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# CS342 Operating Systems - Spring 2021

## Homework #4

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1) Page size 256 Bytes = $2^8$ Bytes

   16 - 8 = 8

   **0010 101**1 1100 0101

   0010 1011 = 0x2B

   0x2B corresponds to 0xFC = 1111 1100

   Physical address is therefore 1111 1100 1100 0101 = 0xFCC5

   **0001 0011** 0001 1100

   0001 0011 = 0x13

   0x13 corresponds to 0xA3 = 1010 0011

   Physical address is therefore 1010 0011 0001 1100 = 0xA31C

   **1110 0100** 1010 0011

   1110 0100 = 0xE4

   0xE4 corresponds to 0xE5 = 1110 0101

   Physical address is therefore 1110 0101 1010 0011 = 0xE5A3

   **0010 1011** 0001 0111

   0010 1011 = 0x2B

   0x2B corresponds to 0xFC = 1111 1100

   Physical address is therefore 1111 1100 0001 0111 = 0xFC17

2) 9 9 9 9 12

   32 MB = $2^{25}$ Bytes

   Page size is $2^{12}$ Bytes

   $2^{25}/2^{12} = 2^{13}$ fourth level page table entries needed

   A fourth level page table can index at most $2^9$ entries

   $2^{13}/2^9 = 2^4$ fourth level page tables needed

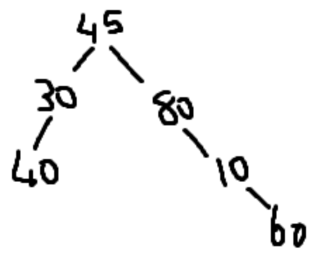
1 first, 1 second, 1 third, 16 fourth level page tables needed

$2^3*2^9 + 2^3*2^9 + 2^3*2^9 + 2^3*2^9*2^4 = 77824$ Bytes of memory is needed

3) ...40...30...

...60...10...80…

45 should be printed last



60 10 80 40 30 45

60 10 40 80 30 45

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40 30 60 10 80 45

40 60 30 10 80 45

40 60 10 80 30 45

40 60 10 30 80 45

4) Semaphore empty = 1;

Semaphore smoker1 = 0;

Semaphore smoker2 = 0;

Semaphore smoker3 = 0;

<u>Non-smoking agent</u>

```
do{
        wait(empty);
        items = selectTwoRandomly(tobacco, paper, match);
        if (items are paper and match){
            signal(smoker1);
        }else if (items are tobacco and match){
            signal(smoker2);
        }else{
            signal(smoker3);
        }
    }while(true);
```

<u>Smoker 1</u>

```
do{
    wait(smoker1);
    signal(empty);
    smoke();
}while(true);
```

<u>Smoker 2</u>

```
do{
    wait(smoker2);
    signal(empty);
    smoke();
}while(true);
```

<u>Smoker 3</u>

```
do{
    wait(smoker3);
    signal(empty);
    smoke();
}while(true);
```

5) Optional Question

6) Page size is 64 bytes = $2^6$ bytes
   Segment size is 2 bits

Page size is 8 bits

a) 0x06B2
b) 0x12E4
c) 0x1348
d) Trap because offset is greater than the length.
e) 0x030A
f) 0x0B48

7) **Exists**

| A | B | C |
|---|---|---|
| 9 | 6 | 6 |

**Max Demand**

| | A | B | C |
|---|---|---|---|
| **P1** | 5 | 4 | 2 |
| **P2** | 3 | 1 | 3 |
| **P3** | 6 | 6 | 4 |
| **P4** | 2 | 2 | 1 |
| **P5** | 5 | 2 | 2 |

**Allocation**

| | A | B | C |
|---|---|---|---|
| **P1** | 1 | 2 | 1 |
| **P2** | 1 | 0 | 2 |
| **P3** | 2 | 2 | 2 |
| **P4** | 0 | 0 | 1 |
| **P5** | 3 | 1 | 0 |

**Available**

| A | B | C |
|---|---|---|
| 2 | 1 | 0 |

**Need (Max Demand - Allocation)**

|  | A | B | C |
|---|---|---|---|
| **P1** | 4 | 2 | 1 |
| **P2** | 2 | 1 | 1 |
| **P3** | 4 | 4 | 2 |
| **P4** | 2 | 2 | 0 |
| **P5** | 2 | 1 | 2 |

With the current available resources, none of the possible needs can be satisfied. The system is in an unsafe state.

8) **Exists**

| A | B | C |
|---|---|---|
| 10 | 6 | 4 |

**Available**

| A | B | C |
|---|---|---|
| 3 | 3 | 0 |

P4 can be satisfied. After P4:

**Available**

| A | B | C |
|---|---|---|
| 4 | 3 | 1 |

P1 can be satisfied. After P1:

**Available**

| **A** | **B** | **C** |
|---|---|---|
| 5 | 3 | 1 |

None of the remaining processes can be satisfied with the current available resources. There is a deadlock.

9) monitor Sem{

```
struct process{
        pid_t pid;
        struct process* next;
}

struct Semaphore{
        int value = 0;
        struct process* queue;
}

condition c;
pid_t pid;

void wait(Semaphor& S){
        S->value--;
        if(S->value < 0){
                struct process* newProcess = (struct process*)
malloc(sizeof(struct process));
                newProcess->pid = getpid();
                newProcess->next = NULL;
                struct process* head = S->queue;

                while(head->next != NULL){
```

```
                head = head->next;
            }

            head->next  = newProcess;
            while(getpid() != pid){
                condition.wait();
            }
        }
}

void signal(Semaphor& S){
        S->value++;
        if(S->value <= 0){
            struct process* oldHead = S->queue;
            S->queue = S->queue->next;
            pid = oldHead->pid;
            free(oldHead);
            condition.broadcast();
        }
}

}
```