Evaluation

- Mid-term Exam: 30%
- End-term Exam: 30%
- Attendance, Assignments, Projects, Class Tests, Class Participation: 40%

Component 1

- Fortran programming
- Parallel computing (MPI & OpenMP)
- Introduction to HPC architecture

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
```

Topic: Fortran Programming

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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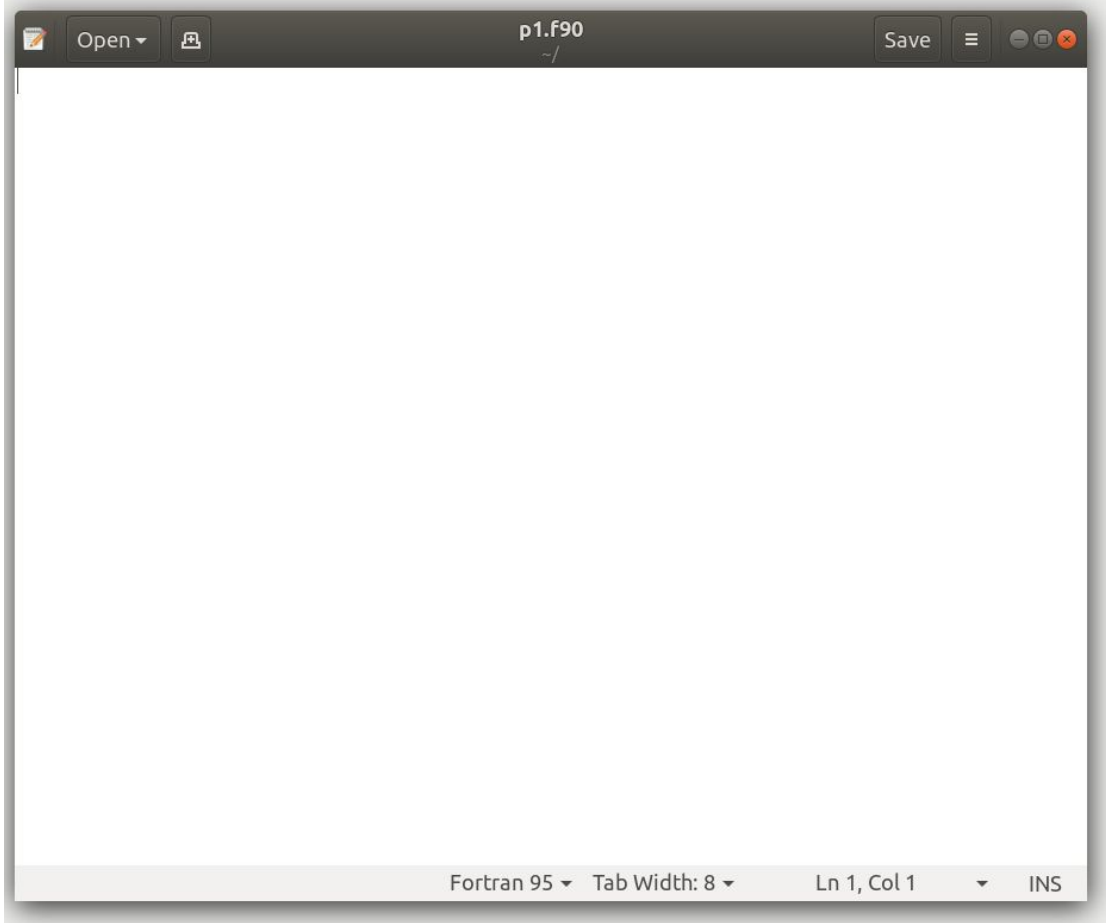
Text editor

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



Online Fortran compiler
https://www.onlinegdb.com/online_fortran_compiler

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```
program test


end program test
```

No output

Each line in a program is called "statement"

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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
  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
```

- 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
  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

Topic: Fortran Programming

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
```

Topic: Fortran Programming

1. Write a program that requests the radius of a sphere from the user, then computes the volume of the sphere using:

   $$V = (4\pi/3)r^3$$

2. Write a Fortran program to examine the integer variable "num." If its value is less than zero, convert the number to its absolute value and display the message "Variable num is changed". Assume that the variable "num" is already defined as an integer and initialized.
3. Write a program to handle the following grade assignment:

   90-100: Ex | 80-89: A | 70-79: B | 60-69: C | 50-59: D | 35-49: P | 0-34: F (assume marks are integers)

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

Topic: Fortran Programming

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
- Book: Computer Programming in Fortran 90 and 95, V. Rajaraman
- Tutorial on Fortran along the emulator,
  https://www.tutorialspoint.com/fortran/fortran_overview.htm