

## PS6

### 1.1

```
program Main
implicit none

integer :: i,u,z,x,y,j
real(4), dimension(:,:), allocatable :: m
real(4), dimension(:,:), allocatable :: n
real(4) :: r(5,5)

u=1
z=2
x=3
y=5

!read the M.dat
open(unit=u, file='M.dat', status='old')
allocate( m(y,x))

do i = 1,y
  read(u,*) (m(i,j),j=1,x)
enddo

close(u)

write(*,*) "N="
do i = 1,y
  write(*, '(5f9.2)') (m(i,:))
enddo

!read the N.dat
open(unit=z, file='N.dat', status='old')
allocate( n(x,y))

do i = 1,x
  read(z,*) (n(i,j),j=1,y)
enddo

close(z)

write(*,*) "M="
do i = 1,x
```

```
  write(*, '(5f9.2)') (n(i,:))
enddo

!call the subroutine
call Matrix_multip(m,n,r)
write(*,*) "M*N="
write(*, '(5f9.2)') r

deallocate(m,n)

u=50
open(unit=u, file='MN.dat', status='replace')
write(u, '(5f9.2)') r
close(u)

end program Main
```

### 1.2

```
!-----
!This is a subroutine
!-----
subroutine Matrix_multip(m,n,r)

implicit none

real(4), intent(in) ,dimension(:,:) :: m(5,3)
real(4), intent(in) ,dimension(:,:) :: n(3,5)
real(4), intent(out) ,dimension(:,:) :: r(5,5)

r=matmul(m,n)

end subroutine Matrix_multip

~
~
~
```

### 1.3

```
[ese-dengwh@login02 fortran_demo1]$ gfortran subroutine_MM.f90 main.f90 -o main.x
[ese-dengwh@login02 fortran_demo1]$ ./main.x
```

```
N=
  19.48    15.79    19.28
  19.28    12.92    15.86
  15.86    11.29    14.04
  11.93    18.60    18.23
  19.28    12.92    15.86

M=
   7.72    4.11    1.44    4.80    5.55
   5.55    4.80    4.04    0.59    8.58
   0.59    8.58    2.26    7.72    4.11

M*N=
 249.40  229.90  193.38  206.09  229.90
 321.28  277.34  239.84  294.73  277.34
 135.42  115.80  100.18  133.52  115.80
 251.66  222.61  191.18  208.97  222.61
 322.83  283.04  242.60  300.72  283.04
```

```
[ese-dengwh@login02 fortran_demo1]$ ll
```

```
total 1676
-rw-r--r-- 1 ese-dengwh ese-ouycc 423 Dec 22 14:08 Declination_angle.f90
-rw-r--r-- 1 ese-dengwh ese-ouycc 1236 Dec 22 14:08 declination_angle.mod
-rw-r--r-- 1 ese-dengwh ese-ouycc 3576 Dec 22 14:24 Declination_angle.o
-rwxr-xr-x 1 ese-dengwh ese-ouycc 125 Dec 8 18:37 DoLoopTest.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8936 Dec 8 19:52 DoLoopTest.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 301 Dec 8 18:37 DoWhileTest.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8936 Dec 8 19:57 DoWhileTest.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 124 Dec 8 19:12 HelloWorld.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8856 Dec 8 19:15 HelloWorld.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 301 Dec 8 19:50 IfElseTest.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8856 Dec 8 19:50 IfElseTest.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 232 Dec 8 19:31 ImplicitTypeTest.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8944 Dec 8 19:31 ImplicitTypeTest.x
-rw-r--r-- 1 ese-dengwh ese-ouycc 6526 Dec 22 14:25 libsea.a
-rw-r--r-- 1 ese-dengwh ese-ouycc 765 Dec 22 14:40 main.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 17984 Dec 22 14:44 main.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 91 Dec 8 18:37 M.dat
-rw-r--r-- 1 ese-dengwh ese-ouycc 230 Dec 22 14:44 MN.dat
-rwxr-xr-x 1 ese-dengwh ese-ouycc 76 Dec 8 18:37 N.dat
-rwxr-xr-x 1 ese-dengwh ese-ouycc 410 Dec 8 18:37 PrecisionTest.f90
-rw-r--r-- 1 ese-dengwh ese-ouycc 408 Dec 22 14:23 Solar_elevation_angle.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 13944 Dec 22 14:26 Solar_elevation_angle_lib.x
-rw-r--r-- 1 ese-dengwh ese-ouycc 4760 Dec 22 14:24 Solar_elevation_angle.o
-rw-r--r-- 1 ese-dengwh ese-ouycc 214 Dec 22 13:51 Solar_hour_angle
-rw-r--r-- 1 ese-dengwh ese-ouycc 261 Dec 22 13:57 Solar_hour_angle.f90
-rw-r--r-- 1 ese-dengwh ese-ouycc 919 Dec 22 13:57 solar_hour_angle.mod
-rw-r--r-- 1 ese-dengwh ese-ouycc 2512 Dec 22 14:24 Solar_hour_angle.o
-rw-r--r-- 1 ese-dengwh ese-ouycc 307 Dec 22 13:22 subroutine_MM.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 183 Dec 8 18:37 TestArray.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8936 Dec 8 19:59 TestArray.x
-rw-r--r-- 1 ese-dengwh ese-ouycc 290 Dec 8 20:36 TestLeapYear.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 303 Dec 8 18:37 TestRelationalOps.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8944 Dec 8 19:46 TestRelationalOps.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 196 Dec 8 19:40 TestUndeclared.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 8936 Dec 8 19:40 TestUndeclared.x
-rwxr-xr-x 1 ese-dengwh ese-ouycc 449 Dec 8 19:25 VariableShowcase.f90
-rwxr-xr-x 1 ese-dengwh ese-ouycc 13272 Dec 8 19:25 VariableShowcase.x
```

```
[ese-dengwh@login02 fortran_demo1]$ vi MN.dat
```

```
249.40  229.90  193.38  206.09  229.90
321.28  277.34  239.84  294.73  277.34
135.42  115.80  100.18  133.52  115.80
251.66  222.61  191.18  208.97  222.61
322.83  283.04  242.60  300.72  283.04
```

## 2.1

```

module Declination_angle

  implicit none

      integer :: d
      real(8) :: a,b,pi

  contains
      subroutine cal()
        pi=3.14159265
        write(*,*) 'Input the number of days since Jan. 1st d'
        read(*,*) d

        b=COS(pi/180*(360/365.24)*(d+10)+(360/pi)*0.0167*SIN((pi/180*360/365.24)*(d-2)))

        a=(ASIN(SIN(-23.44*pi/180)*b))*180/pi

      end subroutine cal
end module Declination_angle

```

## 2.2

```

module Solar_hour_angle

      real(4) :: h,LST
  contains
      subroutine cal2( )
        write(*,*) 'Input the local solar time(in min) LST'
        read(*,*) LST

        h=15*((LST/60)-12)

      end subroutine cal2
end module Solar_hour_angle

```

## 2.3

```

program Solar_elevation_angle

  use declination_angle
  use solar_hour_angle

  implicit none

  real(4) :: SEA, L

  write(*,*) 'Input latitude L'
  read(*,*) L

  call cal()
  call cal2()

  SEA=(ASIN(SIN(L*pi/180)*SIN(a*pi/180)+COS(L*pi/180)*COS(a*pi/180)*COS(h*pi/180)))*180/pi

  print*, "Declination_angle = ", a
  print*, "Solar_hour_angle = ", h
  print*, "Solar_elevation_angle = ", SEA

end program Solar_elevation_angle

```

## 2.4 (Kaifeng: 34.5°N, 2021-12-31, 10:00am)

```
[ese-dengwh@login02 fortran_demo1]$ gfortran -c Declination_angle.f90
[ese-dengwh@login02 fortran_demo1]$ gfortran -c Solar_hour_angle.f90
[ese-dengwh@login02 fortran_demo1]$ gfortran -c Solar_elevation_angle.f90
[ese-dengwh@login02 fortran_demo1]$ ar rcvf libsea.a Declination_angle.o Solar_hour_angle.o
r - Declination_angle.o
r - Solar_hour_angle.o

[ese-dengwh@login02 fortran_demo1]$ gfortran Solar_elevation_angle.f90 -o Solar_elevation_angle_lib.x -L. -lsea
[ese-dengwh@login02 fortran_demo1]$ ./Solar_elevation_angle_lib.x
Input latitude L
34.5
Input the number of days since Jan. 1st d
364
Input the local solar time(in min) LST
600
Declination_angle = -23.415861463273444
Solar_hour_angle = -30.0000000
Solar_elevation_angle = 25.4577274
```