Assignment 06

1. Matrix multiplication

1.1


```
PROGRAM Main
USE Matrix_multip
IMPLICIT NONE

INTEGER      ::     u,i,j
REAL(4),DIMENSION(:,:),ALLOCATABLE :: M,N,Mat


u = 50
open(unit = u, file = 'M.dat', status = 'old')
allocate(M(5,3),N(3,5),Mat(5,5))

do i = 1,5
   read(u,*) (M(i,j),j=1,3)
enddo
close(u)

open(unit = u, file = 'N.dat', status = 'old')
do i = 1,3
   read(u,*) (N(i,j),j=1,5)
enddo
```

close(u)

call matrixmultip(M,N,Mat)

deallocate(M,N,Mat)

END PROGRAM Main

1.2

MODULE Matrix_multip

IMPLICIT NONE

contains

SUBROUTINE matrixmultip(M,N,MAT)

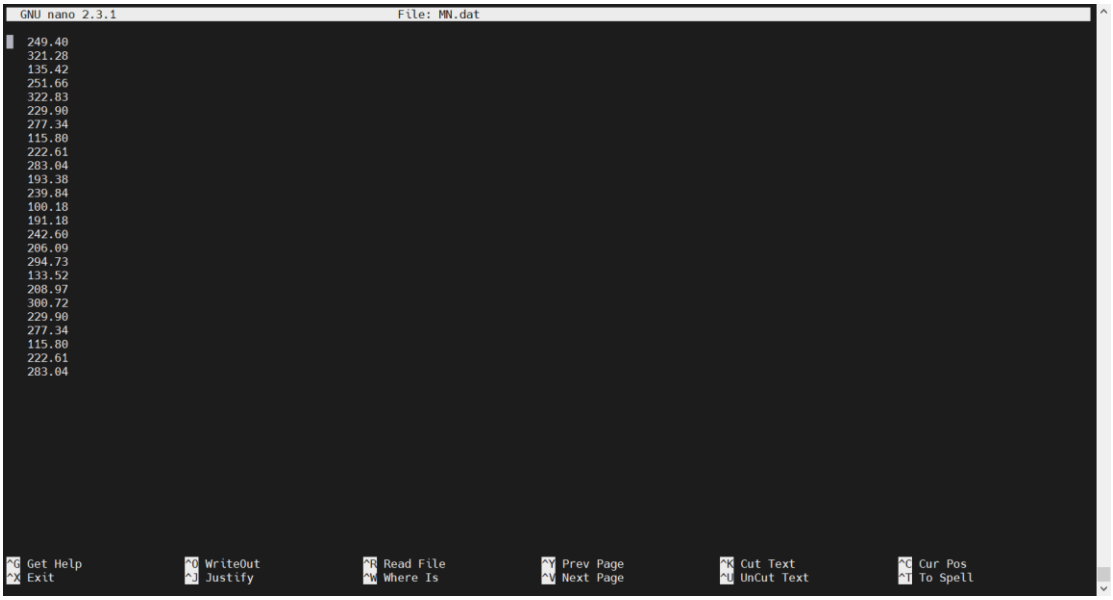
REAL(4) :: MAT(5,5),M(5,3),N(3,5)
INTEGER :: i,j,k,u
u = 50

do i = 1,5
do j = 1,5
MAT(i,j)=0
do k = 1,3
MAT(i,j)=MAT(i,j)+M(i,k)*N(k,j)
enddo
enddo

```
    enddo

    open(unit=u,file='MN.dat',status='replace')
    do i = 1,5
       write(u,'(f9.2)') (MAT(i,j) ,j=1,5)
    enddo
    close(u)

    END SUBROUTINE matrixmultip

END MODULE Matrix_multip
```

1.3

```
[ese-zhangk@login03 ps6]$ gfortran Main.f90 Matrix_multip.f90 -o Main.x
[ese-zhangk@login03 ps6]$ ./Main.x
```



2. Calculate the Solar Elevation Angle

2.1


```
MODULE Declination_angle

IMPLICIT NONE

CONTAINS

   SUBROUTINE dec_ang(d,a)
   IMPLICIT NONE
   INTEGER,INTENT(in) :: d
   REAL,INTENT(out) :: a
   real, parameter :: pi = 3.1415926536

   a = asin(sin(-23.44*pi/180)*cos((360/365.24*(d+10)+360*0.0167*sin(360*(d-2)/365.24*pi/180)/pi)*pi/180))*180/pi

   write(*,*) 'Thr frvlination angle is ', a

   END SUBROUTINE dec_ang
END MODULE Declination_angle
```

2.2


```
MODULE Solar_hour_angle

IMPLICIT NONE
CONTAINS
   SUBROUTINE sol_h_ang(days,hours,long,dtz,h)

   REAL,INTENT(IN) :: hours,long
   REAL,INTENT(OUT) :: h
   REAL :: r,eot,offset,lst,lst_cor
   INTEGER,INTENT(IN) :: days,dtz
   real, parameter :: pi = 3.1415926536
   lst = hours
   r=2*pi/365*(days-1+(hours-12)/24)
   eot = 229.18*(0.000075+0.001868*cos(r)-0.032077*sin(r)-0.014615*cos(2*r)-
0.040849*sin(2*r))
   offset = eot+4*(long-15*dtz)
   lst_cor=lst+offset/60
   h=15*(lst_cor-12)
   write(*,*) 'The solar hour angle is ',h

   END SUBROUTINE sol_h_ang

END MODULE Solar_hour_angle
```

2.3

PROGRAM Solar_elevation_angle

USE Declination_angle
USE Solar_hour_angle

IMPLICIT NONE

REAL :: rs,lat
INTEGER,DIMENSION(12) :: days
INTEGER :: year,mon,day,day_tol,dtz
REAL :: d_a,long,h_a,hour
write(*,*) 'Year:'
read(*,*) year
write(*,*) 'Month:'
read(*,*) mon
write(*,*) 'Day:'
read(*,*) day
write(*,*) 'Hour:'
read(*,*) hour
write(*,*) 'Longtitude:'
read(*,*) long
write(*,*) 'the difference in the local time zone to the universal time (UTC):'
read(*,*) dtz
if ((mod(year,400)==0) .or. (mod(year,100)/=0 .and. mod(year,4)==0)) then
  days=(/31,60,91,121,152,182,213,244,274,305,335,366/)
else
  days=(/31,59,90,120,151,181,212,243,273,304,334,365/)
endif

```
day_tol = days(mon-1)+day-1

call dec_ang(day_tol,d_a)
call sol_h_ang(day_tol,hour,long,dtz,h_a)

END PROGRAM Solar_elevation_angle
```

2.4

```
[ese-zhangk@login03 ps6]$ gfortran -c Declination_angle.f90
[ese-zhangk@login03 ps6]$ gfortran -c Solar_hour_angle.f90
[ese-zhangk@login03 ps6]$ ar rcvf libsea.a Declination_angle.o Solar_hour_angle.o
a - Declination_angle.o
a - Solar_hour_angle.o
[ese-zhangk@login03 ps6]$ gfortran Solar_elevation_angle.f90 -o Solar_elevation_angle.x -L. -lsea
[ese-zhangk@login03 ps6]$ ./Solar_elevation_angle.x
 Year:
2021
 Month:
12
 Day:
31
 Hour:
10.53
 Longtitude:
114.062996
 the difference in the local time zone to the universal time (UTC):
8
 Thr frvlination angle is   -23.1656399
 The solar hour angle is   -28.4798660
```