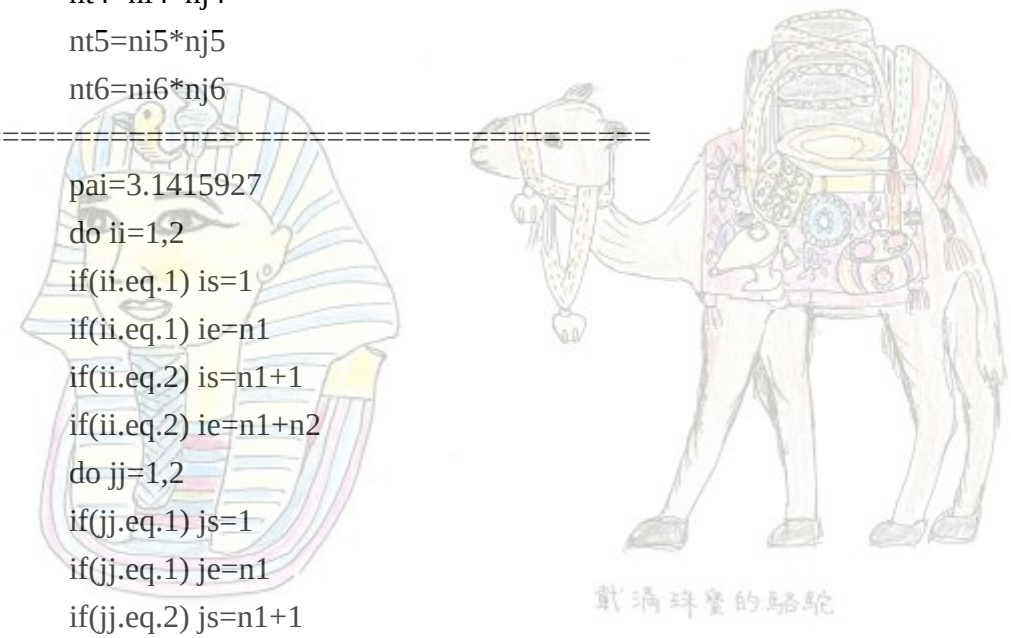
```
      if(ii.eq.jj.and.i.eq.j) hh(ix,jx)=hh(ix,jx)+1
      end do
      close(36)
      close(37)
      end do
      if(ii.eq.3.and.jj.eq.3) write(84) ((hh(i,j),j=1,n3),i=1,n3)
      if(ii.eq.3.and.jj.eq.4) write(84) ((hh(i,j),j=1,n4),i=1,n3)
      if(ii.eq.4.and.jj.eq.3) write(84) ((hh(i,j),j=1,n3),i=1,n4)
      if(ii.eq.4.and.jj.eq.4) write(84) ((hh(i,j),j=1,n4),i=1,n4)
      end do
      end do
      close(84)
4     format(3f10.4)
2     format(4f10.4)
201   format(3i5)
      return
      end
c=====================================================
      subroutine g1(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
     &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
    character(len=*) path
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      real gg(nt0,nt0)
      real xg(4),yg(4),zg(4),p(2),e(2),g(4)
      call openfilen(81,81)
      ni1=ni11+1
      nj1=nj11+1
      ni2=ni21+1
      nj2=nj21+1
      ni3=ni31+1
      nj3=nj31+1
      ni4=ni41+1
      nj4=nj41+1
      ni5=ni51+1
      nj5=nj51+1
      ni6=ni61+1
      nj6=nj61+1
      nt1=ni1*nj1
```

```
        nt2=ni2*nj2
        nt3=ni3*nj3
        nt4=ni4*nj4
        nt5=ni5*nj5
        nt6=ni6*nj6
!=========================================
        pai=3.1415927
        do ii=1,2
        if(ii.eq.1) is=1
        if(ii.eq.1) ie=n1
        if(ii.eq.2) is=n1+1
        if(ii.eq.2) ie=n1+n2
        do jj=1,2
        if(jj.eq.1) js=1
        if(jj.eq.1) je=n1
        if(jj.eq.2) js=n1+1
        if(jj.eq.2) je=n1+n2
        do i=is,ie
        if(ii.eq.1) ix=i
        if(ii.eq.2) ix=i-n1
        open(34,file=path//'node_element_n1.dat',action='read')
        open(35,file=path//'node_element_n2.dat',action='read')
        do j=js,je
        if(jj.eq.1) jx=j
        if(jj.eq.2) jx=j-n1
        do k=1,4
        if(jj.eq.1) read(34,201) nojk,ki,kj
        if(jj.eq.2) read(35,201) nojk,ki,kj
        if(nojk.eq.0) then
        g(k)=0
        end if
        if(nojk.ne.0) then
        if(i.eq.j) then
        if(nojk.eq.1) then
        nstart=0
        call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
        end if
        if(nojk.eq.2) then
```



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```
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if

call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call normal(xx,yy,zz,xn,yn,zn,a)
call rsxyz(k,xx,yy,zz,gs,nojk)
call ggg(g,x,y,z,xg,yg,zg,gs,nt,i,k,nojk,a)

end if
if(i.ne.j) then
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
```

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```
      end if
      if(nojk.eq.4) then
      nstart=nt1+nt2+nt3
      call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
      end if
      if(nojk.eq.5) then
      nstart=nt1+nt2+nt3+nt4
      call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
      end if
      if(nojk.eq.6) then
      nstart=nt1+nt2+nt3+nt4+nt5
      call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
      end if

      call normal(xx,yy,zz,xn,yn,zn,a)
      call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
      call gx(g,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

      end if
      end if
      end do
      gg(ix,jx)=g(1)+g(2)+g(3)+g(4)
      end do
      close(34)
      close(35)
      end do
      if(ii.eq.1.and.jj.eq.1) write(81) ((-gg(i,j),j=1,n1),i=1,n1)
      if(ii.eq.1.and.jj.eq.2) write(81) ((-gg(i,j),j=1,n2),i=1,n1)
      if(ii.eq.2.and.jj.eq.1) write(81) ((-gg(i,j),j=1,n1),i=1,n2)
      if(ii.eq.2.and.jj.eq.2) write(81) ((-gg(i,j),j=1,n2),i=1,n2)
      end do
      end do
      close(81)
4     format(3f10.4)
2     format(4f10.4)
201   format(3i5)
      return
      end
```

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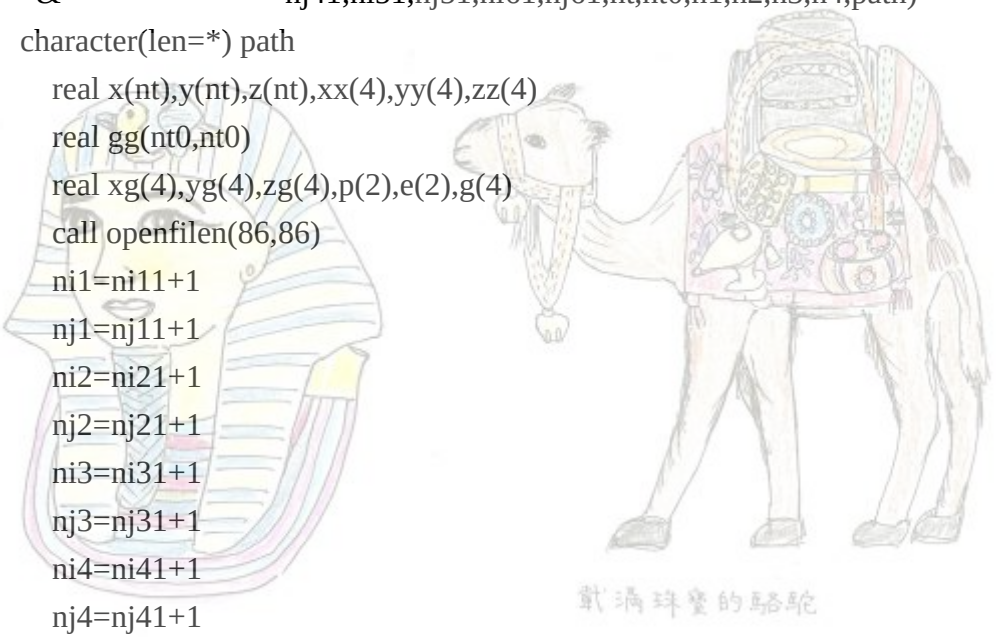
```
!=====================================================
      subroutine g2(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
     &                    nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
    character(len=*) path
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      real gg(nt0,nt0)
      real xg(4),yg(4),zg(4),p(2),e(2),g(4)
      call openfilen(86,86)
      ni1=ni11+1
      nj1=nj11+1
      ni2=ni21+1
      nj2=nj21+1
      ni3=ni31+1
      nj3=nj31+1
      ni4=ni41+1
      nj4=nj41+1
      ni5=ni51+1
      nj5=nj51+1
      ni6=ni61+1
      nj6=nj61+1
      nt1=ni1*nj1
      nt2=ni2*nj2
      nt3=ni3*nj3
      nt4=ni4*nj4
      nt5=ni5*nj5
      nt6=ni6*nj6
!=========================================
      pai=3.1415927
      do ii=1,2
      if(ii.eq.1) is=1
      if(ii.eq.1) ie=n1
      if(ii.eq.2) is=n1+1
      if(ii.eq.2) ie=n1+n2
      do jj=3,4
      if(jj.eq.3) js=n1+n2+1
      if(jj.eq.3) je=n1+n2+n3
      if(jj.eq.4) js=n1+n2+n3+1
      if(jj.eq.4) je=nt
```



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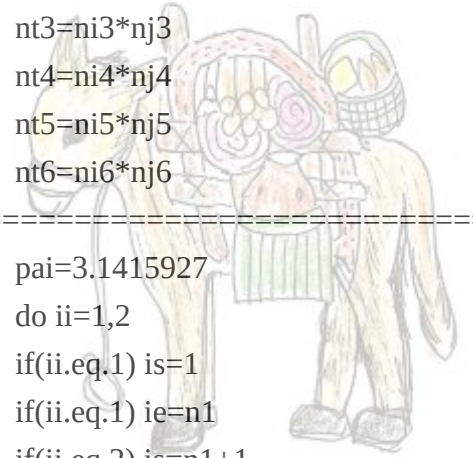

```
    do i=is,ie
    if(ii.eq.1) ix=i
    if(ii.eq.2) ix=i-n1
    open(36,file=path//'node_element_n3.dat',action='read')
    open(37,file=path//'node_element_n4.dat',action='read')
    do j=js,je
    if(jj.eq.3) jx=j-n1-n2
    if(jj.eq.4) jx=j-n1-n2-n3
    do k=1,4
    if(jj.eq.3) read(36,201) nojk,ki,kj
    if(jj.eq.4) read(37,201) nojk,ki,kj
    if(nojk.eq.0) then
    g(k)=0
    end if
    if(nojk.ne.0) then
    if(i.eq.j) then
    if(nojk.eq.1) then
    nstart=0
    call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
    end if
    if(nojk.eq.2) then
    nstart=nt1
    call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
    end if
    if(nojk.eq.3) then
    nstart=nt1+nt2
    call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
    end if
    if(nojk.eq.4) then
    nstart=nt1+nt2+nt3
    call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
    end if
    if(nojk.eq.5) then
    nstart=nt1+nt2+nt3+nt4
    call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
    end if
    if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
```

```
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if

call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call normal(xx,yy,zz,xn,yn,zn,a)
call rsxyz(k,xx,yy,zz,gs,nojk)
call ggg(g,x,y,z,xg,yg,zg,gs,nt,i,k,nojk,a)

end if
if(i.ne.j) then
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if

call normal(xx,yy,zz,xn,yn,zn,a)
call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call gx(g,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)
```

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```
      end if
      end if
      end do
      gg(ix,jx)=g(1)+g(2)+g(3)+g(4)

      end do
      close(36)
      close(37)
      end do
      if(ii.eq.1.and.jj.eq.3) write(86) ((gg(i,j),j=1,n3),i=1,n1)
      if(ii.eq.1.and.jj.eq.4) write(86) ((gg(i,j),j=1,n4),i=1,n1)
      if(ii.eq.2.and.jj.eq.3) write(86) ((gg(i,j),j=1,n3),i=1,n2)
      if(ii.eq.2.and.jj.eq.4) write(86) ((gg(i,j),j=1,n4),i=1,n2)
      end do
      end do
      close(86)
4     format(3f10.4)
2     format(4f10.4)
201   format(3i5)
      return
      end
!=======================================================
      subroutine g3(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
     &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
      character(len=*) path
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      real gg(nt0,nt0)
      real xg(4),yg(4),zg(4),p(2),e(2),g(4)
      call openfilen(83,83)
      ni1=ni11+1
      nj1=nj11+1
      ni2=ni21+1
      nj2=nj21+1
      ni3=ni31+1
      nj3=nj31+1
      ni4=ni41+1
      nj4=nj41+1
```

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```
      ni5=ni51+1
      nj5=nj51+1
      ni6=ni61+1
      nj6=nj61+1
      nt1=ni1*nj1
      nt2=ni2*nj2
      nt3=ni3*nj3
      nt4=ni4*nj4
      nt5=ni5*nj5
      nt6=ni6*nj6
!=========================================
      pai=3.1415927
      do ii=3,4
      if(ii.eq.3) is=n1+n2+1
      if(ii.eq.3) ie=n1+n2+n3
      if(ii.eq.4) is=n1+n2+n3+1
      if(ii.eq.4) ie=nt
      do jj=1,2
      if(jj.eq.1) js=1
      if(jj.eq.1) je=n1
      if(jj.eq.2) js=n1+1
      if(jj.eq.2) je=n1+n2
      do i=is,ie
      if(ii.eq.3) ix=i-n1-n2
      if(ii.eq.4) ix=i-n1-n2-n3
      open(34,file=path//'node_element_n1.dat',action='read')
      open(35,file=path//'node_element_n2.dat',action='read')
      do j=js,je
      if(jj.eq.1) jx=j
      if(jj.eq.2) jx=j-n1
      do k=1,4
      if(jj.eq.1) read(34,201) nojk,ki,kj
      if(jj.eq.2) read(35,201) nojk,ki,kj
      if(nojk.eq.0) then
      g(k)=0
      end if
      if(nojk.ne.0) then
      if(i.eq.j) then
```

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```
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if

call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call normal(xx,yy,zz,xn,yn,zn,a)
call rsxyz(k,xx,yy,zz,gs,nojk)
call ggg(gg,x,y,z,xg,yg,zg,gs,nt,i,k,nojk,a)

end if
if(i.ne.j) then
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
```

```
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if
```

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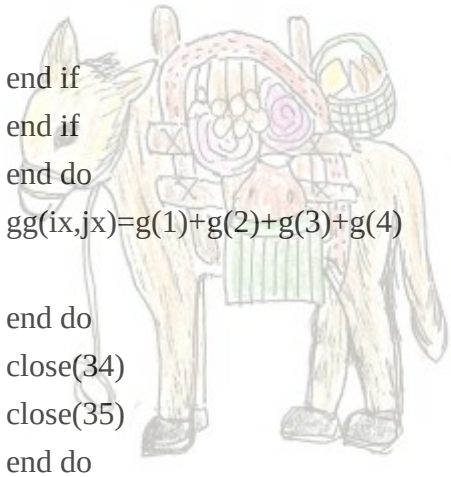
```
call normal(xx,yy,zz,xn,yn,zn,a)
call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call gx(g,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

end if
end if
end do
gg(ix,jx)=g(1)+g(2)+g(3)+g(4)

end do
close(34)
close(35)
end do
if(ii.eq.3.and.jj.eq.1) write(83) ((-gg(i,j),j=1,n1),i=1,n3)
if(ii.eq.3.and.jj.eq.2) write(83) ((-gg(i,j),j=1,n2),i=1,n3)
if(ii.eq.4.and.jj.eq.1) write(83) ((-gg(i,j),j=1,n1),i=1,n4)
if(ii.eq.4.and.jj.eq.2) write(83) ((-gg(i,j),j=1,n2),i=1,n4)
end do
end do
```



```
      close(83)
4     format(3f10.4)
2     format(4f10.4)
201   format(3i5)
      return
      end
!=============================================================
      subroutine g4(gg,x,y,z,ni11,nj11,ni21,nj21,ni31,nj31,ni41,
     &              nj41,ni51,nj51,ni61,nj61,nt,nt0,n1,n2,n3,n4,path)
      character(len=*) path

      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      real gg(nt0,nt0)
      real xg(4),yg(4),zg(4),p(2),e(2),g(4)
      call openfilen(88,88)
      ni1=ni11+1
      nj1=nj11+1
      ni2=ni21+1
      nj2=nj21+1
      ni3=ni31+1
      nj3=nj31+1
      ni4=ni41+1
      nj4=nj41+1
      ni5=ni51+1
      nj5=nj51+1
      ni6=ni61+1
      nj6=nj61+1
      nt1=ni1*nj1
      nt2=ni2*nj2
      nt3=ni3*nj3
      nt4=ni4*nj4
      nt5=ni5*nj5
      nt6=ni6*nj6
!=============================================
      pai=3.1415927
      do ii=3,4
      if(ii.eq.3) is=n1+n2+1
      if(ii.eq.3) ie=n1+n2+n3
```

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```
if(ii.eq.4) is=n1+n2+n3+1
if(ii.eq.4) ie=nt
do jj=3,4
if(jj.eq.3) js=n1+n2+1
if(jj.eq.3) je=n1+n2+n3
if(jj.eq.4) js=n1+n2+n3+1
if(jj.eq.4) je=nt
do i=is,ie
if(ii.eq.3) ix=i-n1-n2
if(ii.eq.4) ix=i-n1-n2-n3
open(36,file=path//'node_element_n3.dat',action='read')
open(37,file=path//'node_element_n4.dat',action='read')
do j=js,je
if(jj.eq.3) jx=j-n1-n2
if(jj.eq.4) jx=j-n1-n2-n3
do k=1,4
if(jj.eq.3) read(36,201) nojk,ki,kj
if(jj.eq.4) read(37,201) nojk,ki,kj
if(nojk.eq.0) then
g(k)=0
end if
if(nojk.ne.0) then
if(i.eq.j) then
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
```

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```
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
nstart=nt1+nt2+nt3+nt4+nt5
call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
end if

call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
call normal(xx,yy,zz,xn,yn,zn,a)
call rsxyz(k,xx,yy,zz,gs,nojk)
call ggg(g,x,y,z,xg,yg,zg,gs,nt,i,k,nojk,a)

end if
if(i.ne.j) then
if(nojk.eq.1) then
nstart=0
call xx_x_1(xx,yy,zz,x,y,z,nt,nj11,ki,kj,nstart)
end if
if(nojk.eq.2) then
nstart=nt1
call xx_x_2(xx,yy,zz,x,y,z,nt,nj21,ki,kj,nstart)
end if
if(nojk.eq.3) then
nstart=nt1+nt2
call xx_x_3(xx,yy,zz,x,y,z,nt,nj31,ki,kj,nstart)
end if
if(nojk.eq.4) then
nstart=nt1+nt2+nt3
call xx_x_4(xx,yy,zz,x,y,z,nt,nj41,ki,kj,nstart)
end if
if(nojk.eq.5) then
nstart=nt1+nt2+nt3+nt4
call xx_x_5(xx,yy,zz,x,y,z,nt,nj51,ki,kj,nstart)
end if
if(nojk.eq.6) then
```

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```
      nstart=nt1+nt2+nt3+nt4+nt5
      call xx_x_6(xx,yy,zz,x,y,z,nt,nj61,ki,kj,nstart)
      end if

      call normal(xx,yy,zz,xn,yn,zn,a)
      call xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
      call gx(g,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)

      end if
      end if
      end do
      gg(ix,jx)=g(1)+g(2)+g(3)+g(4)

    end do
      close(36)
      close(37)
      end do
      if(ii.eq.3.and.jj.eq.3) write(88) ((gg(i,j),j=1,n3),i=1,n3)
      if(ii.eq.3.and.jj.eq.4) write(88) ((gg(i,j),j=1,n4),i=1,n3)
      if(ii.eq.4.and.jj.eq.3) write(88) ((gg(i,j),j=1,n3),i=1,n4)
      if(ii.eq.4.and.jj.eq.4) write(88) ((gg(i,j),j=1,n4),i=1,n4)
      end do
      end do
      close(88)
4     format(3f10.4)
2     format(4f10.4)
201   format(3i5)
      return
      end
!=============================================================
      subroutine xyz_gauss(xg,yg,zg,xx,yy,zz,nojk)
      real xg(4),yg(4),zg(4),xx(4),yy(4),zz(4),p(2,2),e(2,2)
      qr=1./sqrt(3.)
      p(1,1)=-qr
      e(1,1)=-qr
      p(1,2)= qr
      e(1,2)=-qr
      p(2,1)= qr
```

```
e(2,1)= qr
p(2,2)=-qr
e(2,2)= qr

n=2
do l=1,n
do m=1,n
f1=(1-p(l,m)-e(l,m)+p(l,m)*e(l,m))/4.
f2=(1+p(l,m)-e(l,m)-p(l,m)*e(l,m))/4.
f3=(1+p(l,m)+e(l,m)+p(l,m)*e(l,m))/4.
f4=(1-p(l,m)+e(l,m)-p(l,m)*e(l,m))/4.
lm=m+n*(l-1)
xg(lm)=f1*xx(1)+f2*xx(2)+f3*xx(3)+f4*xx(4)
yg(lm)=f1*yy(1)+f2*yy(2)+f3*yy(3)+f4*yy(4)
zg(lm)=f1*zz(1)+f2*zz(2)+f3*zz(3)+f4*zz(4)
end do
end do
return
end
!=============================================
      subroutine rsxyz(k,xx,yy,zz,gs,nojk)

      real xx(4),yy(4),zz(4)
      if(k.eq.1) pc=-1
      if(k.eq.2) pc=1
      if(k.eq.3) pc=1
      if(k.eq.4) pc=-1
      rx1=.25*((-1+pc)*xx(1)-(1+pc)*xx(2)+(1+pc)*xx(3)+(1-pc)*xx(4))
      ry1=.25*((-1+pc)*yy(1)-(1+pc)*yy(2)+(1+pc)*yy(3)+(1-pc)*yy(4))
      rz1=.25*((-1+pc)*zz(1)-(1+pc)*zz(2)+(1+pc)*zz(3)+(1-pc)*zz(4))
      if(k.eq.1.or.k.eq.2) then
      rsx1=.5*(xx(3)-xx(4))
      rsy1=.5*(yy(3)-yy(4))
      rsz1=.5*(zz(3)-zz(4))
      end if
      if(k.eq.3.or.k.eq.4) then
      rsx1=.5*(xx(2)-xx(1))
      rsy1=.5*(yy(2)-yy(1))
```

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```
      rsz1=.5*(zz(2)-zz(1))
      end if
      gs11=rsy1*rz1-rsz1*ry1
      gs12=rsz1*rx1-rsx1*rz1
      gs13=rsx1*ry1-rsy1*rx1

    IF(K.EQ.1) PD=-1
    IF(K.EQ.2) PD=-1
    IF(K.EQ.3) PD=1
    IF(K.EQ.4) PD=1
    RX2=.25*((-1+PD)*XX(1)+(1-PD)*XX(2)+(1+PD)*XX(3)-(1+PD)*XX(4))
    RY2=.25*((-1+PD)*yy(1)+(1-PD)*yy(2)+(1+PD)*yy(3)-(1+PD)*yy(4))
    RZ2=.25*((-1+PD)*ZZ(1)+(1-PD)*ZZ(2)+(1+PD)*ZZ(3)-(1+PD)*ZZ(4))
      IF(K.EQ.1.OR.K.EQ.4) THEN
      RSX2=.5*(XX(2)-XX(3))
    RSY2=.5*(yy(2)-yy(3))
    RSZ2=.5*(ZZ(2)-ZZ(3))
    END IF
      IF(K.EQ.2.OR.K.EQ.3) THEN
    RSX2=.5*(XX(4)-XX(1))
    RSY2=.5*(yy(4)-yy(1))
    RSZ2=.5*(ZZ(4)-ZZ(1))
    END IF
    GS21=RSY2*RZ2-RSZ2*RY2
    GS22=RSZ2*RX2-RSX2*RZ2
    GS23=RSX2*RY2-RSY2*RX2
    GS=SQRT(GS11**2+GS12**2+GS13**2)+SQRT(GS21**2+GS22**2+GS23*
*2)

      return
      end
!=============================================================
      subroutine hx(h,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)
      real x(nt),y(nt),z(nt)
      real h(4),xg(4),yg(4),zg(4),p(2,2),e(2,2)
      n=2
      wl=1
      wm=1
```

```
qr=1./sqrt(3.)
p(1,1)=-qr
e(1,1)=-qr
p(1,2)= qr
e(1,2)=-qr
p(2,1)= qr
e(2,1)= qr
p(2,2)=-qr
e(2,2)= qr

pai=3.1415927
h(k)=0
do l=1,n
do m=1,n
lm=m+n*(l-1)
rilm=(x(i)-xg(lm))**2+(y(i)-yg(lm))**2+(z(i)-zg(lm))**2
rilm2=sqrt(rilm)
rn=(xg(lm)-x(i))*xn+(yg(lm)-y(i))*yn+(zg(lm)-z(i))*zn
rn=rn/rilm2
if(k.eq.1) then
h(k)=h(k)+wl*wm*(1-p(l,m)-e(l,m)+p(l,m)*e(l,m))/rilm*rn*a
end if
if(k.eq.2) then
h(k)=h(k)+wl*wm*(1+p(l,m)-e(l,m)-p(l,m)*e(l,m))/rilm*rn*a
end if
if(k.eq.3) then
h(k)=h(k)+wl*wm*(1+p(l,m)+e(l,m)+p(l,m)*e(l,m))/rilm*rn*a
end if
if(k.eq.4) then
h(k)=h(k)+wl*wm*(1-p(l,m)+e(l,m)-p(l,m)*e(l,m))/rilm*rn*a
end if
end do
end do
h(k)=-1./8/pai*h(k)/4
return
end
!=======================================================
      subroutine gx(g,xg,yg,zg,x,y,z,xn,yn,zn,a,nt,i,k,nojk)
```

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```
real x(nt),y(nt),z(nt)
real g(4),xg(4),yg(4),zg(4),p(2,2),e(2,2)
n=2
wl=1
wm=1
qr=1./sqrt(3.)
p(1,1)=-qr
e(1,1)=-qr
p(1,2)= qr
e(1,2)=-qr
p(2,1)= qr
e(2,1)= qr
p(2,2)=-qr
e(2,2)= qr
pai=3.1415927
g(k)=0
do l=1,n
do m=1,n
lm=m+n*(l-1)
rilm=(x(i)-xg(lm))**2+(y(i)-yg(lm))**2+(z(i)-zg(lm))**2
rilm2=sqrt(rilm)
if(k.eq.1) then
g(k)=g(k)+wl*wm*(1-p(l,m)-e(l,m)+p(l,m)*e(l,m))/rilm2*a
end if
if(k.eq.2) then
g(k)=g(k)+wl*wm*(1+p(l,m)-e(l,m)-p(l,m)*e(l,m))/rilm2*a
end if
if(k.eq.3) then
g(k)=g(k)+wl*wm*(1+p(l,m)+e(l,m)+p(l,m)*e(l,m))/rilm2*a
end if
if(k.eq.4) then
g(k)=g(k)+wl*wm*(1-p(l,m)+e(l,m)-p(l,m)*e(l,m))/rilm2*a
end if
end do
end do
g(k)=1./8/pai*g(k)/4
return
```

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```
      end
!=====================================================
      subroutine ggg(g,x,y,z,xg,yg,zg,gs,nt,i,k,nojk,a)
      real x(nt),y(nt),z(nt)
      real g(4),xg(4),yg(4),zg(4),p(2,2),e(2,2)
      n=2
      wl=1
      wm=1
      qr=1./sqrt(3.)
      p(1,1)=-qr
      e(1,1)=-qr
      p(1,2)= qr
      e(1,2)=-qr
      p(2,1)= qr
      e(2,1)= qr
      p(2,2)=-qr
      e(2,2)= qr

      pai=3.1415927
      g(k)=0
      do l=1,n
      do m=1,n
      lm=m+n*(l-1)
      rilm=(x(i)-xg(lm))**2+(y(i)-yg(lm))**2+(z(i)-zg(lm))**2
      rilm2=sqrt(rilm)
      if(k.eq.1) then
      g(k)=g(k)+wl*wm*(1-p(l,m)-e(l,m)+p(l,m)*e(l,m))/rilm2*gs
      end if
      if(k.eq.2) then
      g(k)=g(k)+wl*wm*(1+p(l,m)-e(l,m)-p(l,m)*e(l,m))/rilm2*gs
      end if
      if(k.eq.3) then
      g(k)=g(k)+wl*wm*(1+p(l,m)+e(l,m)+p(l,m)*e(l,m))/rilm2*gs
      end if
      if(k.eq.4) then
      g(k)=g(k)+wl*wm*(1-p(l,m)+e(l,m)-p(l,m)*e(l,m))/rilm2*gs
      end if
      end do
```

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```
      end do
      g(k)=1./8/pai*g(k)*2
      return
      end
!*****************************************************************************
      subroutine normal(xx,yy,zz,xn,yn,zn,a)
      real xx(4),yy(4),zz(4)
      r1=xx(3)-xx(1)
      r2=yy(3)-yy(1)
      r3=zz(3)-zz(1)
      r4=xx(4)-xx(2)
      r5=yy(4)-yy(2)
      r6=zz(4)-zz(2)
      r=sqrt((r5*r3-r6*r2)**2+(r6*r1-r4*r3)**2+(r4*r2-r5*r1)**2)
      xn=(r5*r3-r6*r2)/r
      yn=(r6*r1-r4*r3)/r
      zn=(r4*r2-r5*r1)/r
      t1=xx(2)-xx(1)
      t2=yy(2)-yy(1)
      t3=zz(2)-zz(1)
      t4=xx(4)-xx(1)
      t5=yy(4)-yy(1)
      t6=zz(4)-zz(1)
      r=.5*sqrt((t2*r3-t3*r2)**2+(t3*r1-t1*r3)**2+(t1*r2-t2*r1)**2)
      t=.5*sqrt((r2*t6-r3*t5)**2+(r3*t4-r1*t6)**2+(r1*t5-r2*t4)**2)
      a=r+t
      return
      end
!=============================================================
      subroutine xx_x_1(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt)
      real xx(4),yy(4),zz(4)
      i1=kj+1+(nj_1+1)*(ki-1)+nstart
      i2=kj    +(nj_1+1)*(ki-1)+nstart
      i3=kj    +(nj_1+1)*ki+nstart
      i4=kj+1+(nj_1+1)*ki+nstart
      xx(1)=x(i1)
      xx(2)=x(i2)
```

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```
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
!=============================================================
      subroutine xx_x_2(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      i1=kj+1+(nj_1+1)*ki+nstart
      i2=kj    +(nj_1+1)*ki+nstart
      i3=kj    +(nj_1+1)*(ki-1)+nstart
      i4=kj+1+(nj_1+1)*(ki-1)+nstart

      xx(1)=x(i1)
      xx(2)=x(i2)
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
!=============================================================
      subroutine xx_x_3(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      i1=kj+1+(nj_1+1)*ki+nstart
```

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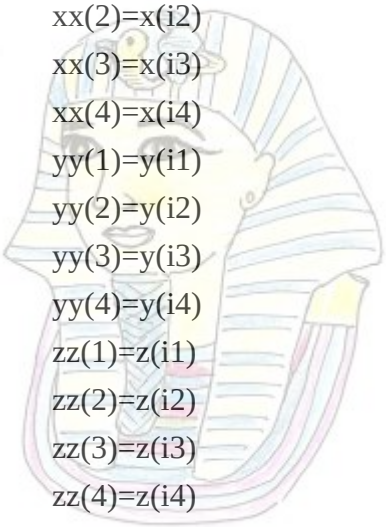
```
      i2=kj    +(nj_1+1)*ki+nstart
      i3=kj    +(nj_1+1)*(ki-1)+nstart
      i4=kj+1+(nj_1+1)*(ki-1)+nstart
      xx(1)=x(i1)
      xx(2)=x(i2)
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
!====================
      subroutine xx_x_4(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      i1=kj    +(nj_1+1)*ki+nstart
      i2=kj+1+(nj_1+1)*ki+nstart
      i3=kj+1+(nj_1+1)*(ki-1)+nstart
      i4=kj    +(nj_1+1)*(ki-1)+nstart
      xx(1)=x(i1)
      xx(2)=x(i2)
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
```



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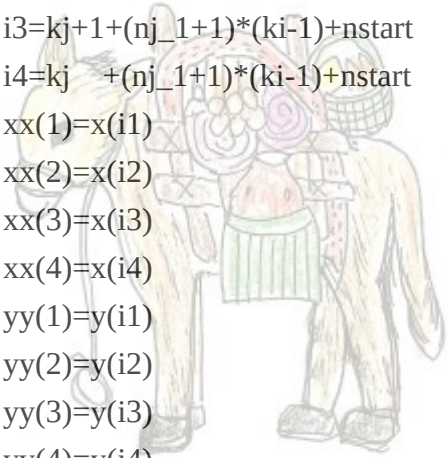

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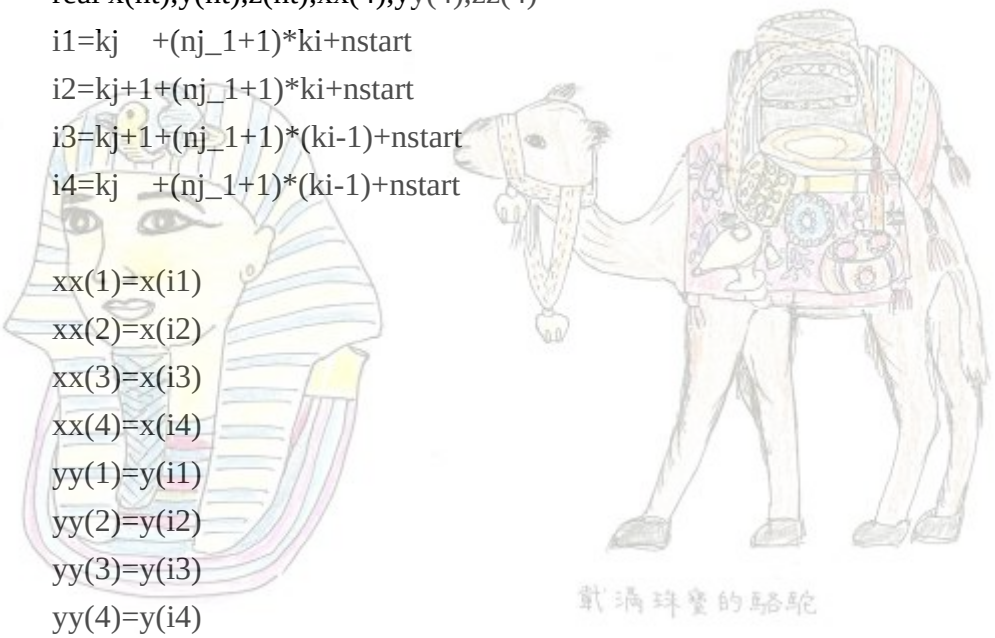
```
!=====================================================
      subroutine xx_x_5(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt),xx(4),yy(4),zz(4)
      i1=kj    +(nj_1+1)*ki+nstart
      i2=kj+1+(nj_1+1)*ki+nstart
      i3=kj+1+(nj_1+1)*(ki-1)+nstart
      i4=kj    +(nj_1+1)*(ki-1)+nstart

      xx(1)=x(i1)
      xx(2)=x(i2)
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
!=====================================================================
========
      subroutine xx_x_6(xx,yy,zz,x,y,z,nt,nj_1,ki,kj,nstart)
      real x(nt),y(nt),z(nt)
      real xx(4),yy(4),zz(4)
      i1=kj    +(nj_1+1)*(ki-1)+nstart
      i2=kj+1+(nj_1+1)*(ki-1)+nstart
      i3=kj+1+(nj_1+1)*ki+nstart
      i4=kj    +(nj_1+1)*ki+nstart
      xx(1)=x(i1)
      xx(2)=x(i2)
      xx(3)=x(i3)
      xx(4)=x(i4)
      yy(1)=y(i1)
      yy(2)=y(i2)
      yy(3)=y(i3)
```



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```
      yy(4)=y(i4)
      zz(1)=z(i1)
      zz(2)=z(i2)
      zz(3)=z(i3)
      zz(4)=z(i4)
      return
      end
!-------------------------------------
      subroutine randu(ix,iy,fl)
!-------------------------------------
      iy=mod(12869*ix+6925,32768)
      fl=float(iy)/2.0**15
      return
      end
!*********************************************************************
!           regular wave control program
!*********************************************************************
      subroutine regular(u,e,sigma,t,hk,rteta0,nch,blod)
      real u(nch)
      do   i=1,nch
      u(i)=e*sin(sigma*t-hk*(i-1)*blod*cos(rteta0))
      end do
      return
      end
!*********************************************************************
!            short crest wave control program
!*********************************************************************
      subroutine cross(u,e1,e2,t,hk1,hk2,rteta01,rteta02,
     &                 sigma1,sigma2,nch,blod)
      real u(nch)
      do 10 i=1,nch
      u(i)=e1*cos(sigma1*t-hk1*(i-1)*blod*cos(rteta01))
     &     +e2*cos(sigma2*t+hk2*(i-1)*blod*cos(rteta02))
10    continue
      return
      end
!*********************************************************************
```

```
!            solitary wave control program
!*************************************************************
      subroutine soliton(it,u,xo,omega,tc,rteta0,ddt,nch,blod)
      real u(nch)
      do 10 i=1,nch
      u(i)=xo*omega/cosh(omega*(ddt*it-tc)-(i-1)*blod*cos(rteta0))**2
10    continue
      return
      end
!*************************************************************
**
!            one directional iregular wave simulation program
!*************************************************************
**
      subroutine freq_wave(it,u,s0,df,nspec,re,ddt,rnum,nch)
      real rnum(nspec),u(nch),s0(nspec),re(nspec)
      pai2=6.283185308
      do i=1,nch
      temp=0
      do j=1,nspec
      sigmat=pai2*df*(j-1)
      aa=re(j)*sqrt(2.*df*s0(j))
      temp=temp+aa*sigmat*cos(sigmat*(it-1)*ddt-rnum(j))
      end do
      u(i)=temp
      end do
      return
      end
!*************************************************************
!            mutiple directional wave simulation (3-d wave) program
!*************************************************************
      subroutine muti_wave(it,u,s0,df,nspec,re,ddt,rnum,nch)
      real rnum(nspec),u(nch),s0(nspec),re(nspec)
      pai2=6.283185308
      do i=1,nch
      temp=0
      do j=1,nspec
      sigmat=pai2*df*(j-1)
```

```
        aa=re(j)*sqrt(2.*df*s0(j))
        temp=temp+aa*sigmat*cos(sigmat*(it-1)*ddt-rnum(j))
        end do
        u(i)=temp
        end do
        return
        end
!-------------------------------------------------------------
        subroutine wvmod(x,n,m,d,dt,tmax,tmin,itype,hkk)
!-------------------------------------------------------------
!       calculation of characteristic function of wave generator
!-------------------------------------------------------------
!       x       : characteristic function ---- 1.0/f(f,h)
!       n       : data number
!       d       : water depth (m)
!       dt      : time interval (sec)
!       tmax : maximum period for wave generator (sec)
!       tmin : minimum period for wave generator (sec)
!       ityp : type of wave generator  1--->piston ; 2--->flap

        dimension x(m),hkk(m)
        real kh
        pai=3.14159265
        df=1.0/(2*n*dt)
        x(1)=0.0
        hkk(1)=0
        do 1 i=2,n
        t=1.0/(df*(i-1))
        if(t .gt. tmax) go to 5
        if(t .lt. tmin) go to 5
        kh=2.*pai/wavel(t,d)
        kh=hkk(i)
        if (kh.gt.40.0) then
        x(i)=x(i-1)
        go to 1
        endif
        aa=sinh(kh)
        bb=cosh(kh)
```

```
      if(itype.eq.2) go to 50
      x(i)=(aa*bb+kh)/aa**2
      go to 1
50    x(i)=kh*(aa*bb+kh)/(aa*(1.0-bb+kh*aa))
      go to 1
5     x(i)=0.0
1     continue
      return
      end
!-----------------------------------------------------------------
      subroutine specin(x,n,m,dt,e,f,fpeak,speak)
      dimension    x(m),e(25),f(25)
!     caution :coefficent should be changed case by case
      f(1)=0
      e(1)=0
      do 55 i=2,25
55    f(i)=0.25*(i-1)
      x(1)=0.0
      do 20 i=2,n
      df=1.0/(2*n*dt)
      dft=df*(i-1)
      if (dft.ge.5.0)    goto 11
      if (dft.ge.f(1) .and. dft.lt.f(2))    then
      xf= abs((dft-f(1))/(f(2)-f(1)))
      x(i)=(1.0-xf)*e(1)+xf*e(2)
      goto 20
      elseif (dft.ge.f(23) .and. dft.lt.f(24))    then
      xf=abs((dft-f(23))/(f(24)-f(23)))
      x(i)=(1.0-xf)*e(23)+xf*e(24)
      goto 20
      elseif (dft.ge.f(24) .and. dft.lt.f(25))    then
      xf=(dft-f(24))/(f(25)-f(24))
      x(i)=(1.0-xf)*e(24)+xf*e(25)
      goto 20
      endif
      do 10 j=2,22
      if (dft.ge.f(j) .and. dft.lt.f(j+1))    then
      xf=(dft-f(j))/(f(j+1)-f(j))
```

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```
      x(i)=(1.0-xf)*e(j)+xf*e(j+1)
      goto 20
      endif
10    continue
11    x(i)=0.0
20    continue
      do 220 ip=2,n
      df=1.0/(2*n*dt)
      dft=df*(ip-1)
      if (dft.ge.fpeak) goto 221
220   continue
221   ipeak=ip
      deltaf=speak-x(ipeak)
      nhs=ipeak-20
      nhe=ipeak+20
      if (nhs.le.1)    nhs=2
      if (nhe.ge.n)    nhe=n
      do 230 ih=nhs,nhe
      df=1.0/(2*n*dt)
      dft=df*(ih-1)
      xdelta=(-((dft-fpeak)/0.25)**2+1.0)*deltaf
      x(ih)=x(ih)+xdelta
230   continue
      return
      end
!-------------------------------------------------------------
      subroutine jonswap(x,n,m,h3,t3,dt)
      dimension x(m)
      df=1.0/(2*n*dt)
      ganma=3.3
      alpha=0.0624/(0.23+0.0336*ganma-0.185*(1.9+ganma)**(-1))
      beta=alpha*(1.094-0.01915*alog(ganma))
      tpeak=t3/(1-0.132*(ganma+0.2)**(-0.559))
      fpeak=1/(tpeak)
      c1j=beta*h3**2*tpeak**(-4)
      c2j=-1.25*tpeak**(-4)
      x(1)=0.0
      do 2 i=2,n
```

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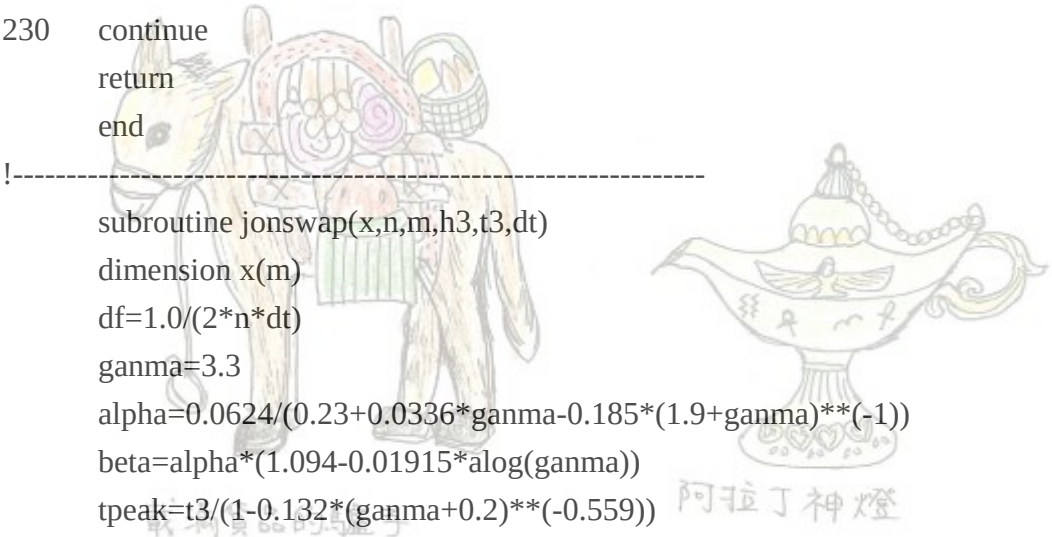

```
      f=df*(i-1)
      if (f.lt.fpeak) sigma=0.07
      if (f.ge.fpeak) sigma=0.09
      f1=c2j*f**(-4)
      f2=-(tpeak*f-1.00)**2/(2.00*sigma**2)
      if (f2.lt.-25.0) then
      f0=1.0
      else
      f0=ganma**exp(f2)
      end if
      if (f1.lt.-25.0) then
      x(i)=0.0
      else
      x(i)=c1j*f**(-5)*exp(f1)*f0
      end if
2     continue
      return
      end
!-------------------------------------------------------------------
      subroutine bm0(x,n,m,h3,t3,dt)
!-------------------------------------------------------------------
!     computation of bretschneider-mitsuyasu type spectrum
!-------------------------------------------------------------------
!     x   : bretschneider mitsuyasu type frequency spectrum
!     n   : data number of spectrum
!     h3 : significant wave height
!     t3 : significant wave period
!     dt : time interval
      dimension x(m)
      df=1.0/(2*n*dt)
      a=0.257*h3**2
      b=t3**(-4)
      c=-1.03*b
      ab=a*b
      x(1)=0.0
      do 1 i=2,n
      f0=df*(i-1)
      cfb=f0**(-4)
```

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```
        cf=c*cfb
        if(cf .lt. -25.0)    go to 2
        x(i)=ab*cfb/f0*exp(cf)
        go to 1
2       x(i)=0.
1       continue
        return
        end
!-----------------------------------------------------------------------
        subroutine bms(x,n,m,h3,t3,dt)
!-----------------------------------------------------------------------
!       computation of shuusei bretschneider-mitsuyasu type spectrum
!-----------------------------------------------------------------------
!       x    : shuusei bretschneider mitsuyasu type frequency spectrum
!       n    : data number of spectrum
!       h3 : significant wave height
!       t3 : significant wave period
!       dt : time interval
        dimension x(m)
        df=1.0/(2*n*dt)
        a=0.205*h3**2
        b=t3**(-4)
        c=-0.75*b
        ab=a*b
        x(1)=0.0
        do 1 i=2,n
        f0=df*(i-1)
        cfb=f0**(-4)
        cf=c*cfb
        if(cf .lt. -25.0)    go to 2
        x(i)=ab*cfb/f0*exp(cf)
        go to 1
2       x(i)=0.
1       continue
        return
        end
! ************************************
      subroutine kh(SHG,Hk)
```

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```
      IF(SHG-10.) 2,2,1
1     XY=SHG
      GO TO 6
2     IF(SHG-1.0) 3,4,4
3     X=SQRT(SHG)
      GO TO 5
4     X=SHG
5     COTHX=1./TANH(X)
      XY=X-(X-SHG*COTHX)/(1.+SHG*(COTHX**2-1.))
      E=1.-XY/X
      X=XY
      IF(ABS(E)-0.0005)6,5,5
6     hk=XY
          RETURN
      END
!=============================================
        function wavel(t,d)
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!       calculation of wave length    (m)
!-------------------------------------------------------------
!       t : wave period (sec)
!       d : water depth (m)
        pai2=6.283185
        dd=pai2*d/(9.8*t**2/pai2)
        x=dd
        if(dd .lt. 1.0) x=sqrt(dd)
4       coth=1.0/tanh(x)
        xx=x-(x-dd*coth)/(1.0+dd*(coth**2-1.0))
        emin=1.0-xx/x
        x=xx
        if(abs(emin) .ge. 0.0005) go to 4
        wavel=pai2/x*d
        return
        end
!*************************************************************************
        subroutine seki(a,b,m,na,nk,nb)
        real a(m,m),b(m,m),c(10000)
```

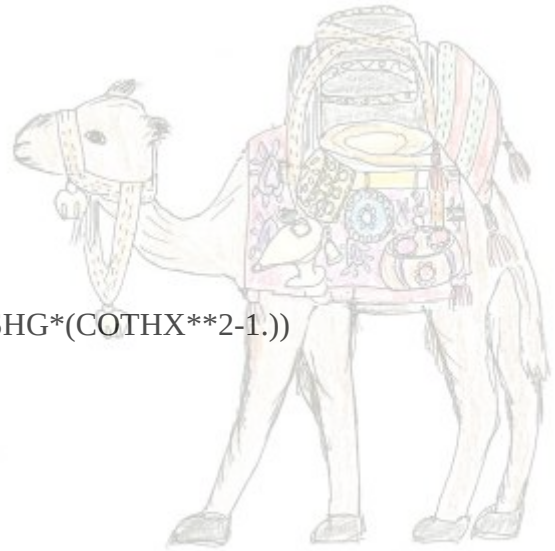

```
      do 100 i=1,na
      do 101 k=1,nk
      c(k)=a(i,k)
101   continue
      do 100 j=1,nb
      r=0.
      do 102 k=1,nk
      r=r+c(k)*b(k,j)
102   continue
      a(i,j)=r
100   continue
      return
      end
!=============================================================
      subroutine minvs(a,ko,n,eps,ill)
      real a(ko,ko)
      integer x(10000)
      logical b
      ill=0
      if((ko.ge.n).and.(n.ge.2).and.(n.le.10000).and.(eps.gt.0.0))
     / go to 1
      ill=30000
      return
1     do 10 i=1,n
      x(i)=i
10    continue
      do 110 k=1,n
      m=k
      w=0.0
      do 20 i=k,n
      absa=abs(a(i,k))
      if(absa.le.w) go to 20
      w=absa
      m=i
20    continue
      if(m.eq.k) go to 50
      l=x(m)
      x(m)=x(k)
```

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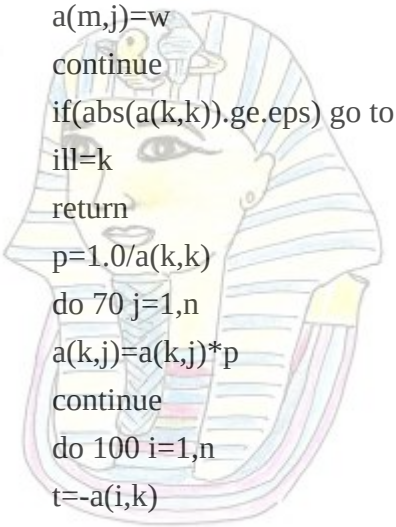
```
      x(k)=l
      do 40 j=1,n
      w=a(k,j)
      a(k,j)=a(m,j)
      a(m,j)=w
40    continue
50    if(abs(a(k,k)).ge.eps) go to 60
      ill=k
      return
60    p=1.0/a(k,k)
      do 70 j=1,n
      a(k,j)=a(k,j)*p
70    continue
      do 100 i=1,n
      t=-a(i,k)
      b=(i.ne.k).and.(t.ne.0.0)
      if(.not.b) go to 100
      do 90 j=1,n
      a(i,j)=a(i,j)+a(k,j)*t
90    continue
100   a(i,k)=p*t
      a(k,k)=p
110   continue
      do 140 i=1,n
120   if(x(i).eq.i) go to 140
      k=x(i)
      do 130 j=1,n
      w=a(j,i)
      a(j,i)=a(j,k)
      a(j,k)=w
130   continue
      l=x(i)
      x(i)=x(k)
      x(k)=l
      go to 120
140   continue
      return
      end
```



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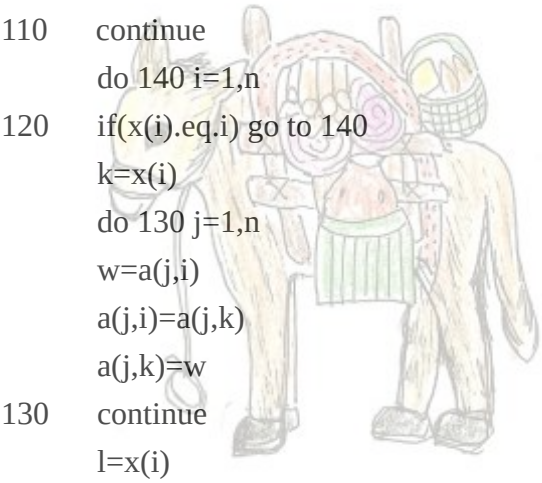

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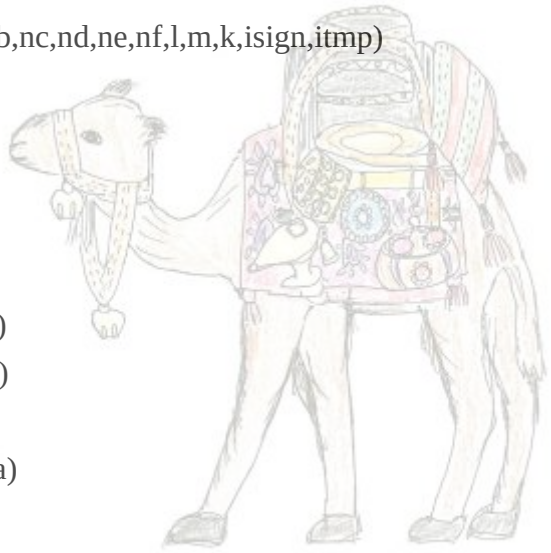
```
!@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
!              mtr2
!++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      subroutine mtr2_1(a,b,nx,na,nb,nc,nd,ne,nf,l,m,k,isign,itmp)
      real a(nx,nx),b(nx,nx)
      call openfileo(41,l)
      call openfileo(42,m)
      call openfilen(43,k)
      call openfilen(44,itmp)
      read(41) ((a(i,j),j=1,nc),i=1,na)
      read(42) ((b(i,j),j=1,ne),i=1,nc)
      call seki(a,b,nx,na,nc,ne)
      write(44) ((a(i,j),j=1,ne),i=1,na)
      backspace 41
      read(41) ((a(i,j),j=1,nc),i=1,na)
      read(42) ((b(i,j),j=1,nf),i=1,nc)
      call seki (a,b,nx,na,nc,nf)
      write(44) ((a(i,j),j=1,nf),i=1,na)
      read(41) ((a(i,j),j=1,nd),i=1,na)
      read(42) ((b(i,j),j=1,ne),i=1,nd)
      call seki (a,b,nx,na,nd,ne)
      rewind 44
      read(44) ((b(i,j),j=1,ne),i=1,na)
      call wa (a,b,nx,na,ne)
      if(isign.eq.1) write(43) ((b(i,j),j=1,ne),i=1,na)
      if(isign.eq.2) write(43) ((-b(i,j),j=1,ne),i=1,na)
      read(41) ((a(i,j),j=1,nc),i=1,nb)
      read(41) ((a(i,j),j=1,nd),i=1,nb)
      rewind 41
      read(41) ((a(i,j),j=1,nc),i=1,na)
      read(41) ((a(i,j),j=1,nd),i=1,na)
      read(42) ((b(i,j),j=1,nf),i=1,nd)
      call seki (a,b,nx,na,nd,nf)
      read(44) ((b(i,j),j=1,nf),i=1,na)
      call wa (a,b,nx,na,nf)
      if(isign.eq.1) write(43) ((b(i,j),j=1,nf),i=1,na)
      if(isign.eq.2) write(43) ((-b(i,j),j=1,nf),i=1,na)
      close(44)
```



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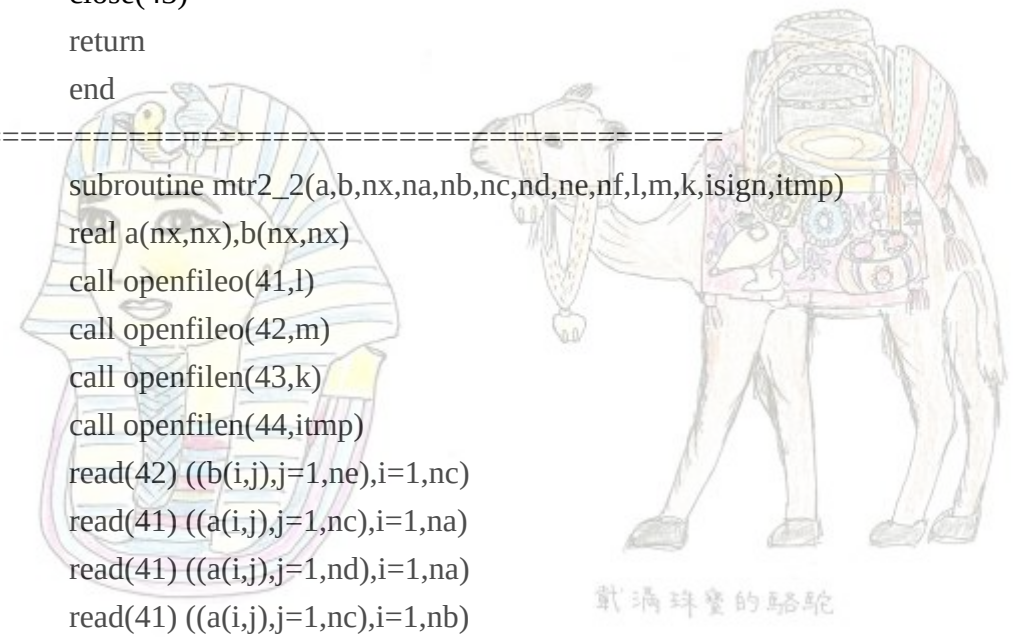
```
      close(41)
      close(42)
      close(43)
      return
      end
!=============================================
      subroutine mtr2_2(a,b,nx,na,nb,nc,nd,ne,nf,l,m,k,isign,itmp)
      real a(nx,nx),b(nx,nx)
      call openfileo(41,l)
      call openfileo(42,m)
      call openfilen(43,k)
      call openfilen(44,itmp)
      read(42) ((b(i,j),j=1,ne),i=1,nc)
      read(41) ((a(i,j),j=1,nc),i=1,na)
      read(41) ((a(i,j),j=1,nd),i=1,na)
      read(41) ((a(i,j),j=1,nc),i=1,nb)
      call seki (a,b,nx,nb,nc,ne)
      rewind 44
      write(44) ((a(i,j),j=1,ne),i=1,nb)
      read(41) ((b(i,j),j=1,nd),i=1,nb)
      backspace 41
      backspace 41
      read(41)    ((a(i,j),j=1,nc),i=1,nb)
      read(42)    ((b(i,j),j=1,nf),i=1,nc)
      call seki (a,b,nx,nb,nc,nf)
      write(44) ((a(i,j),j=1,nf),i=1,nb)
      read(41)    ((a(i,j),j=1,nd),i=1,nb)
      read(42)    ((b(i,j),j=1,ne),i=1,nd)
      call seki (a,b,nx,nb,nd,ne)
      rewind 44
      read(44)    ((b(i,j),j=1,ne),i=1,nb)
      call wa (a,b,nx,nb,ne)
      if(isign.eq.1) write(43) ((b(i,j),j=1,ne),i=1,nb)
      if(isign.eq.2) write(43) ((-b(i,j),j=1,ne),i=1,nb)
      backspace 41
      read(41)    ((a(i,j),j=1,nd),i=1,nb)
      read(42)    ((b(i,j),j=1,nf),i=1,nd)
      call seki (a,b,nx,nb,nd,nf)
```



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```
      read(44)    ((b(i,j),j=1,nf),i=1,nb)
      call wa (b,a,nx,nb,nf)
      if(isign.eq.1) write(43) ((a(i,j),j=1,nf),i=1,nb)
      if(isign.eq.2) write(43) ((-a(i,j),j=1,nf),i=1,nb)
      close(44)
      close(41)
      close(42)
      close(43)
      return
      end
!=======================================
      subroutine mtr2_3(a,nx,na,nb,nc,nd,k,kk,iout)
      real a(nx,nx)
      call openfileo(41,k)
      call openfileo(42,kk)
      call openfilen(43,iout)
      read(41)    ((a(i,j),j=1,nc),i=1,na)
      write(43) ((a(i,j),j=1,nc),i=1,na)
      read(41)    ((a(i,j),j=1,nd),i=1,na)
      write(43) ((a(i,j),j=1,nd),i=1,na)
      read(42)    ((a(i,j),j=1,nc),i=1,nb)
      write(43) ((a(i,j),j=1,nc),i=1,nb)
      read(42)    ((a(i,j),j=1,nd),i=1,nb)
      write(43) ((a(i,j),j=1,nd),i=1,nb)
      close(42)
      close(43)
      close(41)
      return
      end
!$$$$$$$$$$$$$$$$$$$$$$$$$$$
!            mir2
!+++++++++++++++++++++++++++++++++++++++++++++++++++
      subroutine mir2_1(a,b,nx,n,ns,in,itmp,id)
      real a(nx,nx),b(nx,nx)
      call openfilen(41,itmp)
      call openfileo(42,in)
      read(42) ((a(i,j),j=1,n ),i=1,n)
      read(42) ((a(i,j),j=1,ns),i=1,n)
```

```
      read(42) ((a(i,j),j=1,n ),i=1,ns)
      read(42) ((b(i,j),j=1,ns),i=1,ns)
      call minvs(b,nx,ns,1e-8,ill)
      illd=1
      if(ill.ne.0) write (*,10) illd,ill,id
      call seki(b,a,nx,ns,ns,n)
      write(41) ((b(i,j),j=1,n),i=1,ns)
      backspace 42
      backspace 42
      backspace 42
      read(42) ((a(i,j),j=1,ns),i=1,n)
      call seki (a,b,nx,n,ns,n)
      read(42) ((b(i,j),j=1,n ),i=1,ns)
      read(42) ((b(i,j),j=1,ns),i=1,ns)
      rewind 42
      read(42) ((b(i,j),j=1,n ),i=1,n )
      call sa (b,a,nx,n,n)
      call minvs (a,nx,n,1e-8,ill)
      illd=2
      if(ill.ne.0) write (*,10) illd,ill,id
      rewind 41
      read(41) ((b(i,j),j=1,n ),i=1,ns)
      call seki (b,a,nx,ns,n,n)
      rewind 41
      write(41) ((a(i,j),j=1,n ),i=1,n)
      write(41) ((-b(i,j),j=1,n ),i=1,ns)
      close(42)
      close(41)
      return
10    format(1x,'ill(',i1,')=',i7,'    <ID>=#',i2)
      end
!*****************************************************
      subroutine mir2_2(a,b,nx,n,ns,in,itmp,id)
      real a(nx,nx),b(nx,nx)
      call openfilen(41,itmp)
      call openfileo(42,in)
      read(42)    ((a(i,j),j=1,n ),i=1,n)
      call minvs (a,nx,n,1e-8,ill)
```

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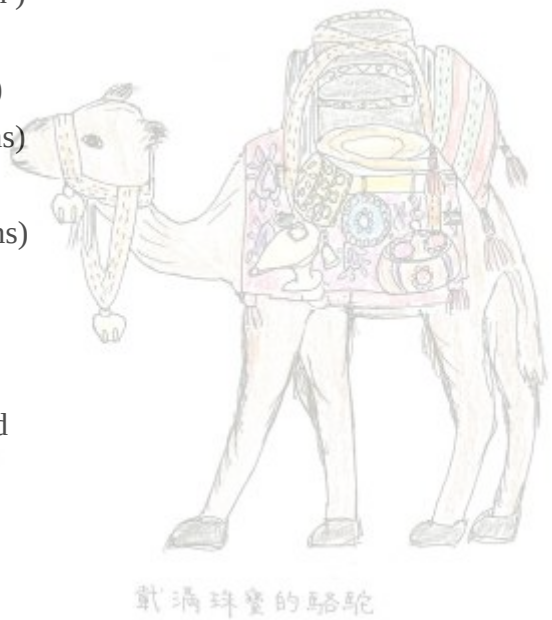
```
      illd=3
      if(ill.ne.0) write(*,10) illd,ill,id
      read(42)    ((b(i,j),j=1,ns),i=1,n )
      call seki (a,b,nx,n,n,ns)
      write(41) ((a(i,j),j=1,ns),i=1,n)
      read(42)    ((b(i,j),j=1,n ),i=1,ns)
      call seki (b,a,nx,ns,n,ns)
      read(42)    ((a(i,j),j=1,ns),i=1,ns)
      call sa (a,b,nx,ns,ns)
      call minvs (b,nx,ns,1e-8,ill)
      illd=4
      if(ill.ne.0) write(*,10) illd,ill,id
      rewind 41
      read(41) ((a(i,j),j=1,ns),i=1,n)
      call seki (a,b,nx,n,ns,ns)
      rewind 41
      write(41) ((-a(i,j),j=1,ns),i=1,n)
      write(41) ((b(i,j),j=1,ns),i=1,ns)
      close(41)
      close(42)
      return
10    format(1x,'ill(',i1,')=',i7,'    <ID>=#',i2)
      end
!*************************************************************
      subroutine mir2_3(a,nx,n,ns,in1,in2,iout)
      real a(nx,nx)
      call openfileo(41,in1)
      call openfileo(42,in2)
      call openfilen(43,iout)
      read(41)    ((a(i,j),j=1,n ),i=1,n)
      write(43) ((a(i,j),j=1,n ),i=1,n)
      read(42)    ((a(i,j),j=1,ns),i=1,n)
      write(43) ((a(i,j),j=1,ns),i=1,n)
      read(41)    ((a(i,j),j=1,n),i=1,ns)
      write(43) ((a(i,j),j=1,n),i=1,ns)
      read(42)    ((a(i,j),j=1,ns),i=1,ns)
      write(43) ((a(i,j),j=1,ns),i=1,ns)
      close(42)
```



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```
      close(43)
      close(41)
      return
      end
!$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$$$$$$$$$$$$
      subroutine sa2_1(a,b,nx,na,nb,nc,nd,l,m,k)
      real a(nx,nx),b(nx,nx)
      call openfileo(41,l)
      call openfileo(42,m)
      call openfilen(43,k)
      read(41)   ((a(i,j),j=1,nc),i=1,na)
      read(42)   ((b(i,j),j=1,nc),i=1,na)
      call sa(a,b,nx,na,nc)
      write(43) ((b(i,j),j=1,nc),i=1,na)
      read(41)   ((a(i,j),j=1,nd),i=1,na)
      read(42)   ((b(i,j),j=1,nd),i=1,na)
      call sa(a,b,nx,na,nd)
      write(43) ((b(i,j),j=1,nd),i=1,na)
      close(41)
      close(42)
      close(43)
      return
      end
!*******************************************
      subroutine sa2_2(a,b,nx,na,nb,nc,nd,l,m,k)
      real a(nx,nx),b(nx,nx)
      call openfileo(41,l)
      call openfileo(42,m)
      call openfilen(43,k)
      read(41) ((a(i,j),j=1,nc),i=1,na)
      read(41) ((a(i,j),j=1,nd),i=1,na)
      read(42) ((b(i,j),j=1,nc),i=1,na)
      read(42) ((b(i,j),j=1,nd),i=1,na)
      read(41) ((a(i,j),j=1,nc),i=1,nb)
      read(42) ((b(i,j),j=1,nc),i=1,nb)
      call sa(a,b,nx,nb,nc)
      write(43) ((b(i,j),j=1,nc),i=1,nb)
```

```
      read(41)    ((a(i,j),j=1,nd),i=1,nb)
      read(42)    ((b(i,j),j=1,nd),i=1,nb)
      call sa(a,b,nx,nb,nd)
      write(43) ((b(i,j),j=1,nd),i=1,nb)
      close(41)
      close(42)
      close(43)
      return
      end
!*****************************************
      subroutine sa2_3(a,nx,na,nb,nc,nd,l,m,k)
      real a(nx,nx)
      call openfileo(41,l)
      call openfileo(42,m)
      call openfilen(43,k)
      read(41)    ((a(i,j),j=1,nc),i=1,na)
      write(43) ((a(i,j),j=1,nc),i=1,na)
      read(41)    ((a(i,j),j=1,nd),i=1,na)
      write(43) ((a(i,j),j=1,nd),i=1,na)
      read(42)    ((a(i,j),j=1,nc),i=1,nb)
      write(43) ((a(i,j),j=1,nc),i=1,nb)
      read(42)    ((a(i,j),j=1,nd),i=1,nb)
      write(43) ((a(i,j),j=1,nd),i=1,nb)
      close(41)
      close(42)
      close(43)
      return
      end

!     ================================================
      subroutine sa(a,b,na,n,ns)
!     ************************************************
!      [a]n,ns - [b]n,ns ======> [b]n,ns
!     ************************************************
      real a(na,na),b(na,na)
      do 100 i=1,n
      do 100 j=1,ns
      b(i,j)=a(i,j)-b(i,j)
```

```
100     continue
        return
        end
!       ****************************************************
        subroutine wa(a,b,na,n,ns)
!        [a]n,ns + [b]n,ns =====> [b]n,ns
!       ========================================
        real a(na,na),b(na,na)
        do 100 i=1,n
        do 100 j=1,ns
        b(i,j)=a(i,j)+b(i,j)
100     continue
        return
        end
!====================== ============================
        subroutine openfilen(l,in)
      character(len=*) path
      parameter(path='\\3dwave09\chou\3dwave4\5x20\')
      character*10 tmpname
      if(in.ge.10.and.in.le.16)then
      if(in.eq.10) open(l,file=path//'tmp/f1.old',form='unformatted',
     &                  status='replace')
      if(in.eq.11) open(l,file=path//'tmp/f1b.old',form='unformatted',
     &                  status='replace')
      if(in.eq.12) open(l,file=path//'tmp/f2b.old',form='unformatted',
     &                  status='replace')
      if(in.eq.13) open(l,file=path//'tmp/f3b.old',form='unformatted',
     &                  status='replace')
      if(in.eq.14) open(l,file=path//'tmp/f4b.old',form='unformatted',
     &                  status='replace')
      if(in.eq.15) open(l,file=path//'tmp/f5b.old',form='unformatted',
     &                  status='replace')
      if(in.eq.16) open(l,file=path//'tmp/f6b.old',form='unformatted',
     &                  status='replace')
      else
      write(tmpname,"('tmp/',i2.2,'.apt')") in
         open(l,file=path//tmpname,form='unformatted',status='replace')
      end if
```

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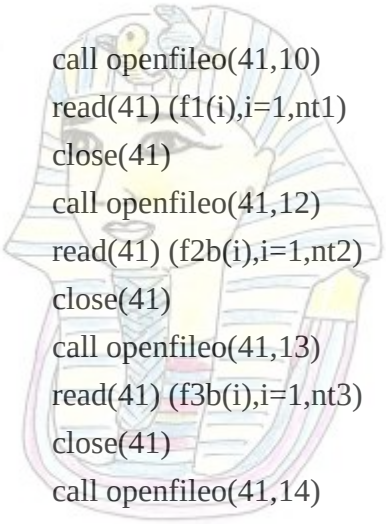
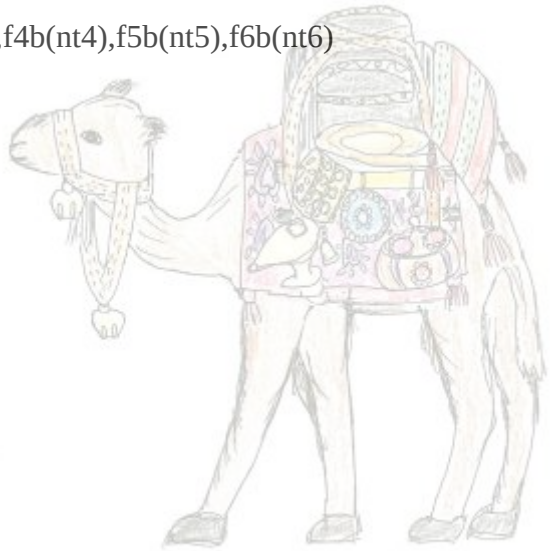
```
        return
        end
!==================
      subroutine openfileo(l,in)
      character(len=*) path
      parameter(path='\\3dwave09\chou\3dwave4\5x20\')
      character*10 tmpname
      if(in.ge.10.and.in.le.16)then
      if(in.eq.10)
       &open(l,file=path//'tmp/f1.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.11)
       &open(l,file=path//'tmp/f1b.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.12)
       &open(l,file=path//'tmp/f2b.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.13)
       &open(l,file=path//'tmp/f3b.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.14)
       &open(l,file=path//'tmp/f4b.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.15)
       &open(l,file=path//'tmp/f5b.old',form='unformatted',status='old',
       &       action='read')
      if(in.eq.16)
       &open(l,file=path//'tmp/f6b.old',form='unformatted',status='old',
       &       action='read')
      else
      write(tmpname,"('tmp/',i2.2,'.apt')") in
        open(l,file=path//tmpname,form='unformatted',status='old',
       &       action='read')
      end if
        return
        end
!$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
        subroutine solf1b1(a,f1,f1b,f2b,f3b,f4b,f5b,f6b,nx,nt1,nt2,nt3,
```

```
     &                    nt4,nt5,nt6,nb1,nb2,nb3,nb4,itype,in1,in2,iout)
      real a(nx,nx)
      real f1(nt1)
      real f1b(nt1),f2b(nt2),f3b(nt3),f4b(nt4),f5b(nt5),f6b(nt6)

      call openfileo(41,10)
      read(41) (f1(i),i=1,nt1)
      close(41)
      call openfileo(41,12)
      read(41) (f2b(i),i=1,nt2)
      close(41)
      call openfileo(41,13)
      read(41) (f3b(i),i=1,nt3)
      close(41)
      call openfileo(41,14)
      read(41) (f4b(i),i=1,nt4)
      close(41)
      call openfileo(41,15)
      read(41) (f5b(i),i=1,nt5)
      close(41)
      call openfileo(41,16)
      read(41) (f6b(i),i=1,nt6)
      close(41)
      call openfileo(42,in1)
      call openfileo(43,in2)
!
      do 1 i=1,nt1
1     f1b(i)=0
!
      if(itype.eq.1) n=nb1
      if(itype.eq.2) n=nb2
      if(itype.eq.3) n=nb3
      if(itype.eq.4) n=nb4
     na1=nb1
     if(itype.eq.3.or.itype.eq.4) na1=nb3
!
      if(itype.eq.2.or.itype.eq.4)then
            read(42) ((a(ii,jj),jj=1,nb1),ii=1,na1)
```





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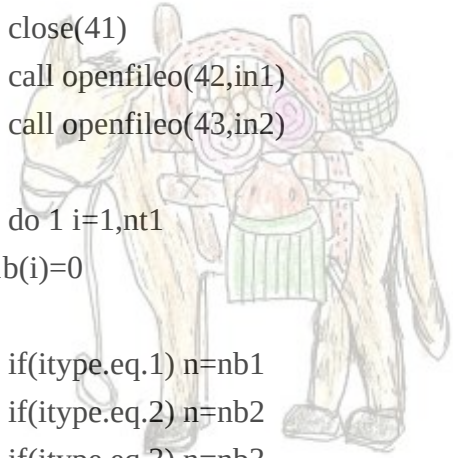

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```
            read(42) ((a(ii,jj),jj=1,nb2),ii=1,na1)
      end if

        read(42) ((a(ii,jj),jj=1,nb1),ii=1,n)
        do 11 i=1,n
      do 11 j=1,nb1
11    f1b(i)=f1b(i)+a(i,j)*f1(j)

        read(42) ((a(ii,jj),jj=1,nb2),ii=1,n)
        close(42)
        do 13 i=1,n
      do 13 j=1,nb2
13    f1b(i)=f1b(i)+a(i,j)*f1(nb1+j)
!
        if(itype.eq.2.or.itype.eq.4)then
           read(43) ((a(ii,jj),jj=1,nb3),ii=1,na1)
           read(43) ((a(ii,jj),jj=1,nb4),ii=1,na1)
      end if

        read(43) ((a(ii,jj),jj=1,nb3),ii=1,n)
        do i=1,n
      do j=1,nt2
        f1b(i)=f1b(i)+a(i,j)*f2b(j)
        end do
      do j=1,nt3
        f1b(i)=f1b(i)+a(i,nt2+j)*f3b(j)
        end do
      do j=1,nt4
        f1b(i)=f1b(i)+a(i,nt2+nt3+j)*f4b(j)
        end do
      do j=1,nt5
        f1b(i)=f1b(i)+a(i,nt2+nt3+nt4+j)*f5b(j)
        end do
      end do

        read(43) ((a(ii,jj),jj=1,nb4),ii=1,n)
        close(43)
        do 17 i=1,n
```

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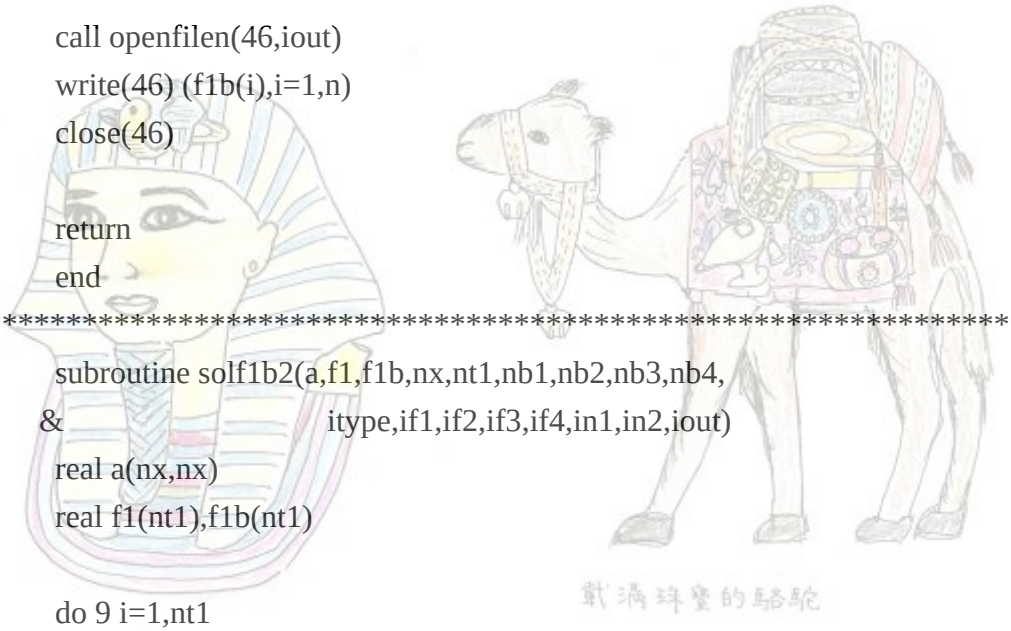
```
      do 17 j=1,nt6
17    f1b(i)=f1b(i)+a(i,j)*f6b(j)

      call openfilen(46,iout)
      write(46) (f1b(i),i=1,n)
      close(46)

      return
      end
!*****************************************************************
      subroutine solf1b2(a,f1,f1b,nx,nt1,nb1,nb2,nb3,nb4,
     &                   itype,if1,if2,if3,if4,in1,in2,iout)
      real a(nx,nx)
      real f1(nt1),f1b(nt1)

      do 9 i=1,nt1
9     f1b(i)=0

      select case (itype)
      case (1)
            na1=nb1
         na2=nb2
            n=na1
   case (2)
            na1=nb1
         na2=nb2
         n=na2
   case (3)
            na1=nb3
         na2=nb4
            n=nb3
   case (4)
            na1=nb3
         na2=nb4
         n=nb4
   end select

      call openfileo(42,in1)
```



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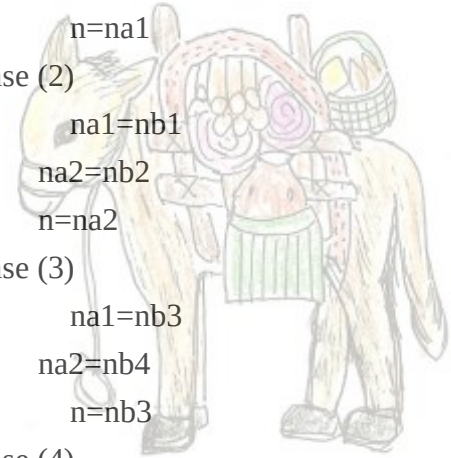
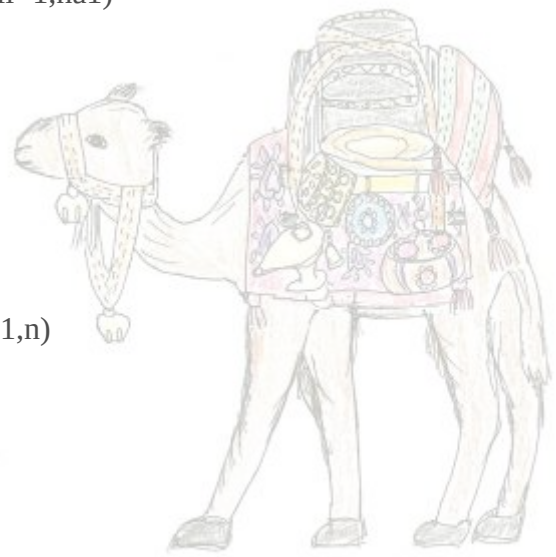


```
      if(itype.eq.2.or.itype.eq.4)then
        read(42) ((a(ii,jj),jj=1,nb1),ii=1,na1)
        read(42) ((a(ii,jj),jj=1,nb2),ii=1,na1)
    end if

      call openfileo(41,if1)
      read(41) (f1(i),i=1,nb1)
      close(41)

      read(42) ((a(ii,jj),jj=1,nb1),ii=1,n)
      do 11 i=1,n
    do 11 j=1,nb1
11  f1b(i)=f1b(i)+a(i,j)*f1(j)

      call openfileo(41,if2)
      read(41) (f1(i),i=1,nb2)
      close(41)
      read(42) ((a(ii,jj),jj=1,nb2),ii=1,n)
      do 13 i=1,n
    do 13 j=1,nb2
13  f1b(i)=f1b(i)+a(i,j)*f1(j)
      close(42)

      call openfileo(42,in2)
      if(itype.eq.2.or.itype.eq.4)then
        read(42) ((a(ii,jj),jj=1,nb3),ii=1,na1)
        read(42) ((a(ii,jj),jj=1,nb4),ii=1,na1)
    end if

      call openfileo(41,if3)
      read(41) (f1(i),i=1,nb3)
      close(41)
      read(42) ((a(ii,jj),jj=1,nb3),ii=1,n)
      do 21 i=1,n
    do 21 j=1,nb3
21  f1b(i)=f1b(i)+a(i,j)*f1(j)

      call openfileo(41,if4)
```



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```
      read(41) (f1(i),i=1,nb4)
      close(41)
      read(42) ((a(ii,jj),jj=1,nb4),ii=1,n)
      do 23 i=1,n
    do 23 j=1,nb4
23  f1b(i)=f1b(i)+a(i,j)*f1(j)
      close(42)

      call openfilen(46,iout)
      write(46) (f1b(i),i=1,n)
      close(46)

      return
      end
!++++++++++++++++++++++ +++++++++++++++++++++++++++++
      subroutine solwsa(f1,f1b,nt1,nb1,in1,in2,iout,iws)
      real f1(nt1),f1b(nt1)

      call openfileo(41,in1)
      call openfileo(42,in2)
      read(41) (f1(i),i=1,nb1)
      read(42) (f1b(i),i=1,nb1)

      do i=1,nb1
      if(iws.eq.1) f1(i)=f1(i)-f1b(i)
      if(iws.eq.2) f1(i)=f1(i)+f1b(i)
    end do
      close(41)
    close(42)

      call openfilen(43,iout)
      write(43) (f1(i),i=1,nb1)
      close(43)
      return
      end
!$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      subroutine check(x,y,z,nt,f1,f1b,nt1,ni1,nj1,f2,f2b,nt2,ni2,nj2,
     &            f3,f3b,nt3,ni3,nj3,f4,f4b,nt4,ni4,nj4,f5,f5b,nt5,ni5,nj5,
```

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```
     &          f6,f6b,nt6,ni6,nj6,mas,eng,ek,ep)
          real x(nt),y(nt),z(nt)
          real f1(nt1),f1b(nt1),f2(nt2),f2b(nt2),f3(nt3),f3b(nt3)
          real f4(nt4),f4b(nt4),f5(nt5),f5b(nt5),f6(nt6),f6b(nt6)
          real xx(4),yy(4),zz(4),fx(4),fy(4),fz(4),f11(4),f1bb(4)
          real mas,eng,ek,ep,zm,ffm,zm2

!         mas: mass
!         eng: total energy= kinetic energy + potential energy
!         ek: kinetic energy
!         ep: potential energy
          mas=0
          eng=0
          ek=0
          ep=0

          do in=1,6

          if(in.eq.1) ie=ni1-1
        if(in.eq.1) je=nj1-1
          if(in.eq.2) ie=ni2-1
        if(in.eq.2) je=nj2-1
          if(in.eq.3) ie=ni3-1
        if(in.eq.3) je=nj3-1
          if(in.eq.4) ie=ni4-1
        if(in.eq.4) je=nj4-1
          if(in.eq.5) ie=ni5-1
        if(in.eq.5) je=nj5-1
          if(in.eq.6) ie=ni6-1
        if(in.eq.6) je=nj6-1

          do 10 i=1,ie
        do 10 j=1,je

          if(in.eq.1) ii=j+(je+1)*(i-1)
          if(in.eq.2) ii=nt1+j+(je+1)*(i-1)
          if(in.eq.3) ii=nt1+nt2+j+(je+1)*(i-1)
          if(in.eq.4) ii=nt1+nt2+nt3+j+(je+1)*(i-1)
```

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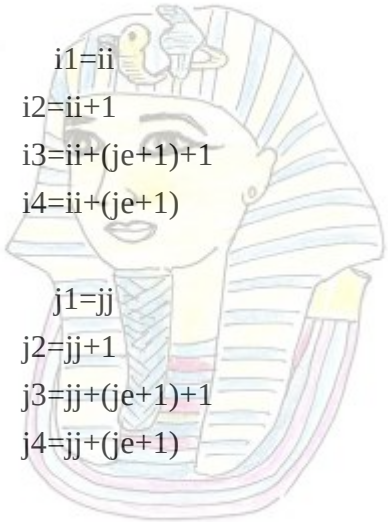
```
    if(in.eq.5) ii=nt1+nt2+nt3+nt4+j+(je+1)*(i-1)
    if(in.eq.6) ii=nt1+nt2+nt3+nt4+nt5+j+(je+1)*(i-1)

    jj=j+(je+1)*(i-1)

    i1=ii
i2=ii+1
i3=ii+(je+1)+1
i4=ii+(je+1)

    j1=jj
j2=jj+1
j3=jj+(je+1)+1
j4=jj+(je+1)

xx(1)=x(i1)
xx(2)=x(i2)
xx(3)=x(i3)
xx(4)=x(i4)

yy(1)=y(i1)
yy(2)=y(i2)
yy(3)=y(i3)
yy(4)=y(i4)

zz(1)=z(i1)
zz(2)=z(i2)
zz(3)=z(i3)
zz(4)=z(i4)

    if(in.eq.1)then
    f11(1)=f1(j1)
    f11(2)=f1(j2)
    f11(3)=f1(j3)
    f11(4)=f1(j4)
    f1bb(1)=f1b(j1)
    f1bb(2)=f1b(j2)
    f1bb(3)=f1b(j3)
```



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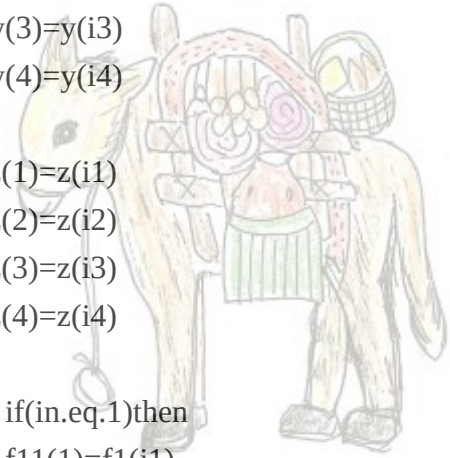

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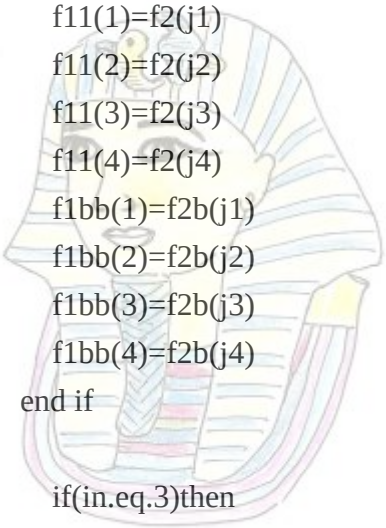
```
    f1bb(4)=f1b(j4)
end if

    if(in.eq.2)then
    f11(1)=f2(j1)
    f11(2)=f2(j2)
    f11(3)=f2(j3)
    f11(4)=f2(j4)
    f1bb(1)=f2b(j1)
    f1bb(2)=f2b(j2)
    f1bb(3)=f2b(j3)
    f1bb(4)=f2b(j4)
end if

    if(in.eq.3)then
    f11(1)=f3(j1)
    f11(2)=f3(j2)
    f11(3)=f3(j3)
    f11(4)=f3(j4)
    f1bb(1)=f3b(j1)
    f1bb(2)=f3b(j2)
    f1bb(3)=f3b(j3)
    f1bb(4)=f3b(j4)
end if

    if(in.eq.4)then
    f11(1)=f4(j1)
    f11(2)=f4(j2)
    f11(3)=f4(j3)
    f11(4)=f4(j4)
    f1bb(1)=f4b(j1)
    f1bb(2)=f4b(j2)
    f1bb(3)=f4b(j3)
    f1bb(4)=f4b(j4)
end if

    if(in.eq.5)then
    f11(1)=f5(j1)
```



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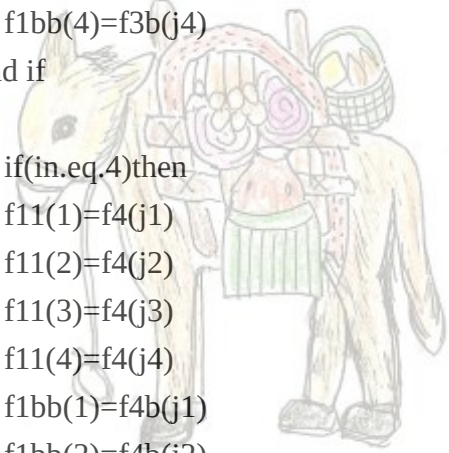

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```
      f11(2)=f5(j2)
      f11(3)=f5(j3)
      f11(4)=f5(j4)
      f1bb(1)=f5b(j1)
      f1bb(2)=f5b(j2)
      f1bb(3)=f5b(j3)
      f1bb(4)=f5b(j4)
    end if

      if(in.eq.6)then
      f11(1)=f6(j1)
      f11(2)=f6(j2)
      f11(3)=f6(j3)
      f11(4)=f6(j4)
      f1bb(1)=f6b(j1)
      f1bb(2)=f6b(j2)
      f1bb(3)=f6b(j3)
      f1bb(4)=f6b(j4)
    end if

      zm=0.25*(zz(1)+zz(2)+zz(3)+zz(4))

    ffm=0.25*(f11(1)*f1bb(1)    +f11(2)*f1bb(2)
     &          +f11(3)*f1bb(3)    +f11(4)*f1bb(4))

    zm2=0.25*(zz(1)*abs(zz(1))    +zz(2)*abs(zz(2))
     &          +zz(3)*abs(zz(3))    +zz(4)*abs(zz(4)))
      ek=ek+0.5*ffm

      if(in.eq.1)then
      call normal(xx,yy,zz,xn,yn,zn,a)
    cosr=-zn
      mas=mas+zm*a*cosr
    ep=ep+0.5*9.81*zm2*a*cosr
    end if

10      continue
```

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```
end do

eng=ek+ep

ek=(abs(ek)/eng)*100
ep=(abs(ep)/eng)*100

return
end
!$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$$$$$$$$$$$$
```

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