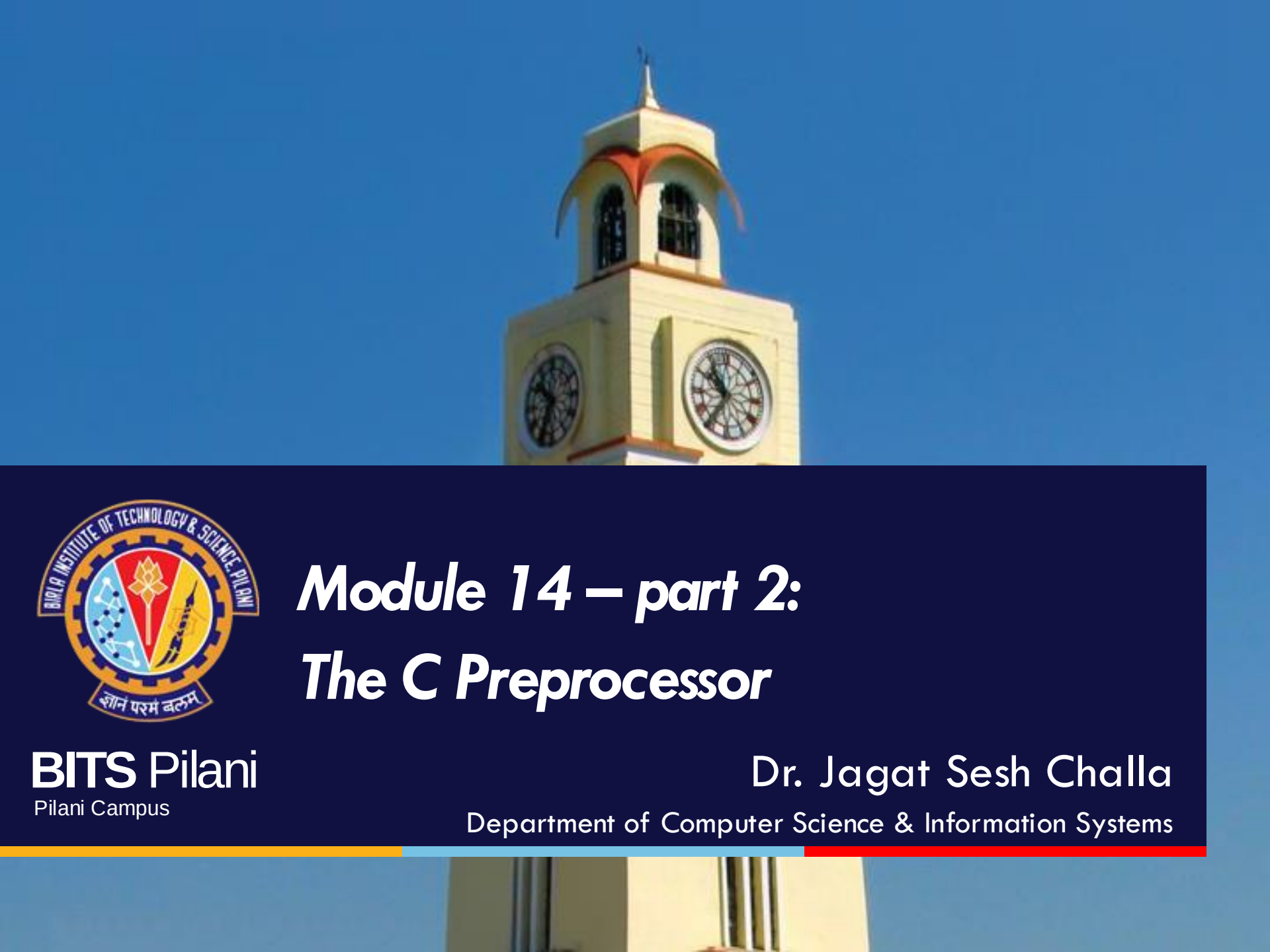

Module 14 – part 2: The C Preprocessor

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Module Overview

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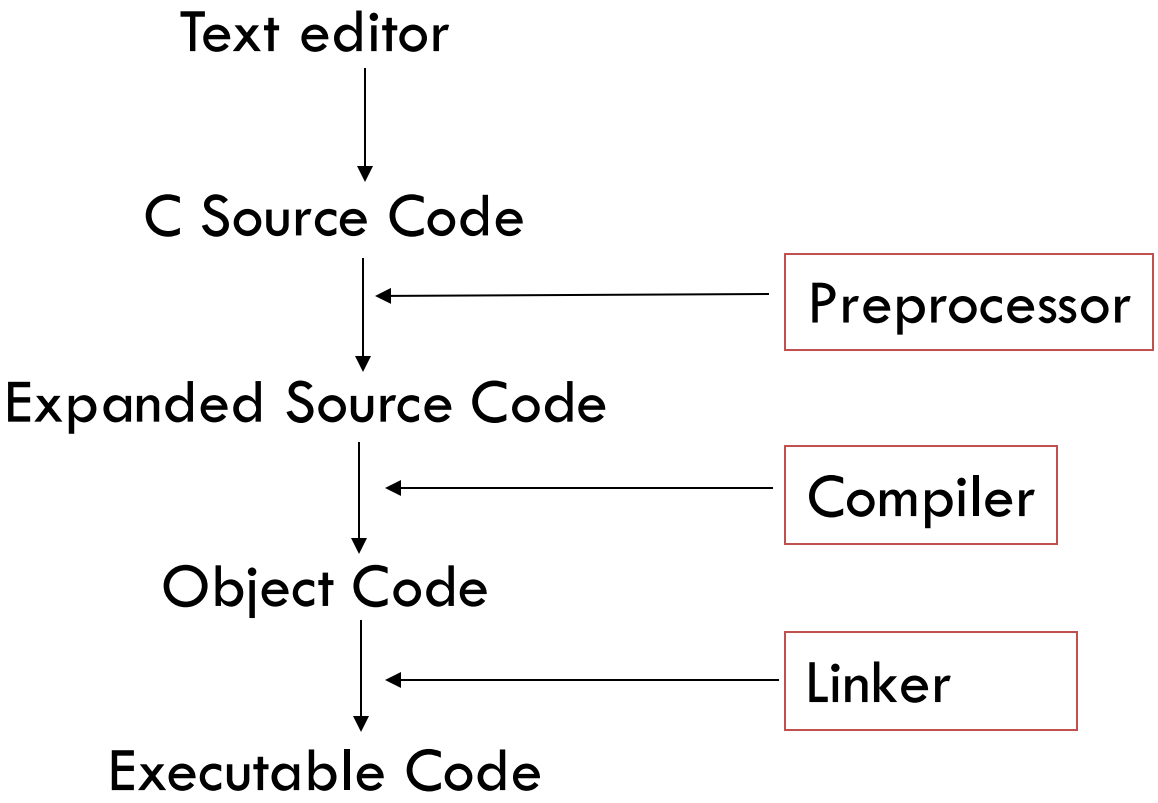
- C Preprocessor
  - Preprocessor Directives
    - Macro expansion
    - File inclusion
    - Conditional Compilation

The C Preprocessor

The C Preprocessor

- The **C Preprocessor** is a "Program that processes source program before it is passed to the compiler"
- Preprocessor commands are called as **Directives**
- Each directive begins with a **# symbol**

C Program execution



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Macro Expansion Directives

Macro Expansion Directives: Example 1 (Defining constants)


```
#define MAX 100
#define SIZE 10
void main()
{
  int k, a[SIZE];
  for(k=0; k<MAX; k+=10)
  printf("%d",k);
}
```

During preprocessing each occurrence of MAX is replaces by 100 and each occurrence of SIZE is replaced by 10.

And then the program is compiled!

Example 2 (Define Operators)

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```
#define AND &&
#define OR ||
#define EQUALS ==
#define MOD %
#define NOTEQUAL !=

void Leap_year(unsigned int yr)
{
  if((yr MOD 4 EQUALS 0) AND (yr MOD 100 NOTEQUAL 0) OR (yr
  MOD 400 EQUALS 0))
      printf("Given Year is Leap Year\n");
  else
      printf("Given Year is Not a Leap Year\n");
}
```

Example 3 (Define Conditions)

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```
#define AND &&
#define OR ||
#define RANGE ((ch>='a' AND ch<='z')OR(ch>='A' AND
  ch<='Z'))
void Alpha_Check(char ch)
{
  if(RANGE)
     printf("Entered character is an Alphabet\n");
  else
     printf("Entered character not an Alphabet\n");
}
```

Macros with Arguments

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```
#define CUBE(x) (x*x*x)
```

If statements appears in the program like

```
vol = CUBE(side);
```

It will expand to:

```
vol = (side*side*side);
```

If statements appears in the program like

```
vol = CUBE(x+y);
```

It will expand to:

```
vol = (x+y*x+y*x+y);
```

If statements appears in the program like

```
printf("Volume = CUBE(a)"); Expansion???
```

Nesting of Macros

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One Macro definition can be used in another Macro

Example:

Consider the Macro Definitions

```
#define SQUARE(p)  ((p)*(p))
#define CUBE(p)    (SQUARE(p))*(p))
#define EIGHTH(p)  (CUBE(p)*CUBE(p)*SQUARE(p))
```

How it will expand???

Nesting of Macros (Contd.)

Macros calls can be nested as function calls

Consider a Macro definition:

```
#define MIN(P,Q)   (((P<Q))?(P):(Q))

int MinThree(int a, int b, int c)
{
   int min;
   min = MIN(a, MIN(b,c)); /* Macro Call */
   return (min);
}
```

Exercise:

Write a macro call for getting min of five values.

Advantages of Macros

- One place replacement is required for any changes
- Easy to handle
- Less error prone
- Easy to debug

Macro vs Function()

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- Functions make the program compact and smaller but they slow down the program
  - ***Each call results in a push on the activation stack.***
  - ***The corresponding return is a pop from the stack.***

- Macros make the program run faster but increases the program size
  - ***Macros reduce the function call overhead by performing code replacement at compile time.***
  - ***Code replacement happens once (per compilation), whereas function calls can be repetitive causing performance bottleneck.***

Important Questions:

When is it best to use macro?

And when is it best to use function?

Can we replace all Macros with functions?

- Macros do not have types (for parameters)
- What will happen if we declare

```
#define fact(n) (n==0) ? 1 : n*fact(n-1)
```

- Try this out! Recursive substitutions are not possible
- **Why not?**
  - *Because the compiler does not "execute" code.*
  - *Only code replacement is done.*
  - *Code replacement is a one-time job.*
  - *Code replacement is not recursive.*

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File Inclusion Directives

File Inclusion Directives

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How to include a file in your program?

#include “file_name” **OR**
#include<file_name>

What is the difference between above?

1. *If a large program is divided into several files, each containing a set of related functions. These files should be included at the beginning of the main program file.*
2. *Inclusion of header files for using some predefined functions in C library.*

When a header file is included, the preprocessor includes the file in the source code program (.c file) before its compilation.

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Compiler Control Directives

Compiler Control Directives: #ifdef

We can skip over the compilation process of the part of the source program by inserting the preprocessing commands:

#ifdef and #endif

Syntax:

```
#ifdef macroname
        statement 1;
        statement 2;
#endif
```

If macro has been defined, the block of code will be processed as usual; otherwise not.

Compiler Control Directives: #if


```
#define CHECK 1
void  main()
{ #if CHECK==1
        statement1;
        statement2;
  #elif CHECK==0
        statement3;
        statement4;
  #else
        statement5;
        statement6;
  #endif
```

CHECK is Macro Name

What we need?

1. If we don't want to compile some part of the program so we can skip those statements.

2. To make a program portable so it can work on two or more than two types of different architectures.

“ifndef” guards for header files


```
#ifndef HEADER1
#define HEADER1

#include <stdio.h>
...
...

#endif
```

“if not defined”

then define

While linking multiple .o files in a C project, if compiler sees same inclusion in multiple file that are being linked, it throws an error. This guard helps in including the header file only once.

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Thank you

Q & A