**Assignement -4**

1. **Basic Process Creation**

**Objective :**

**● Understanding process creation using fork() in C.**

**Task :**

**● Write a C program that creates a child process using fork().**

**● Print the process IDs (PID) of both parent and child.**

**● Use getpid() and getppid() to display process details.**

**Expected Output :**

**● Display parent and child PIDs.**

**● Identify whether execution happens in the child or parent process.**

#include <stdio.h>

#include <windows.h>

int main()

{

    STARTUPINFO si;

    PROCESS\_INFORMATION pi;

    ZeroMemory(&si, sizeof(si));

    si.cb = sizeof(si);

    ZeroMemory(&pi, sizeof(pi));

    if (!CreateProcess(

            NULL,

            "cmd /c echo Child Process Running",

            NULL,

            NULL,

            FALSE,

            0,

            NULL,

            NULL,

            &si,

            &pi

            )){

        printf("Process creation failed. Error: %d\n", GetLastError());

        return 1;

    }

    printf("Parent Process:\n");

    printf("PID: %lu\n", GetCurrentProcessId());

    printf("Child Process Created (PID: %lu)\n", pi.dwProcessId);

    WaitForSingleObject(pi.hProcess, INFINITE);

    CloseHandle(pi.hProcess);

    CloseHandle(pi.hThread);

    return 0;

}

**Output :**

=thread-group-added,id="i1"

GNU gdb (GDB) 7.6.1

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and "show warranty" for details.

This GDB was configured as "mingw32".

For bug reporting instructions, please see:

<http:*//www.gnu.org/software/gdb/bugs/>.*

Warning: Debuggee TargetArchitecture not detected, assuming x86\_64.

=cmd-param-changed,param="pagination",value="off"

=cmd-param-changed,param="args",value="2>CON 1>CON <CON"

[New Thread 68308.0xcbec]

[New Thread 68308.0xddfc]

Loaded 'C:\Windows\SysWOW64\kernel32.dll'. Symbols loaded.

Loaded 'C:\Windows\SysWOW64\KernelBase.dll'. Symbols loaded.

Loaded 'C:\Windows\SysWOW64\apphelp.dll'. Symbols loaded.

Loaded 'C:\Windows\SysWOW64\msvcrt.dll'. Symbols loaded.

[New Thread 68308.0xa054]

Child Process Running

Parent Process:

PID: 68308

Child Process Created (PID: 62164)

The program 'D:\OScript\Assignment4\pr\_1.exe' has exited with code 0 (0x00000000).

[Running] cd "d:\OScript\Assignment4\" && gcc pr\_1.c -o pr\_1 && "d:\OScript\Assignment4\"pr\_1

Child Process Running

Parent Process:

PID: 24500

Child Process Created (PID: 49416)

[Done] exited with code=0 in 3.093 seconds

1. **Process Synchronization Using wait()**

**Objective :**

**● Understanding how a parent waits for a child process to finish execution.**

**Task :**

**● Modify the previous program to make the parent wait for the child to complete execution using wait() .**

**● Print messages before and after the child process exits.**

**Expected Output :**

**● The parent should wait for the child to finish before printing its final message.**

#include <stdio.h>

#include <windows.h>

int main()

{

    STARTUPINFO si;

    PROCESS\_INFORMATION pi;

    ZeroMemory(&si, sizeof(si));

    si.cb = sizeof(si);

    ZeroMemory(&pi, sizeof(pi));

    printf("Parent Process (PID: %lu) is creating a child process...\n", GetCurrentProcessId());

    if (!CreateProcess(

            NULL,

            "cmd /c echo Child Process Running",

            NULL,

            NULL,

            FALSE,

            0,

            NULL,

            NULL,

            &si,

            &pi

        )) {

        printf("Process creation failed. Error: %d\n", GetLastError());

        return 1;

    }

    printf("Child Process Created (PID: %lu)\n", pi.dwProcessId);

    printf("Parent Process is waiting for the child to complete...\n");

    WaitForSingleObject(pi.hProcess, INFINITE);

    printf("Child Process has finished execution.\n");

    printf("Parent Process (PID: %lu) resumes execution.\n", GetCurrentProcessId());

    CloseHandle(pi.hProcess);

    CloseHandle(pi.hThread);

    return 0;

}

**Output :**

PS D:\OScript>  & 'c:\Users\Khushi\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-k35pw3y1.kcb' '--stdout=Microsoft-MIEngine-Out-w5kj5mew.nfu' '--stderr=Microsoft-MIEngine-Error-hf1qobia.1lw' '--pid=Microsoft-MIEngine-Pid-reqtjsqk.qp0' '--dbgExe=C:\MinGW\bin\gdb.exe' '--interpreter=mi'

[Running] cd "d:\OScript\Assignment4\" && gcc pr\_2.c -o pr\_2 && "d:\OScript\Assignment4\"pr\_2

Child Process Running

Parent Process (PID: 61520) is creating a child process...

Child Process Created (PID: 14316)

Parent Process is waiting for the child to complete...

Child Process has finished execution.

Parent Process (PID: 61520) resumes execution.

[Done] exited with code=0 in 3.23 seconds

1. **Process Execution using exec()**

**Objective :**

**● Executing a new program within a child process.**

**Task :**

**● Create a C program where the child process replaces itself with another program (e.g., /bin/ls) using execlp().**

**● The parent process waits for the child to complete execution.**

**Expected Output :**

**● The child process successfully replaces itself with the ls command output.**

#include <stdio.h>

#include <windows.h>

int main()

{

    STARTUPINFO si;

    PROCESS\_INFORMATION pi;

    ZeroMemory(&si, sizeof(si));

    si.cb = sizeof(si);

    ZeroMemory(&pi, sizeof(pi));

    printf("Parent Process (PID: %lu) is creating a child process...\n", GetCurrentProcessId());

    if (!CreateProcess(

            NULL,

            "cmd /c dir",

            NULL,

            NULL,

            FALSE,

            0,

            NULL,

            NULL,

            &si,

            &pi

        )) {

        printf("Process creation failed. Error: %d\n", GetLastError());

        return 1;

    }

    printf("Child Process Created (PID: %lu). Executing 'dir' command...\n", pi.dwProcessId);

    printf("Parent Process is waiting for the child to complete...\n");

    WaitForSingleObject(pi.hProcess, INFINITE);

    printf("Child Process has finished execution.\n");

    printf("Parent Process (PID: %lu) resumes execution.\n", GetCurrentProcessId());

    CloseHandle(pi.hProcess);

    CloseHandle(pi.hThread);

    return 0;

}

**Output :**

PS D:\OScript>  & 'c:\Users\Khushi\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-o0y5y4bt.ibl' '--stdout=Microsoft-MIEngine-Out-xu2ztkto.5dd' '--stderr=Microsoft-MIEngine-Error-qeysp42x.mru' '--pid=Microsoft-MIEngine-Pid-sn4otmtn.kk2' '--dbgExe=C:\MinGW\bin\gdb.exe' '--interpreter=mi'

[Running] cd "d:\OScript\Assignment4\" && gcc pr\_3.c -o pr\_3 && "d:\OScript\Assignment4\"pr\_3

 Volume in drive D is New Volume

 Volume Serial Number is 3A17-096A

 Directory of d:\OScript\Assignment4

10-02-2025  13:36    <DIR>          .

10-02-2025  12:53    <DIR>          ..

10-02-2025  13:11             2,371 pr\_1.c

10-02-2025  13:09            50,768 pr\_1.exe

10-02-2025  13:18             1,598 pr\_2.c

10-02-2025  13:16            51,280 pr\_2.exe

10-02-2025  13:25             1,601 pr\_3.c

10-02-2025  13:36            42,944 pr\_3.exe

10-02-2025  13:35             1,056 pr\_child\_4.c

10-02-2025  13:33            42,128 pr\_child\_4.exe

10-02-2025  13:36             2,350 pr\_parent\_4.c

10-02-2025  13:32            42,562 pr\_parent\_4.exe

              10 File(s)        238,658 bytes

               2 Dir(s)  243,303,321,600 bytes free

Parent Process (PID: 71568) is creating a child process...

Child Process Created (PID: 28756). Executing 'dir' command...

Parent Process is waiting for the child to complete...

Child Process has finished execution.

Parent Process (PID: 71568) resumes execution.

[Done] exited with code=0 in 3.235 seconds

**4. Inter-Process Communication using Pipes**

**Objective :**

**● Using pipes for communication between processes.**

**Task :**

**● Create a parent and child process.**

**● The parent sends a message to the child process via a pipe.**

**● The child reads the message from the pipe and prints it.**

**Expected Output :**

**● The child successfully reads and displays the message sent by the parent.**

**Parent :**

#include <stdio.h>

#include <windows.h>

int main()

{

    HANDLE hRead, hWrite;

    SECURITY\_ATTRIBUTES sa = { sizeof(SECURITY\_ATTRIBUTES), NULL, TRUE };

    char message*[]* = "Hello from Parent!";

    char buffer[128];

    DWORD bytesRead, bytesWritten;

    if (!CreatePipe(&hRead, &hWrite, &sa, 0))

{

        printf("Failed to create pipe. Error: %d\n", GetLastError());

        return 1;

    }

    STARTUPINFO si;

    PROCESS\_INFORMATION pi;

    ZeroMemory(&si, sizeof(si));

    si.cb = sizeof(si);

    ZeroMemory(&pi, sizeof(pi));

    si.hStdInput = hRead;

    si.dwFlags |= STARTF\_USESTDHANDLES;

    printf("Parent Process (PID: %lu) is creating a child process...\n", GetCurrentProcessId());

    if (!CreateProcess(

            NULL,

            "cmd /c child.exe",

            NULL,

            NULL,

            TRUE,

            0,

            NULL,

            NULL,

            &si,

            &pi

        )) {

        printf("Child process creation failed. Error: %d\n", GetLastError());

        return 1;

    }

    WriteFile(hWrite, message, sizeof(message), &bytesWritten, NULL);

    CloseHandle(hWrite);

    WaitForSingleObject(pi.hProcess, INFINITE);

    CloseHandle(pi.hProcess);

    CloseHandle(pi.hThread);

    CloseHandle(hRead);

    printf("Parent Process (PID: %lu) has finished.\n", GetCurrentProcessId());

    return 0;

}

**Output :**

PS D:\OScript>  & 'c:\Users\Khushi\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-pok3d413.yib' '--stdout=Microsoft-MIEngine-Out-fmdmyw42.aqt' '--stderr=Microsoft-MIEngine-Error-a2mibnci.qwq' '--pid=Microsoft-MIEngine-Pid-0mdwynrg.hci' '--dbgExe=C:\MinGW\bin\gdb.exe' '--interpreter=mi'

Running] cd "d:\OScript\Assignment4\" && gcc pr\_parent\_4.c -o pr\_parent\_4 && "d:\OScript\Assignment4\"pr\_parent\_4

Parent Process (PID: 25488) is creating a child process...

Parent Process (PID: 25488) has finished.

[Done] exited with code=0 in 3.197 seconds

**Child :**

#include <stdio.h>

#include <windows.h>

int main() {

    char buffer[128];

    DWORD bytesRead;

    if (ReadFile(GetStdHandle(STD\_INPUT\_HANDLE), buffer, sizeof(buffer), &bytesRead, NULL))

{

        buffer[bytesRead] = '\0'; *// Null terminate the string*

        printf("Child Process (PID: %lu) received message: %s\n", GetCurrentProcessId(), buffer);

   }

else

{

        printf("Failed to read from pipe. Error: %d\n", GetLastError());

   }

    return 0;

}

**Output :**

PS D:\OScript>  & 'c:\Users\Khushi\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-pok3d413.yib' '--stdout=Microsoft-MIEngine-Out-fmdmyw42.aqt' '--stderr=Microsoft-MIEngine-Error-a2mibnci.qwq' '--pid=Microsoft-MIEngine-Pid-0mdwynrg.hci' '--dbgExe=C:\MinGW\bin\gdb.exe' '--interpreter=mi'

Running] cd "d:\OScript\Assignment4\" && gcc pr\_parent\_4.c -o pr\_parent\_4 && "d:\OScript\Assignment4\"pr\_parent\_4

Parent Process (PID: 25488) is creating a child process...

Parent Process (PID: 25488) has finished.

[Done] exited with code=0 in 3.197 seconds

**5. Process Scheduling Simulation**

**Objective :**

**● Implementing a basic Round Robin scheduling algorithm.**

**Task :**

**● Simulate Round Robin scheduling for multiple processes with different burst times.**

**● Assume a time quantum and display process execution order.**

**Expected Output :**

**● A sequence of time slices showing process execution, demonstrating context switching.**

#include <stdio.h>

typedef struct {

    int id;

    int burstTime;

    int waitTime;

    int turnAround;

} Process;

void roundRobinScheduling(Process processes*[]*, int n, int quantum) {

    int time = 0, remaining = n;

    printf("\nProcess Execution Order:\n");

    while (remaining > 0) {

        for (int i = 0; i < n; i++) {

            if (processes[i].burstTime > 0) {

                printf("[ Time %d ] -> Process P%d executes\n", time, processes[i].id);

                int execTime = (processes[i].burstTime > quantum) ? quantum : processes[i].burstTime;

                time += execTime;

                processes[i].burstTime -= execTime;

                if (processes[i].burstTime == 0) {

                    remaining--;

                    processes[i].turnAround = time;

                    processes[i].waitTime = processes[i].turnAround - processes[i].burstTime;

                }

            }

        }

    }

    printf("\nProcess Completion Times:\n");

    printf("PID\tTurnaround Time\tWaiting Time\n");

    for (int i = 0; i < n; i++) {

        printf("P%d\t%d\t\t%d\n", processes[i].id, processes[i].turnAround, processes[i].waitTime);

    }

}

int main()

{

    int n, quantum;

    printf("Enter number of processes: ");

    scanf("%d", &n);

    Process processes[n];

    printf("Enter burst times for %d processes:\n", n);

    for (int i = 0; i < n; i++)

{

        processes[i].id = i + 1;

        printf("P%d: ", processes[i].id);

        scanf("%d", &processes[i].burstTime);

    }

    printf("Enter time quantum: ");

    scanf("%d", &quantum);

    roundRobinScheduling(processes, n, quantum);

    return 0;

}

**Output :**

PS D:\OScript>  & 'c:\Users\Khushi\.vscode\extensions\ms-vscode.cpptools-1.23.6-win32-x64\debugAdapters\bin\WindowsDebugLauncher.exe' '--stdin=Microsoft-MIEngine-In-h2u3hxmo.1ah' '--stdout=Microsoft-MIEngine-Out-40mizlnq.q5b' '--stderr=Microsoft-MIEngine-Error-5jk4yok3.gax' '--pid=Microsoft-MIEngine-Pid-2qtg41z4.c5y' '--dbgExe=C:\MinGW\bin\gdb.exe' '--interpreter=mi'

[Running] cd "d:\OScript\Assignment4\" && gcc pr\_5.c -o pr\_5 && "d:\OScript\Assignment4\"pr\_5

Process Execution Order:

[ Time 0 ] -> Process P1 executes

[ Time 3 ] -> Process P2 executes

[ Time 6 ] -> Process P3 executes

[ Time 9 ] -> Process P1 executes

[ Time 12 ] -> Process P3 executes

[ Time 15 ] -> Process P1 executes

[ Time 18 ] -> Process P3 executes

Process Completion Times:

PID     Turnaround Time   Waiting Time

P1      15              7

P2      6                2

P3      18             9