Aim : To simulate the radioactive decay using the Monti Carlo method.

Theory :

Monti Carlo Method:

They are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. The underlying concept is to use randomness to solve problems that might be deterministic in principle.

Simulation of radioactive decay:

The radioactive decay simulation done by taking the value of the λ (decay constant) from the user. Then find out the probability for decay of the nucleous in the next step or probability for not decay now . And then generate the random number , then check the random number is greater than the probability or not . If the random number is greater than or equal to the probability of not decay then the nucleous is not decay now but if the random number is less than the probability of the not decay , then the nucleous is decay now.

Probability of decay in next step = $1 – \exp(-\lambda)$

Program in Fortran 95:

```
program simulation

   ! Refrence for the documantions :: https://www.ijeast.com/papers/86-
90,Tesma505,IJEAST.pdf

   implicit none

   ! Decleartion of the variables

   real :: decay_prob , atoms_prob , halflife
   integer :: num_atoms , count , interval , i
   logical :: f1

   ! Getting the user input for half life time period and intial atoms

   print *, "Enter the half life time period :: "
   read *, halflife
   print *, "Enter the number atoms at start :: "
   read *, num_atoms

   !validing the parameters
```

```
    if (halflife <= 0 .or. num_atoms <=0) then
       print *, "input parameters are not correct please enter valid parameters"
       stop "Invalid Parameter"
    endif

    ! Checking and opening the file with status new or replace

    inquire(file="decay.dat",exist=f1) ! for checking the existance of the file
    if (f1) then
       open(1,file="decay.dat",status="replace")
    else
       open(1,file="decay.dat",status="new",action="write")
    endif

    ! Calculating the probability those atoms doesn't decay in this interval but decay in
future

    decay_prob = 1 - exp(-(0.693)/halflife)

    ! taking time to zero and write the initial points to the file

    interval = 0

    write(1,*)interval,num_atoms

    ! generating the random-number as atoms_prob and checking for those whoes are less
than decay_prob
    ! and count the decay element and write number of left atoms into the file until the zero
atoms are left

    do while(num_atoms .ne. 0)
       count = 0
       do i = 1,num_atoms
          call random_number(atoms_prob)
          if (atoms_prob <= decay_prob) then
             count = count + 1
          endif
       enddo
       interval = interval + 1
       num_atoms = num_atoms - count
       write(1,*)interval,num_atoms
    enddo

    ! closing the file
```

```
        close(1)

        print *, "simulation is complete "

        stop

      end program
```

Output of Program :

```
 Enter the half life time period ::
10
 Enter the number atoms at start ::
1000
 simulation is complete
```

Simulation Result :