



Academic Year: 2022-2023

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Course:	Operating System Laboratory
Course Code:	DJ19CEL403
Experiment No.:	07

- AIM:** USING THE CPU-OS SIMULATOR TO ANALYZE AND SYNTHESIZE THE FOLLOWING:
- A. PROCESS SCHEDULING ALGORITHMS.
 - B. THREAD CREATION AND SYNCHRONIZATION.
 - C. DEADLOCK PREVENTION AND AVOIDANCE.

A. PROCESS SCHEDULING ALGORITHMS.

a. Compiled a process loop test

The screenshot displays the Program Compiler (YASMIN: CPU-OS Simulator) interface. The main window is divided into several sections:

- PROGRAM SOURCE (INPUT):** Contains the source code for a process loop test:

```
program LoopTest
i = 0
for n = 0 to 40
    i = i + 1
next
end
```
- COMPILER PROGRESS:** Shows the compilation progress with the following output:

```
2:.....Found keyword = [4]
2:.....Found Assignment statement [4]
1:.....Found keyword NEXT [5]
0:Found keyword END [6]
Code generation completed...
Displaying generated code
Display completed...
*** NOTE: Click on numbers in brackets to highlight corresponding source
```
- PROGRAM CODE (OUTPUT):** Displays the generated assembly code with columns for Address, CPU Instruction, Binary Code, Line, and Comments. The code includes instructions for moving values, comparing, jumping, and halting the simulation.
- COMPILER:** A control panel at the bottom with buttons for Edit Source, Compile, Optimize, Options, and Compiler Help. It also includes buttons for Show Symbol Table, Show Class Map, Show Subroutine List, and Show AST.
- SOURCE:** A section for loading and saving source files, with buttons for Load, Save, and Print.
- ASSEMBLY CODE:** A section for loading and saving assembly code, with buttons for Load, Save, and Print.
- BINARY CODE:** A section for loading and saving binary code, with buttons for Load, Save, and Print.



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b. Binary Code

Binary Code for LOOPTEST

Code Information

Start Address: 0
Code Size (Bytes): 69

Code Instructions

Address: 0000 Upcode: MOV Opnd1: #0 Opnd2: R03

DECODE NEXT INSTRUCTION

SKIP TO NEXT

RESET TO START OF CODE

SKIP TO PREVIOUS

Binary Code Data

ADDRESS

PROGRAM CODE

```
0000: 000000001030001030101000000001
0016: 04000104010200000028010430010401
0032: 02200200440001010103110000010103
0048: 00010301050001050101110000010102
0064: 1D02001C2F
```

Go to address: GO Instruction address: FIND Stay on top: ☐ CLOSE

c. Loaded into memory

CPU Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

CPU INSTRUCTIONS IN MEMORY (RAM)

PAdd	LAdd	Instruction	Base	T
<input checked="" type="checkbox"/>	0100	MOV #0, R03	0100	0
<input type="checkbox"/>	0106	MOV R03, R01	0100	0
<input type="checkbox"/>	0111	MOV #0, R04	0100	0
<input type="checkbox"/>	0117	MOV R04, R02	0100	0
<input type="checkbox"/>	0122	MOV #40, R04	0100	0
<input type="checkbox"/>	0128	CMP R04, R02	0100	0
<input type="checkbox"/>	0133	JGT 68	0100	0
<input type="checkbox"/>	0137	MOV R01, R03	0100	0
<input type="checkbox"/>	0142	ADD #1, R03	0100	0
<input type="checkbox"/>	0148	MOV R03, R05	0100	0
<input type="checkbox"/>	0153	MOV R05, R01	0100	0
<input type="checkbox"/>	0158	ADD #1, R02	0100	0
<input type="checkbox"/>	0164	JMP 28	0100	0
<input type="checkbox"/>	0168	HLT	0100	0

Cache - Pipeline

Execution Unit

Pipeline: ☒ Single pipeline ☐ Dual pipeline

Select pipeline: 0

Cache: Select cache type: Data

SPECIAL CPU REGISTERS

PC: 0 SR: 0

SP: \$096 BR: 100

SR Status Flag: OV ☐ Z ☐ N ☐

CPU Mode: User ☒ Kernel ☐

IR: 0

MAR: 2

MDR: 0

PROGRAM LIST

Name	Base	Start	Type
LOOPTEST	0100	0000	R

PROGRAM STACK (RAM)

Pos	Val (D)	Addr
-----	---------	------

GENERAL PURPOSE CPU REGISTERS

Reg	Val (D)	C	Val (D)
R03	0		
R04	0		
R05	0		
R06	0		
R07	0		
R08	0		
R09	0		
R10	0		
R11	0		
R12	0		
R13	0		
R14	0		
R15	0		
R16	0		
R17	0		
R18	0		
R19	0		
R20	0		
R21	0		
R22	0		
R23	0		
R24	0		
R25	0		
R26	0		
R27	0		
R28	0		
R29	0		
R30	0		
R31	0		

Code successfully loaded in memory

LOAD COMPILED CODE IN MEMORY

REMOVE PROGRAM

REMOVE ALL PROGRAMS

CREATE PROGRAM INSTANCE

DELETE PROGRAM INSTANCE

Program Control

STEP ☒ by instruction ☐ by single tick

RUN

STOP

RESET PROGRAM

SHOW PCB...

Advanced

New CPU

COMPILER...

OS 0...

INPUT OUTPUT...

VIRTUAL OS...

INTERRUPTS...

Registers

Program Stack | Watch

Reg Value: 0

CHANGE

RESET ALL

Show Reg Access Status: ☐

Select Register Set Size: 32



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d. Created 4 instances of the process

OS Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

RUNNING PROCESSES

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

WAIT: 0 sec. QUEUE KILL Force kill Suspend on state change Suspend on pre-emption SHOW MEMORY... SHOW PCB...

READY PROCESSES (Ready Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
1	LOOPTEST	1	3	0	No	P1	0		
2	LOOPTEST	1	3	0	No	P2	0		
3	LOOPTEST	1	3	0	No	P3	0		
4	LOOPTEST	1	3	0	No	P4	0		

CLEAR REMOVE Suspend on state change SHOW MEMORY... SHOW PCB...

WAITING PROCESSES (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

CLEAR REMOVE RESUME Suspend on state change SHOW MEMORY... SHOW PCB...

SCHEDULER

Policies: Autotun

☒ First-Come, First-Served (FCFS) ☐ Lottery Scheduling
☐ Shortest-Job-First (SJF) ☐ Fair-Share Scheduling

☐ Round Robin (RR) ☐ Use Default

Round Robin and Priority Configuration

RR Time Slice: 5 ticks ☐ No priority ☐ Static ☐ Dynamic
☐ 0.2 secs ☐ Non-preemptive ☐ Pre-emptive

OS Control Views | OS Help

STEP FAST SLOW CPU Speed

START SUSPEND

Use Single CPU ☐
Allow CPU Affinity ☐
Run scheduler with no processes ☐

PROGRAM LIST

Program Name	Process	Program
LOOPTEST	P5	

Process Name: P5 Priority: 3 Pages: 1 Default scheduler? ☐
Lifetime: 0 Ticks: ☒ Secs ☐
Display profile on exit ☐
If parent des, children do ☒
Arrival Delay: Delayed Process ☐
Arrival Delay: 1 Ticks: ☐ Secs ☐
CREATE NEW PROCESS

SHOW COMPILER... CPU 0... CLOSE

e. FCFS scheduling

OS Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

RUNNING PROCESSES

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
2	LOOPTEST	1	3	0	No	P2	0		

WAIT: 0 sec. QUEUE KILL Force kill Suspend on state change Suspend on pre-emption SHOW MEMORY... SHOW PCB...

READY PROCESSES (Ready Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
3	LOOPTEST	1	3	0	No	P3	0		
4	LOOPTEST	1	3	0	No	P4	0		

CLEAR REMOVE Suspend on state change SHOW MEMORY... SHOW PCB...

WAITING PROCESSES (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

CLEAR REMOVE RESUME Suspend on state change SHOW MEMORY... SHOW PCB...

SCHEDULER

Policies: Autotun

☒ First-Come, First-Served (FCFS) ☐ Lottery Scheduling
☐ Shortest-Job-First (SJF) ☐ Fair-Share Scheduling

☐ Round Robin (RR) ☐ Use Default

Round Robin and Priority Configuration

RR Time Slice: 5 ticks ☐ No priority ☐ Static ☐ Dynamic
☐ 0.2 secs ☐ Non-preemptive ☐ Pre-emptive

OS Control Views | OS Help

STEP FAST SLOW CPU Speed

STOP SUSPEND

Use Single CPU ☐
Allow CPU Affinity ☐
Run scheduler with no processes ☐

PROGRAM LIST

Program Name	Process	Program
LOOPTEST	P1	

Process Name: P1 Priority: 3 Pages: 1 Default scheduler? ☐
Lifetime: 0 Ticks: ☒ Secs ☐
Display profile on exit ☐
If parent des, children do ☒
Arrival Delay: Delayed Process ☐
Arrival Delay: 1 Ticks: ☐ Secs ☐
CREATE NEW PROCESS

SHOW COMPILER... CPU 0... CLOSE



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f. Round Robin Scheduling with no priority

OS Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

RUNNING PROCESSES

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
1	LOOPTEST	Running	1	3	5	No	P1	0	0

READY PROCESSES (Ready Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
2	LOOPTEST	Ready	1	3	5	No	P2	0	0
3	LOOPTEST	Ready	1	3	5	No	P3	0	0
4	LOOPTEST	Ready	1	3	5	No	P4	0	0
5	LOOPTEST	Ready	1	3	5	No	P5	0	0

WAITING PROCESSES (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
-----	------	-------	--------	----------	-------	------	-------	-----	------

SCHEDULER

Policies: ☐ First-Come, First-Served (FCFS) ☐ Lottery Scheduling
☐ Shortest-Job-First (SJF) ☐ Fair Share Scheduling
☒ Round Robin (RR) ☐ Use Default

Round Robin and Priority Configuration

RR Time Slice: ☐ 5 ticks ☒ 0.2 secs

Priority: ☒ No priority ☐ Non-preemptive ☐ Pre-emptive

Dynamic: ☐ Static ☐ Dynamic

OS Control Views | OS Help |

STEP STOP SUSPEND

Fast CPU Speed Slow

Use Single CPU ☐
Allow CPU Affinity ☐
Run scheduler with no processes ☐

PROGRAM LIST

Program Name: LOOPTEST

Process: P6

Priority: 3

Pages: 1

Display profile on exit ☐
If parent dies, children die ☒

Default scheduler? ☐
Lifetime: 0
Process Lifetime: 0
Ticks: ☒ Secs ☐ Ticks
Arrival Delay: 0
Delayed Process: ☐
Arrival Delay: 0
Ticks: ☐ Secs ☐ Ticks

CREATE NEW PROCESS

SHOW COMPILER... CPU 0... CLOSE

g. Round Robin with priority and non preemptive

OS Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

RUNNING PROCESSES

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
-----	------	-------	--------	----------	-------	------	-------	-----	------

READY PROCESSES (Ready Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
2	LOOPTEST	Ready	1	2	0	No	P2	0	0
1	LOOPTEST	Ready	1	3	0	No	P1	0	0
3	LOOPTEST	Ready	1	4	0	No	P3	0	0

WAITING PROCESSES (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
-----	------	-------	--------	----------	-------	------	-------	-----	------

SCHEDULER

Policies: ☐ First-Come, First-Served (FCFS) ☐ Lottery Scheduling
☐ Shortest-Job-First (SJF) ☐ Fair Share Scheduling
☒ Round Robin (RR) ☐ Use Default

Round Robin and Priority Configuration

RR Time Slice: ☐ 5 ticks ☒ 0.2 secs

Priority: ☒ No priority ☒ Non-preemptive ☐ Pre-emptive

Dynamic: ☐ Static ☐ Dynamic

OS Control Views | OS Help |

STEP START SUSPEND

Fast CPU Speed Slow

Use Single CPU ☐
Allow CPU Affinity ☐
Run scheduler with no processes ☐

PROGRAM LIST

Program Name: LOOPTEST

Process: P4

Priority: 4

Pages: 1

Display profile on exit ☐
If parent dies, children die ☒

Default scheduler? ☐
Lifetime: 0
Process Lifetime: 0
Ticks: ☒ Secs ☐ Ticks
Arrival Delay: 0
Delayed Process: ☐
Arrival Delay: 0
Ticks: ☐ Secs ☐ Ticks

CREATE NEW PROCESS

SHOW COMPILER... CPU 0... CLOSE



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h. Round Robin with priority and preemptive

The screenshot displays the OS Simulator interface with the following components:

- Running Processes:** A table showing one process, PID 4, named LOOPTEST, in the running state with a priority of 1.
- Ready Processes (Ready Queue):** A table showing three processes (PID 2, 1, 3) all named LOOPTEST, with priorities 2, 3, and 4 respectively, waiting in the queue.
- SCHEDULER:** The Round Robin (RR) policy is selected. The Round Robin and Priority Configuration shows a Round Robin Time Slice of 5 ticks, with Pre-emptive scheduling enabled.
- OS Control:** Includes buttons for STEP, START, and SUSPEND, along with a CPU Speed slider.
- PROGRAM LIST:** Shows the LOOPTEST process with details like Process Name, Priority, Pages, and various delay settings.

Observation:

- FCFS (First-Come-First-Serve), Non-Preemptive Round Robin, and Preemptive Round Robin are CPU scheduling algorithms.
- FCFS is simple but may cause long waiting times.
- Non-Preemptive Round Robin has fixed time slices but may waste CPU time.
- Preemptive Round Robin provides fair CPU utilization and



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B. Thread creation and synchronization.

a. Loaded and Compiled Thread Test 1

The screenshot displays the 'Program Compiler' window. The 'PROGRAM SOURCE (INPUT)' tab shows the following code:

```
program ThreadTest1
sub thread1 as thread
writeln("In thread1")
while true
wend
end sub
sub thread2 as thread
call thread1
writeln("In thread2")
while true
wend
end sub
call thread2
writeln("In main")
do
loop
```

The 'COMPILER PROGRESS' section shows the following output:

```
1:....Found DO statement [15]
1:....Found keyword LOOP [16]
0:Found keyword END [17]
Code generation completed...
Displaying generated code
Display completed...
*** NOTE: Click on numbers in brackets to highlight corresponding source
```

The 'PROGRAM CODE (OUTPUT)' tab shows the assembly code:

LAdd	CPU Instruction	Binary Code	Line	Comments
0029	JMP 19	1D020013	0005	Jump to code at address 19 (UNCO...
0033	SWI 1	2E020001	0006	Terminate thread process THREAD...
****	SUB THREA...		0007	
0037	PSH #1	0E00FFFF	0008	Thread priority
0041	PSH #0	0E000000	0008	Thread code address
0045	SWI 5	2E020005	0008	Enter thread code
0049	MOV #22, R02	000000160102	0009	Copy the value of 22 to _STempRe...
0055	OUT @R02, 0	330302020000	0009	Output data in mem location
0061	OUT #10, 1	3300000A020...	0009	Output literal value
0068	MOV #1, R02	000000010102	0010	Copy the value of 1 to _STempReg...
0074	JZR S2	25020052	0010	Jump to code at address 82 if status ...
0078	JMP 68	1D020044	0011	Jump to code at address 68 (UNCO...
0082	SWI 1	2E020001	0012	Terminate thread process THREAD...
****	MAIN PROG...			
0086	PSH #1	0E00FFFF	0013	Thread priority
0090	PSH #37	0E000025	0013	Thread code address
0094	SWI 5	2E020005	0013	Enter thread code
0098	MOV #38, R02	000000260102	0014	Copy the value of 38 to _STempRe...
0104	OUT @R02, 0	330302020000	0014	Output data in mem location
0110	OUT #10, 1	3300000A020...	0014	Output literal value
0117	JMP 117	1D020075	0016	Jump to code at address 117 (UNC...
0121	HLT	2F	0017	Stop simulation

b. Console Output

The screenshot displays the 'OS Simulator' window. The 'RUNNING PROCESSES' table is empty. The 'READY PROCESSES (Ready)' table shows the following processes:

Pid	Name
4	P1TOT1
3	P1T0
2	THREADTES...

The 'Console' window shows the following output:

```
In main
In thread2In thread1
```

The 'SCHEDULER' window shows the following settings:

- Policies: Round Robin (RR)
- Round Robin and Priority Configuration: RR Time Slice: 5 ticks
- Priority: No priority
- Pre-emptive: ☒

The 'OS Control' window shows the following settings:

- STEP:
- CPU Speed: Fast
- Use Single CPU: ☐
- Allow CPU Affinity: ☐
- Run scheduler with no processes: ☐

The 'PROGRAM LIST' window shows the following processes:

Process Name	Process
LOOPTEST	
THREADTEST1	



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c. Loaded and Compiled CriticalRegion1

The screenshot displays the 'Program Compiler' window for the 'CriticalRegion1' program. The 'PROGRAM SOURCE (INPUT)' pane shows the assembly code with addresses and instructions. The 'PROGRAM CODE (OUTPUT)' pane shows the compiled binary code with addresses and instructions. The 'COMPILER' pane shows the compilation options and buttons. The 'SOURCE' pane shows the source code. The 'ASSEMBLY CODE' pane shows the assembly code. The 'BINARY CODE' pane shows the binary code.

Address	CPU Instruction	Binary Code	Line	Comments
0275	MOV #98, R05	000000620105	0019	Copy the value of 98 to _STempRe...
0281	OUT @R05, 0	330305020000	0019	Output data in mem location
0287	OUT #10, 1	3300000A020...	0019	Output literal value
0294	SWI 1	2E020001	0020	Terminate thread process THREAD...
**** MAIN PROG...				
0298	MOV #119, R...	000000770102	0022	Copy the value of 119 to _STempRe...
0304	OUT @R02, 0	330302020000	0022	Output data in mem location
0310	OUT #10, 1	3300000A020...	0022	Output literal value
0317	PSH #1	0E00FFFF	0024	Thread priority
0321	PSH #0	0E000000	0024	Thread code address
0325	SWI 5	2E020005	0024	Enter thread code
0329	PSH #1	0E00FFFF	0025	Thread priority
0333	PSH #149	0E000095	0025	Thread code address
0337	SWI 5	2E020005	0025	Enter thread code
0341	SWI 7	2E020007	0027	OS system call: Wait for Child
0345	MOV #132, R...	000000840102	0028	Copy the value of 132 to _STempRe...
0351	OUT @R02, 0	330302020000	0028	Output data in mem location
0357	OUT #10, 1	3300000A020...	0028	Output literal value
0364	HLT	2F	0029	Stop simulation
**** DATA:				
0009	In thread1	496E2074687...		
0025	thread1 g =	746872656164...		
0043	Exiting thread1	45786974696...		

d. Console Output

The screenshot displays the 'OS Simulator' window. The 'RUNNING PROCESSES' table shows the current state of the system. The 'Console' window shows the output of the program. The 'SCHEDULER' window shows the scheduling policies and settings. The 'PROGRAM LIST' window shows the list of programs.

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

Console Output:

```
In main
In thread1
In thread2
thread2 g = 18
Exiting thread2
thread1 g = 25
Exiting thread1
Exiting main
```

Scheduler Settings:

- Policies: Round Robin (RR)
- Round Robin and Priority Configuration: RR Time Slice: 10 ticks, Priority: No priority
- OS Control: STEP, START, SUSPEND, CPU Speed: Fast, Slow

Program List:

Program Name	Process	Program
CriticalRegion1		



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e. Loaded and Compiled CriticalRegion2

The screenshot displays the YASMIN CPU-OS Simulator interface. The 'PROGRAM SOURCE (INPUT)' window shows the assembly code for 'CriticalRegion2'. The 'PROGRAM CODE (OUTPUT)' window shows the compiled binary code. The 'COMPILER' window shows the compilation options and results.

PROGRAM SOURCE (INPUT)

Code Information: Start Address: 346, Code Size (Bytes): 413

Code Instructions: DECODE NEXT INSTRUCTION, SKIP TO NEXT, RESET TO START OF CODE, SKIP TO PREVIOUS

Binary Code Data: ADDRESS, PROGRAM CODE

PROGRAM CODE (OUTPUT)

LAdd	CPU Instruction	Binary Code	Line	Comments
0323	MOV #98, R05	000000620105	0020	Copy the value of 98 to _STempRe...
0329	OUT @R05, 0	330305020000	0020	Output data in mem location
0335	OUT #10, 1	3300000A020...	0020	Output literal value
0342	SWI 2	2E020002	0021	Terminate sync thread process THR...
**** MAIN PROG...				
0346	MOV #119, R...	000000770102	0023	Copy the value of 119 to _STempR...
0352	OUT @R02, 0	330302020000	0023	Output data in mem location
0358	OUT #10, 1	3300000A020...	0023	Output literal value
0365	PSH #1	0E00FFFF	0025	Thread priority
0369	PSH #0	0E000000	0025	Thread code address
0373	SWI 5	2E020005	0025	Enter thread code
0377	PSH #1	0E00FFFF	0026	Thread priority
0381	PSH #173	0E0000AD	0026	Thread code address
0385	SWI 5	2E020005	0026	Enter thread code
0389	SWI 7	2E020007	0028	OS system call: Wait for Child
0393	MOV #132, R...	000000840102	0029	Copy the value of 132 to _STempR...
0399	OUT @R02, 0	330302020000	0029	Output data in mem location
0405	OUT #10, 1	3300000A020...	0029	Output literal value
0412	HLT	2F	0030	Stop simulation
**** DATA:				
0009	In thread1	496E2074687...		
0025	thread1 g =	746872656164...		
0043	Exiting thread1	45786974696...		

COMPILER

Edit Source | Compile | Optimize | Options | Compiler Help

COMPILE | RUN | SHOW SYMBOL TABLE... | SHOW CLASS MAP... | SHOW SUBROUTINE LIST... | SHOW AST...

Auto save source files

SOURCE

LOAD... | SAVE... | PRINT...

ASSEMBLY CODE

Start Address: 346, Code Size: 413, PRINT... | Include source | LOAD... | SAVE... | SHOW OS 0... | SHOW CPU 0...

BINARY CODE

LOAD... | SAVE... | Use compiler optimisations

f. Console Output

The screenshot displays the YASMIN CPU-OS Simulator interface. The 'RUNNING PROCESSES' window shows the state of the program. The 'Console' window shows the output of the program. The 'SCHEDULER' window shows the scheduling policies and options. The 'PROGRAM LIST' window shows the list of processes.

RUNNING PROCESSES

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

Console

OUTPUT

```
In main
In thread1
thread1 g = 20
Exiting thread1
In thread2
thread2 g = 12
Exiting thread2
Exiting main
```

SCHEDULER

Policies: Autotun

First-Come, First-Served (FCFS) | Shortest-Job-First (SJF) | Round Robin (RR) | Lottery Scheduling | Fair-Share Scheduling

Round Robin and Priority Configuration

RR Time Slice: 10 ticks | Priority: No priority | Non-preemptive | Pre-emptive

OS Control: Views | OS Help

STEP | START | SUSPEND | CPU Speed

Use Single CPU | Allow CPU Affinity | Run scheduler with no processes

PROGRAM LIST

Process Name	Process	Program
CRITICALREGION2	P1	

Process Name: P1, Priority: 1, Pages: 1, Default scheduler? | Lifetime: 0, Ticks: 0, Arrival Delay: 0, Delayed Process: 0, Arrival Delay: 0

CREATE NEW PROCESS



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g. Loaded and Compiled CriticalRegion3

The screenshot shows the YASM CPU-OS Simulator interface. The 'PROGRAM SOURCE (INPUT)' window displays assembly code for 'CriticalRegion3'. The 'PROGRAM CODE (OUTPUT)' window shows the compiled binary code. The 'COMPILER' window has buttons for 'Compile', 'Optimize', and 'Options'. The 'ASSEMBLY CODE' window shows the compiled code with columns for LAdd, CPU Instruction, Binary Code, Line, and Comments.

LAdd	CPU Instruction	Binary Code	Line	Comments
0019	SWI 18	2E020012	0005	OS system call: Enter critical region
0130	SWI 19	2E020013	0011	OS system call: Exit critical region

ENTER keyword Assembly code

LEAVE keyword Assembly code

h. Console Output

The screenshot shows the YASM CPU-OS Simulator interface. The 'RUNNING PROCESSES' window shows the state of the program. The 'Console' window displays the output of the program, including thread creation and termination messages. The 'SCHEDULER' window shows the configuration for the Round Robin (RR) scheduler.

Console Output:

```

In main
In thread1
In thread2
thread1 g = 20
Exiting thread1
thread2 g = 12
Exiting thread2
Exiting main
  
```

SCHEDULER Configuration:

- Policy: Round Robin (RR)
- Round Robin and Priority Configuration:
 - RR Time Slice: 10 ticks
 - Priority: No priority
 - Dynamic: Static
- OS Control:
 - Use Single CPU: []
 - Allow CPU Affinity: []
 - Run scheduler with no processes: []



C. Deadlock prevention and avoidance.

a. Loaded and Compiled P1

Program Compiler [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

PROGRAM SOURCE (INPUT)

NoName1.txt NoName | NoName | NoName |

```
program DeadlockP1
resource(0, allocate)
wait(3)
resource(1, allocate)
for n = 1 to 20
next
end
```

COMPILER PROGRESS

```
1:....Found Assignment statement [5]
1:....Scanning for keyword TO - Found [5]
1:....Found keyword NEXT [6]
0:Found keyword END [7]

Code generation completed...
Displaying generated code
Display completed...

*** NOTE: Click on numbers in brackets to highlight corresponding source
```

PROGRAM CODE (OUTPUT)

NoName NoName | NoName | NoName |

LAdd	CPU Instruction	Binary Code	Line	Comments
**** CODE:				
**** MAIN PROG...				
0000	PSH #0	0E000000	0002	Push the value of 0 on top of stack
0004	SWI 12	2E02000C	0002	OS system call: Resource allocate w...
0008	POP R01	0F0101	0002	Pop the value from top of stack into ...
0011	MOV #3, R04	000000030104	0003	Copy the value of 3 to _STempReg...
0017	PSH R04	0E0104	0003	Wait time
0020	SWI 6	2E020006	0003	OS system call: Wait
0024	PSH #1	0E000001	0004	Push the value of 1 on top of stack
0028	SWI 12	2E02000C	0004	OS system call: Resource allocate w...
0032	POP R02	0F0102	0004	Pop the value from top of stack into ...
0035	MOV #1, R06	000000010106	0005	Copy the value of 1 to _STempReg...
0041	MOV R06, R04	0001060104	0005	Copy the value of _STempReg245 t...
0046	MOV #20, R06	0000000140106	0005	Copy the value of 20 to _STempRe...
0052	CMP R06, R04	3001060104	0005	Compare N with _STempReg265
0057	JGT 71	20020047	0005	Jump to code at address 71 if status ...
0061	ADD #1, R04	110000010104	0006	Add: N = N + 1
0067	JMP 52	1D020034	0006	Jump to code at address 52 (UNCO...
0071	HLT	2F	0007	Stop simulation
**** DATA:				

COMPILER

Edit Source **Compile** Optimize Options Compiler Help

COMPILER: COMPILER PROGRESS: SHOW SYMBOL TABLE... SHOW CLASS MAP... SHOW SUBROUTINE LIST... SHOW AST...

SOURCE

LOAD... SAVE... PRINT...

Auto save source files ☐

ASSEMBLY CODE

Start Address: 0 Code Size: 72 PRINT... Include source ☐

LOAD IN MEMORY... Select CPU: 0 Base Address: 0

SHOW OS 0... SHOW CPU 0... CLOSE

BINARY CODE

LOAD... SHOW... SAVE... Use compiler optimisations ☐

b. Loaded and Compiled P2

Program Compiler [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

PROGRAM SOURCE (INPUT)

NoName1.txt NoName | NoName | NoName |

```
program DeadlockP2
resource(1, allocate)
wait(3)
resource(2, allocate)
for n = 1 to 20
next
end
```

COMPILER PROGRESS

```
1:....Found Assignment statement [5]
1:....Scanning for keyword TO - Found [5]
1:....Found keyword NEXT [6]
0:Found keyword END [7]

Code generation completed...
Displaying generated code
Display completed...

*** NOTE: Click on numbers in brackets to highlight corresponding source
```

PROGRAM CODE (OUTPUT)

NoName NoName | NoName | NoName |

LAdd	CPU Instruction	Binary Code	Line	Comments
**** CODE:				
**** MAIN PROG...				
0000	PSH #1	0E000001	0002	Push the value of 1 on top of stack
0004	SWI 12	2E02000C	0002	OS system call: Resource allocate w...
0008	POP R01	0F0101	0002	Pop the value from top of stack into ...
0011	MOV #3, R04	000000030104	0003	Copy the value of 3 to _STempReg...
0017	PSH R04	0E0104	0003	Wait time
0020	SWI 6	2E020006	0003	OS system call: Wait
0024	PSH #2	0E000002	0004	Push the value of 2 on top of stack
0028	SWI 12	2E02000C	0004	OS system call: Resource allocate w...
0032	POP R02	0F0102	0004	Pop the value from top of stack into ...
0035	MOV #1, R06	000000010106	0005	Copy the value of 1 to _STempReg...
0041	MOV R06, R04	0001060104	0005	Copy the value of _STempReg245 t...
0046	MOV #20, R06	0000000140106	0005	Copy the value of 20 to _STempRe...
0052	CMP R06, R04	3001060104	0005	Compare N with _STempReg265
0057	JGT 71	20020047	0005	Jump to code at address 71 if status ...
0061	ADD #1, R04	110000010104	0006	Add: N = N + 1
0067	JMP 52	1D020034	0006	Jump to code at address 52 (UNCO...
0071	HLT	2F	0007	Stop simulation
**** DATA:				

COMPILER

Edit Source **Compile** Optimize Options Compiler Help

COMPILER: COMPILER PROGRESS: SHOW SYMBOL TABLE... SHOW CLASS MAP... SHOW SUBROUTINE LIST... SHOW AST...

SOURCE

LOAD... SAVE... PRINT...

Auto save source files ☐

ASSEMBLY CODE

Start Address: 0 Code Size: 72 PRINT... Include source ☐

LOAD IN MEMORY... Select CPU: 0 Base Address: 0

SHOW OS 0... SHOW CPU 0... CLOSE

BINARY CODE

LOAD... SHOW... SAVE... Use compiler optimisations ☐



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c. Loaded and Compiled P3

Program Compiler [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

PROGRAM SOURCE (INPUT)

NoName1.txt | NoName | NoName | NoName

```
program DeadlockP3
resource(2, allocate)
wait(3)
resource(3, allocate)
for n = 1 to 20
next
end
```

COMPILER PROGRESS

```
1:....Found Assignment statement [5]
1:....Scanning for keyword TO - Found [5]
1:....Found keyword NEXT [6]
0:Found keyword END [7]

Code generation completed...
Displaying generated code
Display completed...

*** NOTE: Click on numbers in brackets to highlight corresponding source
```

PROGRAM CODE (OUTPUT)

LAdd	CPU Instruction	Binary Code	Line	Comments
**** CODE:				
**** MAIN PROG...				
0000	PSH #2	0E000002	0002	Push the value of 2 on top of stack
0004	SWI 12	2E02000C	0002	OS system call: Resource allocate w...
0008	POP R01	0F0101	0002	Pop the value from top of stack into ...
0011	MOV #3, R04	00000030104	0003	Copy the value of 3 to _STempReg...
0017	PSH R04	0E0104	0003	Wait time
0020	SWI 6	2E020006	0003	OS system call: Wait
0024	PSH #3	0E000003	0004	Push the value of 3 on top of stack
0028	SWI 12	2E02000C	0004	OS system call: Resource allocate w...
0032	POP R02	0F0102	0004	Pop the value from top of stack into ...
0035	MOV #1, R06	000000010106	0005	Copy the value of 1 to _STempReg...
0041	MOV R06, R04	0001060104	0005	Copy the value of _STempReg24S t...
0046	MOV #20, R06	000000140106	0005	Copy the value of 20 to _STempRe...
0052	CMP R06, R04	3001060104	0005	Compare N with _STempReg26S
0057	JGT 71	20020047	0005	Jump to code at address 71 if status ...
0061	ADD #1, R04	110000010104	0006	Add: N = N + 1
0067	JMP 52	1D020034	0006	Jump to code at address 52 (UNCO...
0071	HLT	2F	0007	Stop simulation
**** DATA:				

COMPILER

Edit Source | **Compile** | Optimize | Options | Compiler Help

COMPILER: [Compile] [Run] [Show Symbol Table...] [Show Class Map...] [Cancel] [Show Subroutine List...] [Show AST...]

SOURCE

LOAD... SAVE... PRINT... Auto save source files

ASSEMBLY CODE

Start Address: 0 Code Size: 72 PRINT... Include source

LOAD IN MEMORY... Select CPU: 0 Base Address: 0

SHOW OS 0... SHOW CPU 0... CLOSE

d. Loaded and Compiled P4

Program Compiler [YASMIN: CPU-OS Simulator, Version: 7.5.50, Copyright © 2006-2013, Besim Mustafa, Edge Hill University, UK]

PROGRAM SOURCE (INPUT)

NoName1.txt | NoName | NoName | NoName

```
program DeadlockP4
resource(3, allocate)
wait(3)
resource(0, allocate)
for n = 1 to 20
next
end
```

COMPILER PROGRESS

```
1:....Found Assignment statement [5]
1:....Scanning for keyword TO - Found [5]
1:....Found keyword NEXT [6]
0:Found keyword END [7]

Code generation completed...
Displaying generated code
Display completed...

*** NOTE: Click on numbers in brackets to highlight corresponding source
```

PROGRAM CODE (OUTPUT)

LAdd	CPU Instruction	Binary Code	Line	Comments
**** CODE:				
**** MAIN PROG...				
0000	PSH #3	0E000003	0002	Push the value of 3 on top of stack
0004	SWI 12	2E02000C	0002	OS system call: Resource allocate w...
0008	POP R01	0F0101	0002	Pop the value from top of stack into ...
0011	MOV #3, R04	00000030104	0003	Copy the value of 3 to _STempReg...
0017	PSH R04	0E0104	0003	Wait time
0020	SWI 6	2E020006	0003	OS system call: Wait
0024	PSH #0	0E000000	0004	Push the value of 0 on top of stack
0028	SWI 12	2E02000C	0004	OS system call: Resource allocate w...
0032	POP R02	0F0102	0004	Pop the value from top of stack into ...
0035	MOV #1, R06	000000010106	0005	Copy the value of 1 to _STempReg...
0041	MOV R06, R04	0001060104	0005	Copy the value of _STempReg24S t...
0046	MOV #20, R06	000000140106	0005	Copy the value of 20 to _STempRe...
0052	CMP R06, R04	3001060104	0005	Compare N with _STempReg26S
0057	JGT 71	20020047	0005	Jump to code at address 71 if status ...
0061	ADD #1, R04	110000010104	0006	Add: N = N + 1
0067	JMP 52	1D020034	0006	Jump to code at address 52 (UNCO...
0071	HLT	2F	0007	Stop simulation
**** DATA:				

COMPILER

Edit Source | **Compile** | Optimize | Options | Compiler Help

COMPILER: [Compile] [Run] [Show Symbol Table...] [Show Class Map...] [Cancel] [Show Subroutine List...] [Show AST...]

SOURCE

LOAD... SAVE... PRINT... Auto save source files

ASSEMBLY CODE

Start Address: 0 Code Size: 72 PRINT... Include source

LOAD IN MEMORY... Select CPU: 0 Base Address: 0

SHOW OS 0... SHOW CPU 0... CLOSE



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e. Deadlock Graph

WARNING: PROCESS DEADLOCK IS DETECTED

Resource List

Resource	Used by	Requested by	Allocated	Blocked	Released
R0	4	7	0	0	0
R1	5	4	0	0	0
R2	6	5	0	0	0
R3	7	6	0	0	0
R4	0	0	0	0	0
R5	0	0	0	0	0

Waiting Processes (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
7	DEADLOCKP4	1	1	0	No	No	P4	3	
4	DEADLOCKP2	1	1	0	No	No	P1	1	
5	DEADLOCKP2	1	1	0	No	No	P2	1	
6	DEADLOCKP3	1	1	0	No	No	P3	2	

SCHEDULER

Deadlocked processes and resources

Key: ● Process ■ Resource

01:36:55:968: Resource R1 is allocated to process P2 (5)
01:36:55:968: Process P2 (5) is requesting resource R2 (6)
01:36:55:968: Resource R2 is allocated to process P3 (6)
01:36:55:968: Process P3 (6) is requesting resource R3 (7)
01:36:55:968: Resource R3 is allocated to process P4 (7)
01:36:55:968: Process P4 (7) is requesting resource R0 (4)
01:36:55:968: Resource R0 is allocated to process P1 (4)
01:36:55:968: Process P1 (4) is requesting resource R1 (5)
01:36:55:968: Resource R1 is allocated to process P2 (5) (DEADLOCKP2)
01:36:55:968: Process P2 (5) is requesting resource R2 (6) (DEADLOCKP3)
01:36:55:968: Resource R2 is allocated to process P3 (6) (DEADLOCKP3)
01:36:55:968: Process P3 (6) is requesting resource R3 (7) (DEADLOCKP3)

f. Releasing a resource

There are no deadlocked processes

Resource List

Resource	Used by	Requested by	Allocated	Blocked	Released
R0	4	7	0	0	0
R1	5	4	0	0	0
R2	6	5	0	0	0
R3	7	6	0	0	0
R4	0	0	0	0	0
R5	0	0	0	0	0

Waiting Processes (Waiting Queue)

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
7	DEADLOCKP4	1	1	0	No	No	P4	3	
4	DEADLOCKP2	1	1	0	No	No	P1	1	
5	DEADLOCKP2	1	1	0	No	No	P2	1	
6	DEADLOCKP3	1	1	0	No	No	P3	2	

SCHEDULER

Deadlocked processes and resources

Key: ● Process ■ Resource



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g. Removing a process

The screenshot shows the OS Simulator interface with a warning: "WARNING: PROCESS DEADLOCK IS DETECTED". The "Allocating resources for process id 7" dialog is open, showing resource allocation for R0, R1, R2, R3, R4, and R5. The "SCHEDULER" panel shows the "Policies" tab with "Round Robin (RR)" selected. The "PROGRAM LIST" panel shows a list of processes, including DEADLOCKP1, DEADLOCKP2, DEADLOCKP3, and DEADLOCKP4. The "WAITING PROCESSES (Waiting Queue)" table is visible at the bottom.

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
4	DEADLOCKP1	1	3	3	No	P1		0	
5	DEADLOCKP2	1	3	3	No	P2		1	
6	DEADLOCKP2	1	3	2	No	P3		2	
7	DEADLOCKP4	1	3	3	No	P4		3	

h. Disallow hold and wait

The screenshot shows the OS Simulator interface with the "Allocating resources for process id 4" dialog open. The "SCHEDULER" panel shows the "Policies" tab with "Round Robin (RR)" selected. The "PROGRAM LIST" panel shows a list of processes, including DEADLOCKP1, DEADLOCKP2, DEADLOCKP3, and DEADLOCKP4. The "WAITING PROCESSES (Waiting Queue)" table is visible at the bottom.

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid
-----	------	-------	--------	----------	-------	------	-------	-----	------



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i. Disallow circular wait

The screenshot shows the OS Simulator interface. The 'Resource List' window displays six resources (R0-R5) with their allocation and request status. The 'SCHEDULER' window shows the 'Deadlocked processes and resources' section, which is currently empty, indicating no deadlocks. The 'Prevent' section is configured with 'Disallow circular wait' checked. The 'Waiting Processes (Waiting Queue)' table is empty.

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid

j. Total Ordering

The screenshot shows the OS Simulator interface. The 'Resource List' window displays six resources (R0-R5) with their allocation and request status. The 'SCHEDULER' window shows the 'Policies' section, where 'Round Robin (RR)' is selected. The 'OS Control' section shows the 'STEP' button. The 'PROGRAM LIST' section shows a list of processes, including DEADLOCKP1, DEADLOCKP2, DEADLOCKP3, and DEADLOCKP4.

Pid	Name	State	Memory	Priority	Burst	Swap	PName	CPU	PPid