Component 1

- Fortran programming
- Introduction to HPC architecture
- Parallel computing
- Message Passing Interface

Evaluation of CD61004 subject

Weight 40 to 50%

Assignments/ Home work/ projects/ presentations/short tests/ term papers/ Attendance/ others : Teachers and TAs will regularly provide assignments or

Weight 60 to 50%

Class Tests: Minimum 3 class tests of longer duration (each around one hour)

Topic: Fortran Programming

Objectives

- How to compile Fortran code
- Basics of Fortran programming

Topic: Fortran Programming

Low level language vs high level language

Program written in assembly language to print ‘hello world’

```
section .data                    ;.data starts here
      msg db 10d,13d,"Hello World "   ;String gets initialized
      l equ $-msg                ;Length Of String
section .text                    ;.text starts here
      global _start              ;Moving to _start
_start:                          ;_start label
      mov rax,1                  ;Sys_Write Function
      mov rdi,1                  ;Std_Out File Descriptor
      mov rsi,msg                ;Offset of msg
      mov rdx,l                  ;Length Of msg
      syscall                    ;Call the Kernel
      mov rax,60                 ;Sys_Exit Function
      mov rdi,0                  ;Sucessful Termination
      syscall              ;Call The Kernel
end:                             ;end Label
```

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Why Fortran

- Oldest programming language still being used
- General purpose, high-level programming language developed in 1957 for numeric and scientific computing (engineering applications)
- Fortran stands for *For*mula *Tran*slation
- Many supercomputing applications are written in Fortran and still being in usage

Fortran programming

- All program names should end with ".f90".
- How to compile a Fortran program
  - *compilers: gfortran, ifort, etc*
  - *gfortran program.f90 -o program.x*
  - *How to install gfortran in ubuntu:*

    sudo apt update

    sudo apt install gfortran
- NOT case-sensitive
- Line starting with "!" are treated as comment line.

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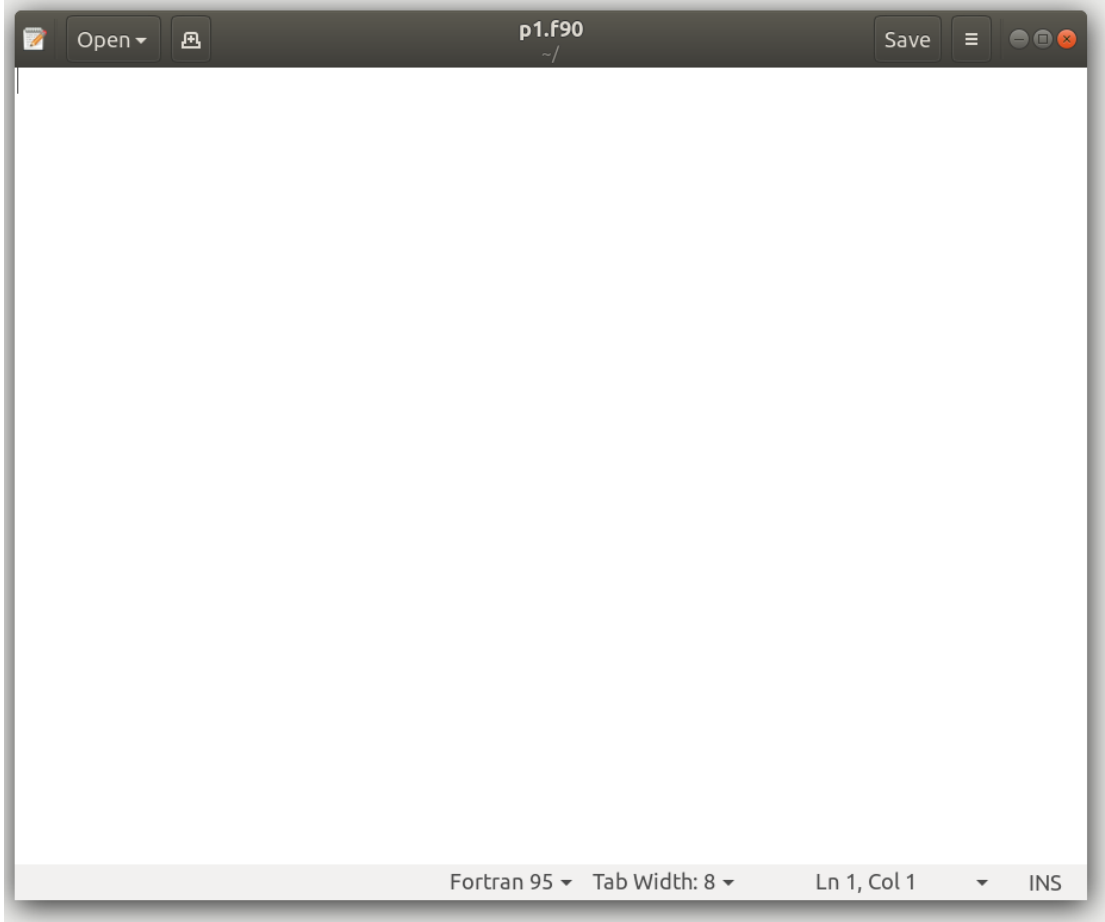
Text editor

```
(base) sandeep&raakshasi $ gedit p1.f90 &
[1] 18655
(base) sandeep&raakshasi $
```



Topic: Fortran Programming

```
program test


end program test
```

No output

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```
program test

   write(*,*) ' Hello World'

end program test
```

Output

Hello World

Printing data to stdout

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```
program test

   write(*,*) ' Sum ', 27 + 23 + 22

end program test
```

Output

```
Sum  72
```

Sum of three numbers

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```
program test

   is1 = 27

   is2 = 23

   is3 = 22

   write(*,*) ' Sum ',  is1 + is2 + is3

end program test
```

Output

```
Sum    72
```

Using variables to do the sum

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```
program test

   is1 = 27

   is2 = 23

   is3 = 22

   write(*,*) ' Sum ',  is1 + is2 + is3

end program test
```

Output

```
 Sum    72
```

- Rules for variable names:
  - It must start with alphabet. Rest of the name can have both letters (a-z), number and underscore(_) character
  - Space or blank character is not allowed

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```
program test


   is1 = 27

   is2 = 23

   is3 = 22

   itotal = is1 + is2 + is3

   write(*,*) ' Sum ',  itotal

end program test
```

Output

```
Sum    72
```

Improve the readability

Topic: Fortran Programming

```
program test


   s1 = 27

   s2 = 23

   s3 = 22

   total = s1 + s2 + s3

   write(*,*) ' Sum ',  total

end program test
```

Output

```
 Sum     72.0000000
```

Notice the difference in output

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```
program test
  implicit none

  integer :: s1, s2, s3, total

   s1 = 27

   s2 = 23

   s3 = 22

   total = s1 + s2 + s3

   write(*,*) ' Sum ',  total

end program test
```

Output

```
 Sum     72
```

Declaring the variables

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```
program test
  implicit none

  integer :: s1, s2, s3, total

   s1 = 27

   s2 = 23

   s3 = 22.5

   total = s1 + s2 + s3

   write(*,*) ' Sum ',  total

end program test
```

Output

```
 Sum     72
```

Sum is not correct

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FORTRAN program has FOUR elements

```
program test
  implicit none

  integer :: s1, s2, s3, total

   s1 = 27

   s2 = 23

   s3 = 22.5

   total = s1 + s2 + s3

   write(*,*) ' Sum ',  total

end program test
```

Program name

Declaration and initialization of variables

Main body of the program

Subprogram(s)

Structure of the FORTRAN program

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FORTRAN program has FOUR elements

```
program test
  implicit none

  integer :: s1, s2, s3, total

   s1 = 27

   s2 = 23

   s3 = 22.5

   total = s1 + s2 + s3

   write(*,*) ' Sum ',  tota

end program test
```

Program name

Declaration and initialization of variables

The available data types are,

real (kind=8)::
integer ::
complex ::
character(len=100) ::
logical ::

Subprogram(s)

Structure of the FORTRAN program

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IF conditional statement

```
if (logical expression 1) then
      ! block 1
 else if (logical expression 2) then
      ! block 2
 -------------------------
 -------------------------
 -------------------------
else
     ! block 3
end if
```

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IF conditional statement

```
if (logical expression 1) then
      ! block 1
 else if (logical expression 2) then
      ! block 2
 -------------------------
 -------------------------
 -------------------------
else
     ! block 3
end if
```

Operator	Alternative	Meaning
.eq.	==	equal to
.ne.	/=	not equal to
.lt.	<	less than
.le.	<=	less than or equal to
.gt.	>	greater than
.ge.	>=	greater than or equal to
.and. .or. .not.		boolean expressions

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IF conditional statement

```
if (s1 > s2) then
      write(*,*) s1," is greater than ",s2
 else if (s1 > s3) then
       write(*,*) s1," is greater than ",s3
 else
       write(*,*) s1," is smallest among all numbers"
end if
```

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Write a program using *if statements* to find a largest of three numbers

Write a program to calculate the area of a circle

Fortran emulator: https://www.tutorialspoint.com/compile_fortran_online.php

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FORTRAN – Reading material

- Please go through this FORTRAN program for a quick overview,

  https://learnxinyminutes.com/docs/fortran95/
- Please go through this document for quick overview of FORTRAN

  https://www.ldeo.columbia.edu/~mspieg/mmm/Fortran.pdf
- For a video on FORTRAN programming, look at

  https://www.youtube.com/watch?v=__2UgFNYgf8
- Book: Computer Programming in Fortran 90 and 95, V. Rajaraman
- Tutorial on Fortran along the emulator,

  https://www.tutorialspoint.com/fortran/fortran_overview.htm