Quiz 1

True or False:

1. A good scheduling algorithm for hard real time tasks must try to complete each task in the shortest time possible.

2. Soft real time systems are those which do not have any time constraint associated with them.

Multiple Choice Questions:

3. What is the output of the program.

```
#include<stdio.h>
#define N 3+5
void swap(int a, int b);
int main(){
   int a=N*2;
   int b=N*4;
   swap(a, b);
   printf("a=%d,b=%d\n",a,b);
}

void swap(int a, int b)
{
    int c = a;
    a=b;
    b=c;
}
```

A. a=13, b=23

B. a=23, b =13

C. a=16, b=32

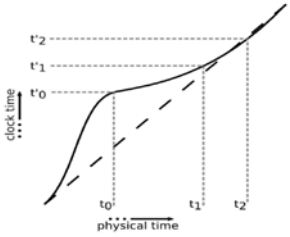
D. a=32, b=16

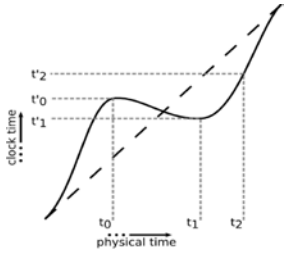
4. What is the last line of the output of the program?

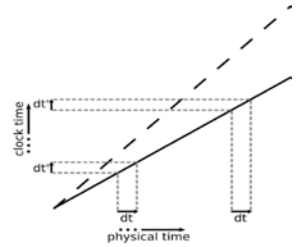
```
#include <stdio.h>
void foo()
{  int a = 10;
   static int sa = 10;
   a += 5;
   sa += 5;
   printf("a = %d, sa = %d\n", a, sa);
}

int main()
{
   int i;
   for (i = 0; i < 5; ++i)
       foo();
}
```

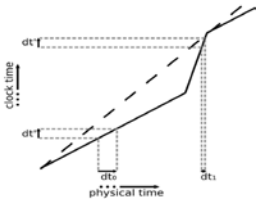
A. a=15, sa=15
B. a=15, sa=35
C. a=35, sa=35
D. None of the above

5. Which of the following clocks is not monotonic?

A. 

B. 

C. 

D. 

Quiz 2

True or False :

1. Make keeps track of when files were last compiled and only recompiles those target files for which source files were changed since make was last executed. (T/F)

2. Tasks are preemptible in RTOS. (T/F)

3. You can implement a real-time task using both kernel program or user program, as long as you can assign different priorities to the tasks. (T/F)

Multiple Choice:

4. When we execute a C program, the CPU runs in ____ mode unless it is making a system call.
   A. user B. kernel C. supervisory D. system

5. What is a benefit of using kernel module instead of installing all anticipated functionalities into a base kernel?
   A. Allow pre-emption
   B. Easy to debug
   C. Save memory space
   D. Efficienty

6. Can child process access static variable created by parent process before fork()?
   A. Yes, since the variable is declared as "static", the child process can access and modify the value.

   B. No, because child process and parent process are separate in address space.

C. No, because the static variable s are not saved in stack in address space.

D. Yes, but the modification can be seen only in child process, and the value in parent process will not be changed.

Short Answer Question:

7. What is the output of the following program? Note that wait(&status) waits until child process has changed the state.

```
#include<stdio.h>
#include<wait.h>
#include<signal.h>
pid_t pid;
int counter = 0;

void handler1(int sig)
{
  counter++;
  printf("counter = %d\n", counter);
  /* Flushes the printed string to stdout */
  fflush(stdout);
  kill(pid, SIGUSR1);
}

void handler2(int sig)
{
  counter += 3;
  printf("counter = %d\n", counter);
  exit(0);
}

int main()
{
```

```
  pid_t p;
  int status;
  signal(SIGUSR1, handler1);
  if ((pid = fork()) == 0)
  {
    signal(SIGUSR1, handler2);
    kill(getppid(), SIGUSR1);
    while(1) ;
  }
  if ((p = wait(&status)) > 0)
  {
    counter += 4;
    printf("counter = %d\n", counter);
  }
}
```

Quiz 3

Multiple Choice Questions:

1. When a process is created using the classical fork() system call, which of the following is not inherited by the child process?

   A. Code B. Process ID C. User ID D. Data

2. With the following code, how many "hello" messages are printed?

```
#include <stdio.h>
#include <sys/types.h>
int main()
{
  fork();
  fork();
  fork();
  printf("hello\n");
  return 0;
}
```

   A. 2 B. 4 C. 6 D. 8 E. 16

3. Given the following three real-time tasks: T1(1, 6, 2, 8), T2(2, 10, 2, 10), and T3(12, 2, 10) in a system. What is the CPU utilization of the system if no other tasks exist?
   A. 60% B. 65% C.70% D. 73.3%

4. In cyclic executive scheduling, which of the following statement is correct?
   A. CE scheduling algorithm is based on static priority of tasks. A task's priority is inverse proportional to its period.
   B. A drawback of CE scheduling algorithm is that you have to compute an offline schedule which can be arbitrarily long.
   C. The frame size of the CE algorithm cannot be to large, otherwise the computational complexity is too high.
   D. The frame size of the CE algorithm cannot be too small since we want an instance of a task is completed within a single frame.

5. Multi-processor systems have advantage of _____ over multi-thread systems.
   A. cost B. reliability C. uncertainty D. Scalability

6. Which one of the following is NOT shared by threads in the same process?
   A. code B. stack C. heap D. None of the mentioned

7. Which of the following is NOT true?
   A. Processes may send each other signals
   B. Kernel may send signals internally
   C. signal() function is used to send a signal to a process
   D. A signal can be triggered by kill() function

8. Given the task set: T1(4, 1); T2(6, 1); T3(12, 2). What is the largest suitable frame size f?
   A. 3 B. 4 C. 6 D. 12

Quiz 4

1. Given real time tasks T1(4, 1) and T2(8, 3), reduce the cyclic executive (CE) scheduling problem as a network flow problem.

(1) For a frame size of 4, give the directed graph with edge capacity (called flow graph).

(2) Find maximum attainable flow on the flow graph, show the maximum flow network.

(3) According the result in (2), give the corresponding CE schedule.

2. Consider the following system of independent preemptable periodic tasks:

$$T1 = (3, 1), T2 = (5,1), \text{ and } T3 = (15, 3)$$

(1) Check the schedulability of each task using a **necessary and sufficient condition**, using the Rate Monotonic algorithm.

(2) Give the schedule in the first 15 time units.

3. Multiple Choice: Consider n periodic tasks Ti:(p_i, e_i) for $1 \le i \le n$, where p_i=2^i, and e_i=1. What is the value of largest n, so that the task set is (Rate Monotonic) RM schedulable?

A. 2 B. 4 C. 8 D. infinity

4. Consider the 3 tasks: T1 = (3, 1), T2 = (5,1), and T3 = (15, 3)
What is the schedule over the period [0,15) using EDF?

Quiz 5

True or False:

1. In PCP, if a resource R is free, the resource requesting task will acquire the resource R. (T/F)

2. The priority ceiling of a resource and the priority ceiling of the system is fixed, once the set of real time tasks and their requested resources are given. (T/F)

3. When a task has the same priority to the system's priority ceiling, if the resource is free the task will acquire a certain resource. (T/F)

4. When resource contention occurs in a real-time system, the priority celling protocal can be used with RM scheduler for resource access control. (T/F)

5. What is the major cause of Priority Inversion?

6. (1) What is the drawback of NPCS?

   (2) What is the drawback of PIP?

7. Give the RM schedule with PCP for the following task set. Consider the first job of these tasks only.

Consider Set of 5 Tasks:

T1: (7, 20, 3, 20, [R1, 1])

T1 requests resource R1 one time unit after it is scheduled.

T2: (5, 22, 3, 22, [R2, 1])

T2 requests resource R2 one time unit after it is scheduled.

T3: (4, 23, 2, 24)

No CS or resource requests in T3.

T4: (2, 25, 6, 25, [R1, 4; [R2, 1.5]])

T4 requests resource R1 one time unit after it is scheduled, and R2 is requested in CS for resource R1 (assume R2 is requested after 2 time units when R1 is allocated to T4).

T5: (0, 25, 6, 26, [R2, 4])

T5 requests resource R2 one time unit after it is scheduled.

8. Consider the following set of tasks (consider only one job in each task):

   T1(5; 10; 4; 10 [R1; 2])

   T2(2; 15; 6; 15 [R3; 4[R2 ; 1]])

   T3(0; 20; 8; 20 [R2; 6[R3; 3]])

The resource R1 is required by T1 after it has executed for 1 time unit.

The resource R2 is required by task T2 after it has executed for 2 time units and by Task T3 after it has executed 1 time unit.

The resource R3 is required by task T2 after it has executed 1 time unit and by task T3 after it has executed 3 time units.

Show the schedule for these tasks based on RM algorithm and uses the NPCS, PIP, and PCP.

Solution to Quiz 1

1.F

2.F

3.A (a=13,b=23)

4.B (a=15, sa=35)

5.B

Solution to Quiz 2

1. T

2. T

3. F

4. A(user)

5. C(save memory space)

6. D(Yes, but the modification can be seen only in child process, and the value in parent process will not be changed.)

7. counter = 1

   counter = 3

   counter = 5

Solution to Quiz 3

1. B (process ID)

2. D (8)

3. C (70%)

4. D (The frame size of the CE algorithm cannot be too small since we want an instance of a task is completed within a single frame.)

5. B (reliability)

6. B (stack)

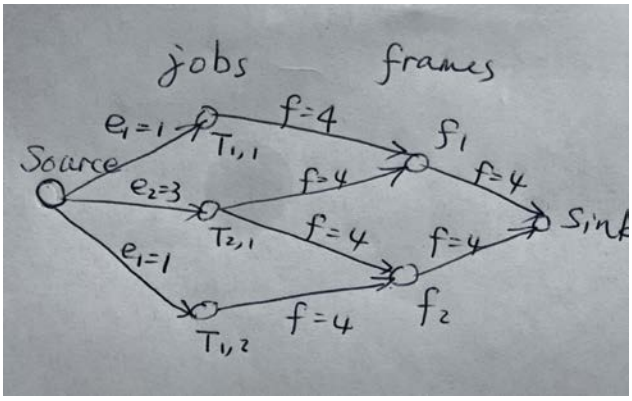
7. C (A field is updated in the signal table when the signal is sent)

8. B (f=4)

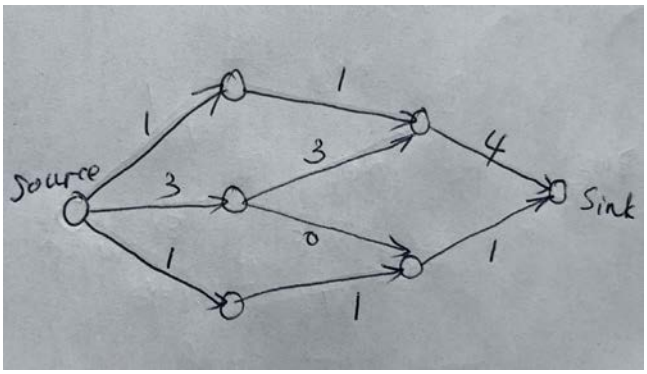
Solution to Quiz 4

1. Hyperperiod H=8, f=4, there are 3 job instances, and 2 frame sizes.

(1)



(2)



(3) f1: T1 T2 T2 T2 f2:T1, I, I, I

2. (1) For the first i tasks:

When i=1, k1=1, t=p1=3, so w_1(t) = e_1=1< p_1=3

When i=2, k1=1 and k2=1, t=3 and t=5, we have

w_2(3)=e1+e2=2<3

w_2(5)=2e1+e2=3<5

When i=3, k1=1,2,3,4,5; k2=1,2,3; k3=1. So t=3,5,6,9,10,12,15 and

w_3(3) = e1+e2+e3=5>3

w_3(5) = 2e1+e2+e3=6>t

w_3(6) = 2e1+2e2+e3=7>t

w_3(9) = 3e1+2e2+e3=8<t

w_3(10)=4e1+2e2+e3=9<10

w_3(12) =4e1+3e2+e3=10<12

w_3(15) =5e1+3e2+e3=11<15

It is RM schedulable.

(2) RM schedule : T1, T2, T3, T1, T3, T2, T1, T3, I, T1, T2, I, T1, I, I

3. D (infinity)
4. EDF schedule: T1, T2, T3, T1, T3, T2, T1, T3, I, T1, T2, I, T1, I, I

Solution to Quiz 5

1. F 2. F 3. F 4. T
5. Tasks are redemptive, while the resource allocation is non-preemptive.
6. (1) There can be a long period of priority inversion even without resource contention.

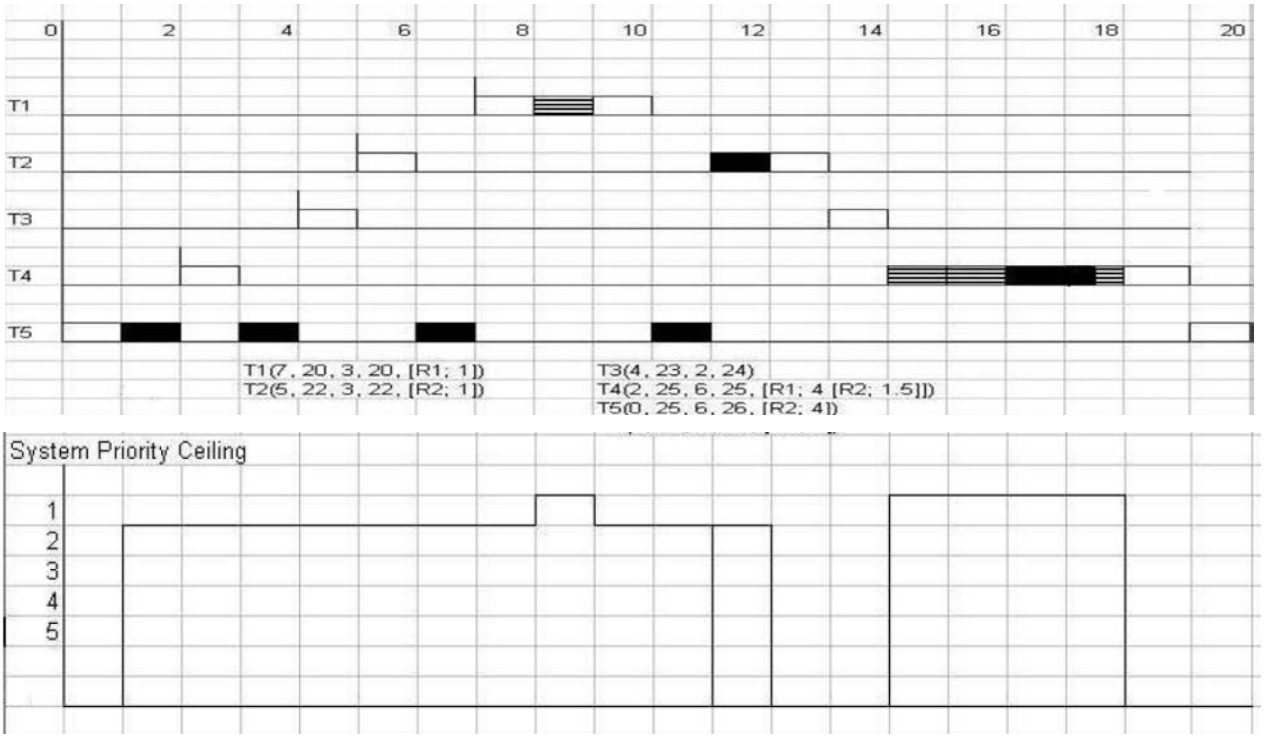
   (2) There can be deadlocks with PIP.

7. Answer:

1. Determine priorities: T1>T2>T3>T4>=T5
2. Compute priority ceiling of resources: ceiling(R1) = Priority(T1), ceiling(R2) = Priority(T2)
3. Check the occurrence of events:
   (1) t=0, T5 is released (schedule T5)
   (2) t=1, T5 requests R2: Resource allocation decision: Check if priority of T5 > System priority celling: yes, so R2 is allocated and T5 is in CS.
   (3) t=2, T4 is released: Scheduling decision: Check if priority of T4 > T5: yes, T4 is scheduled

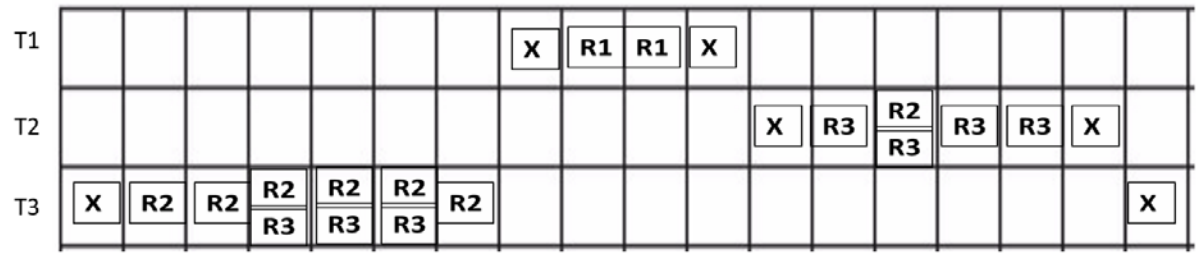
(4) t=3, T4 requests R1: Resource allocation decision: Check if priority of T4 > System priority celling: no, system priority ceiling is Priority(T2), it is higher than Priority(T4), so R1 cannot be allocated. Now, priority inheritance occurs. ….

(5) t=6, T2 requests R2: Resource allocation decision: Check if priority of T2 > System priority celling: no, they are the same, so R2 cannot be Allocated to T2, and T5 blocks T2.
(6) t=7, T1 is released: Check if priority of T1 > T5: yes, so T1 is scheduled.
(7) t=8, T1 requests R1: Resource allocation decision: Check if priority of T1 > System priority celling: yes, so R1 is allocated to T1. ….
(8) t=10, T1 is completed and T5 is in its critical section and with highest priority among the waiting tasks, so T5 is scheduled. ….

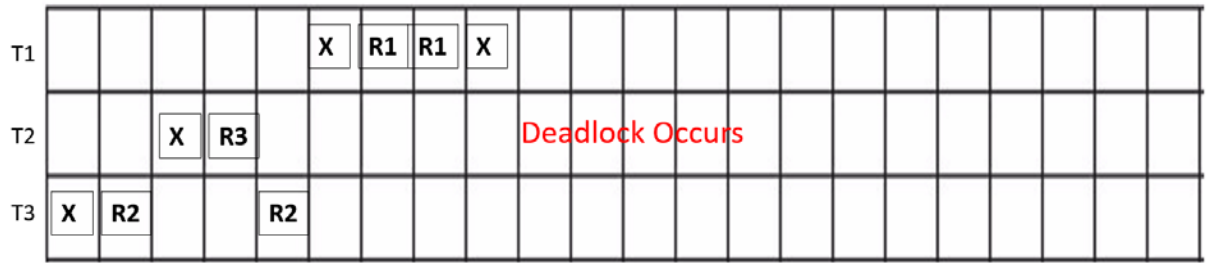


8. Answer:

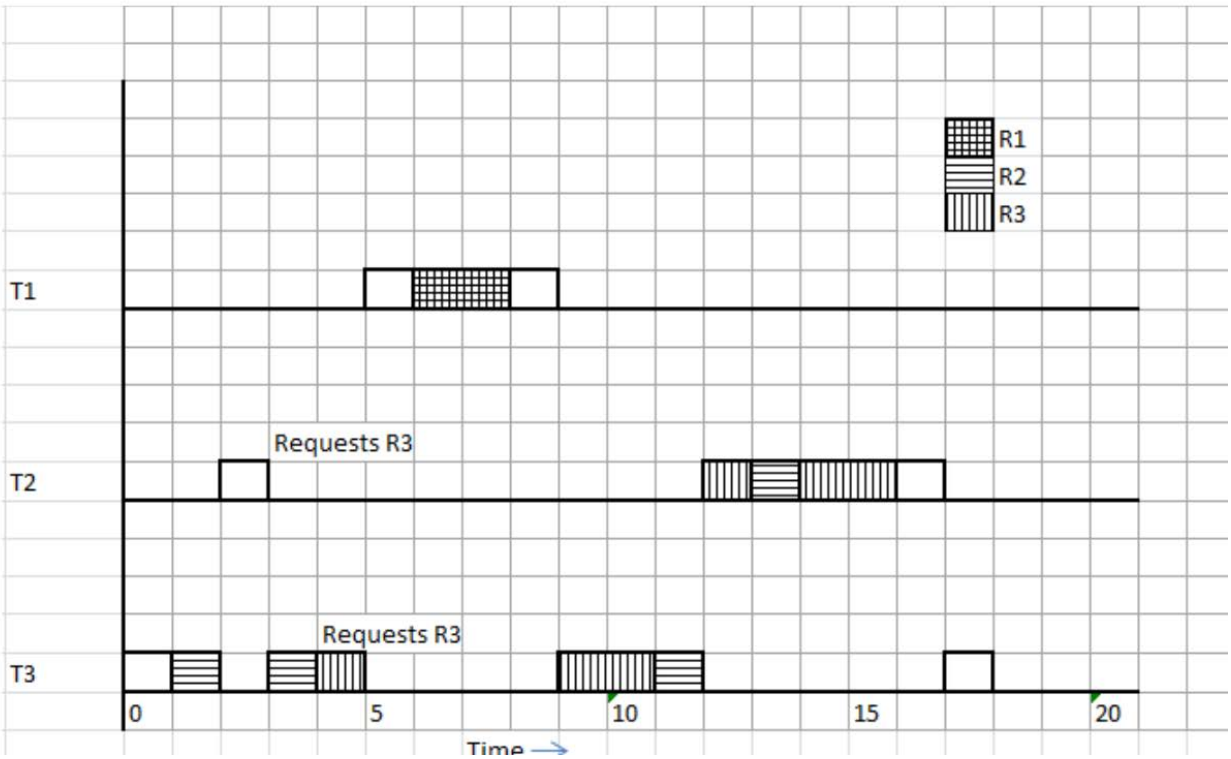
NPCS:



PIP:


T1
X
R1
R1
X
T2
X
R3
Deadlock Occurs
T3
X
R2
R2

PCP:


R1
R2
R3
T1
Requests R3
T2
Requests R3
T3
0
5
10
15
20
Time