STUDY GUIDE

1. Draw a task graph and find feasible intervals for the tasks below. Assume Class is from 9:00-10:15, Lunch is served 12:00-1:00 and the afternoon bus leaves no earlier than 4:30 and arrives near your house no later than 5:15. Assume there are plenty of busses in the morning.

1. Wake up no earlier than 6:30 Am
2. get ready
3. ride bus to school
4. catch at least a little of Dr Brown's class

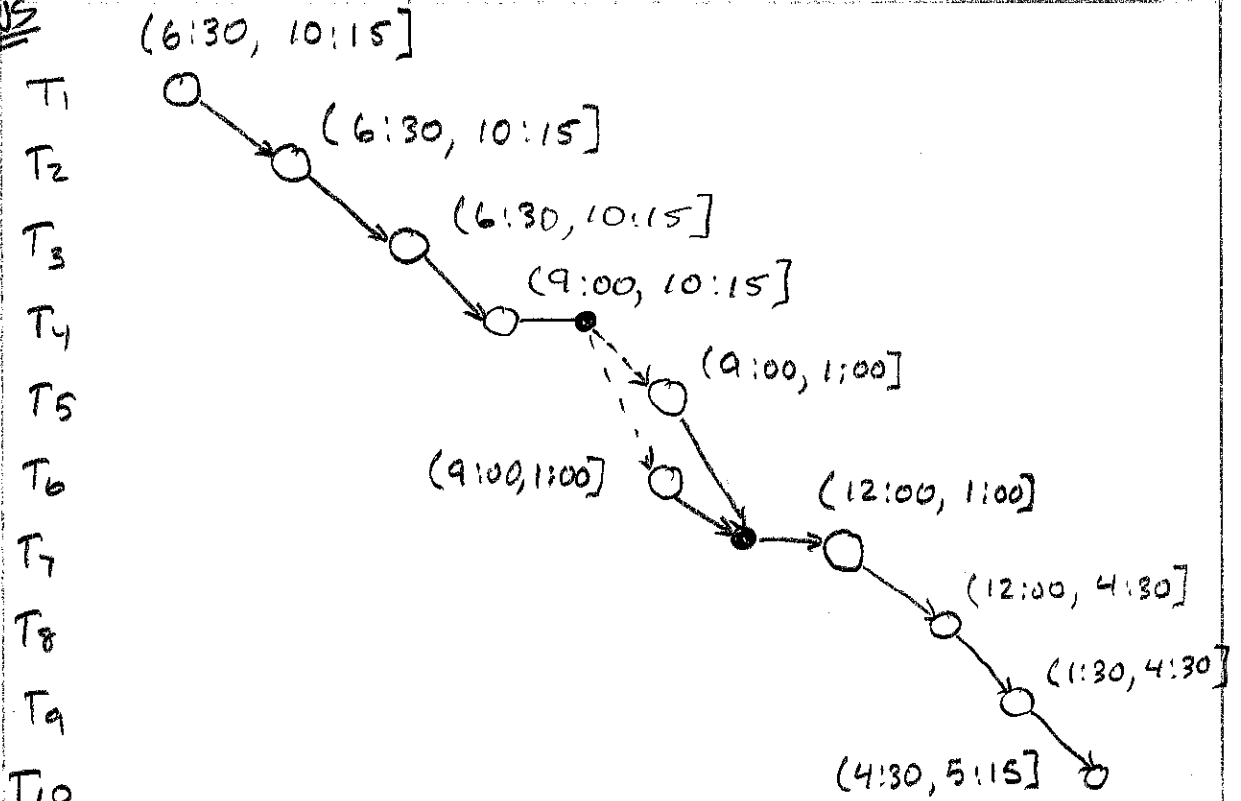
Either

5. Study, or
6. Work on lab

Then

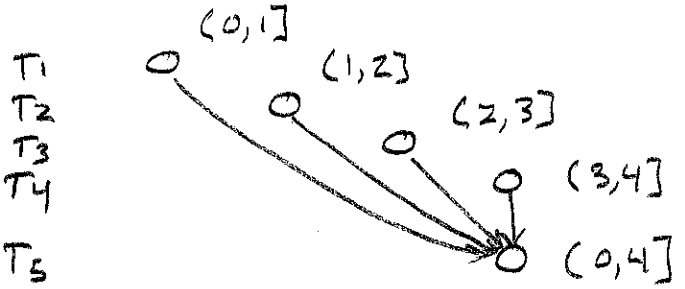
7. Eat lunch
9. Read
9. Attend at least some of the 1:30-4:30 lab
10. Ride the afternoon bus home

ANS



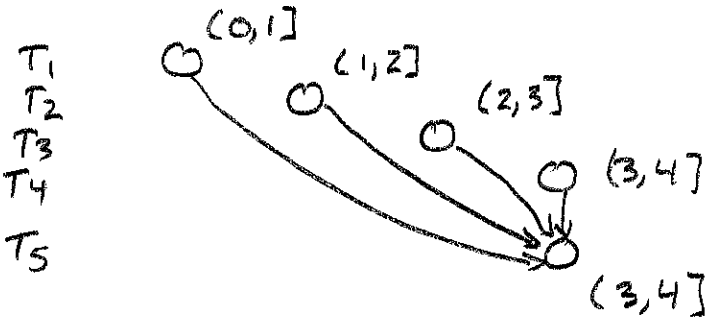
2. A certain scale uses a single A/D converter to read 4 load cells and a calibration referance. All 4 measurements are required to compute a weight. J_1, J_2, J_3 and J_4 read the 4 inputs, J_5 computes the weight. The A/D can only be started in integer intervals (i.e. (0, 1], (1, 2] etc.) All jobs have a period of 4, but $\Phi_1 = 0$ $\Phi_2 = 1$, $\Phi_3 = 2$ and $\Phi_4 = 3$. Also $D_1 = D_2 = D_3 = D_4 = 1$. Draw a task graph. Ignore control dependencies. Show feasible intervals.

ANS



3. Draw another task graph, but show effective release times and deadlines.

ANS



4. Consider $T_1 = (4, 1)$, $T_2 = (3, 1)$
Is the schedule below valid? Explain.

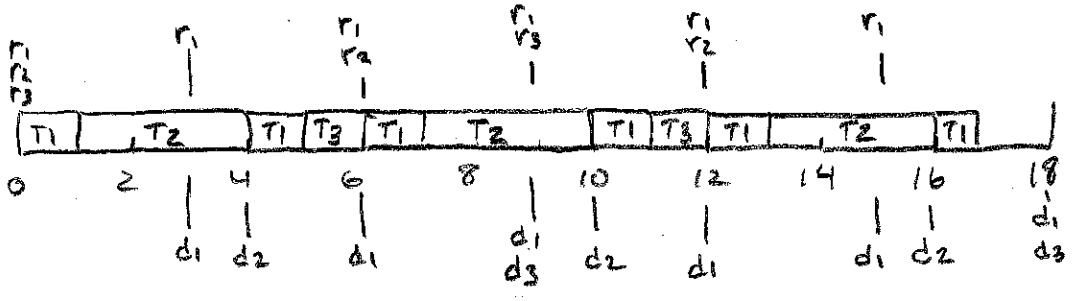
ANS No, Either T1 starts at 7 before it is released at 8, or it has been given too much time in interval (4, 8].

5. Is the schedule in 4 feasible? Explain.

ANS No, A feasible schedule must also be valid.

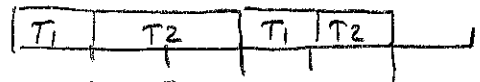
6. Schedule the following tasks for a clock-driven scheduler using EDF.
$T_1 = (3, 1)$, $T_2 = (6, 3, 4)$, $T_3 = (9, 1)$
$H = LCM(3, 6, 9) = 18$

ANS



7 If the Tasks in problem 6 are scheduled with the DM algorithm. Will it meet its deadlines (solve by attempting to schedule the critical instant for all tasks)

ANS

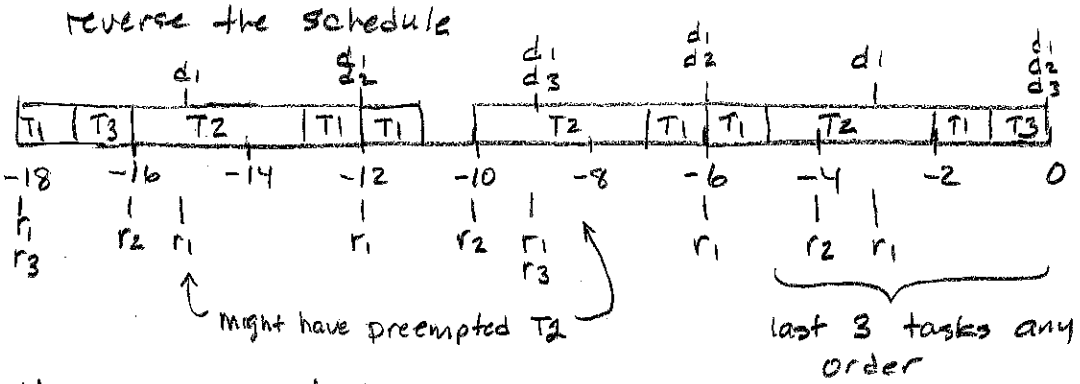


T_2 Fails to meet its deadline!

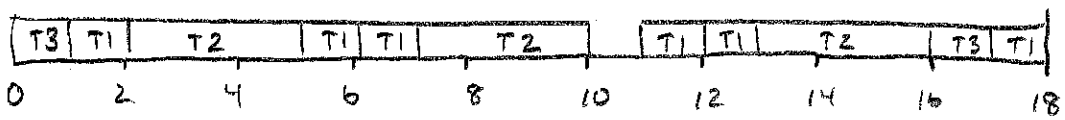
8. Schedule the tasks in problem 6 using LRT

ANS

reverse the schedule



Now, reverse it back:



9. Find the candidate frame sizes for the tasks $(3, 1, 2), (4, 0, 8), (6, 0, 6), (6, 0, 3)$

ANS

1. $f \geq 1, 2$

2a. $f \leq \min(p_i) = 3$

b. $nf = H = 12$, $f = 3, \frac{12}{5}, 2, \frac{12}{7}, \frac{3}{2}, \frac{4}{3}, \frac{6}{5}$

3. $2f \leq D_i + \gcd(f, p_i) \quad \forall i$

Clearly $f \leq \frac{3}{2}$ are candidates because $\min(D_i) = 3$

But now we must check $f = 3, \frac{12}{5}, 2$ and $\frac{12}{7}$ manually

Try $f = 3$: $2(3) \overset{?}{\leq} 3 + \gcd(3,3) = 6$ ✓

$2(3) \overset{?}{\leq} 4 + \gcd(3,4) = 5$ X

Try $f = \frac{12}{5}$: $2(\frac{12}{5}) \overset{?}{\leq} 3 + \gcd(\frac{12}{5}, 3) = 3\frac{3}{5}$ X

Try $f = 2$: $2(2) \overset{?}{\leq} 3 + \gcd(2,3) = 4$ ✓

$2(2) \overset{?}{\leq} 4 + \text{---}$ ✓

obvious for $p_i = 6$

Try $f = \frac{12}{7}$: $2(\frac{12}{7}) \leq 3 + \gcd(\frac{12}{7}, 3) = 3\frac{3}{7}$ ✓

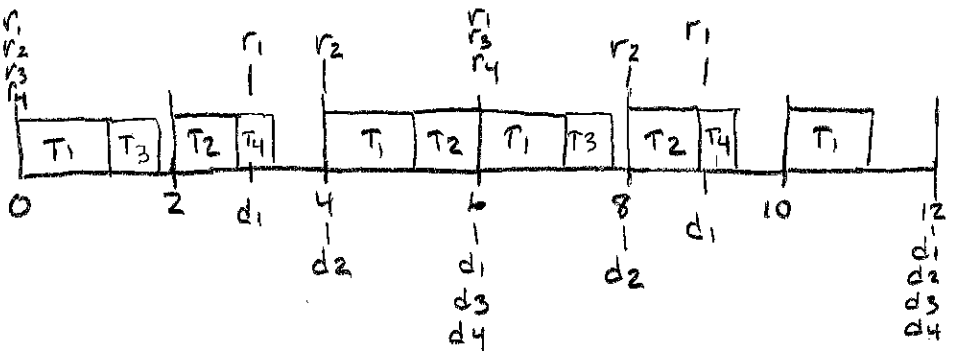
$2(\frac{12}{7}) \leq 4 + \text{---}$ ✓

obvious for $p_i = 6$

So Candidates are $\boxed{2, \frac{12}{7}, \frac{3}{2}, \frac{4}{3}, \frac{6}{5}}$

10. Suppose you choose a frame size of 2 in problem 9. Can the tasks be scheduled? if so, give the schedule. If not, Explain.

ANS



This is one possible schedule, there are others.

11. Suppose The tasks in problem 9 can be Scheduled, and that 2 aperiodic tasks run in the background. Assume the first has an execution time uniformly distributed between 1 and 2, and the second has an execution time of 1, 90% of the time and 2 10% of the time. The first has an average interarrival period of 50 and the second has an average interarrival period of 25

a) find the utilization, U, due to periodic tasks.

ANS $U = \frac{1.2}{3} + \frac{0.8}{4} + \frac{0.6}{6} + \frac{0.3}{6} = \boxed{0.75}$

b) find the utilization, U_A, of the aperiodic tasks:

ANS $U_A = \sum \lambda_i E[\beta_i]$

$E[\beta_1] = 1.5, \quad E[\beta_2] = (1)(0.9) + (2)(0.1) = 1.1$

$\lambda_1 = \frac{1}{50} = 0.02, \quad \lambda_2 = \frac{1}{25} = 0.04$

$(0.02)(1.5) + (0.04)(1.1) = 0.03 + 0.044 = \boxed{0.074}$

c) Find the average response time of the aperiodic tasks

ANS $W = \frac{U_A}{\lambda(1-U)} + \frac{W_0}{(1-U)^2\left[1-\left(\frac{U_A}{1-U}\right)\right]}$

But $W_0 = \frac{1}{2} \sum_i \lambda_i E[B_i^2]$

$$E(B_1^2) = \int_1^2 x^2 dx = \frac{x^3}{3}\Big|_1^3 = \frac{9}{3} - \frac{1}{3} = \frac{7}{3}$$

$$E(B_2^2) = (1^2)(0.9) + (2^2)(0.1) = 1.3$$

$$W_0 = \frac{1}{2}\left(0.02\left(\frac{8}{3}\right) + 0.04(1.3)\right) = 0.052\overline{6}$$

$$\lambda = \lambda_1 + \lambda_2 = 0.02 + 0.04 = 0.06$$

Finally

$$W = \frac{0.074}{(0.06)(1-0.75)} + \frac{0.052\overline{6}}{(1-0.75)^2\left[1 - \frac{0.074}{1-0.75}\right]}$$

$$= 4.9\overline{3} + 1.197 = \boxed{6.13}$$

12. State whether or not the following tasks can be scheduled with (a) EDF, and (b) DM

a) $T_i = (3, 1, 2), (10, 2.5)$ and $(21, 1, 20)$

ANS $\Delta_1 = \frac{1}{2}$, $\Delta_2 = \frac{1}{4}$, $\Delta_3 = \frac{1}{4}$, so they are schedualable under EDF.

For DM, accellerated schedule is simple periodic, so $U = 1.0$, but that is sufficent to prove schedulable.

b) $T_1 = (6, 2)$, $T_2 = (11, 4)$, $T_3 = (14, 3)$, $T_4 = (19, 2)$.

ANS Utilization is $U = 1.017$. No scheduling algorithm will schedule these tasks.

c) $T_1 = (9, 3)$, $T_2 = (11, 5)$

ANS $U = 0.788 \leq 1$ so schedulable under EDF.

In this case DM = RM, so

$$U \overset{?}{\leq} n(2^{1/n} - 1) = 0.828$$

$0.788 < 0.828$, so Schedulable under DM.

d) $T_1 = (3, 1)$, $T_2 = (4, 1)$, $T_3 = (8, 2, 7)$

ANS $\Delta = 0.869 \leq 1$ so schedulable under EDF

For accelerated schedule, $U = 0.869$

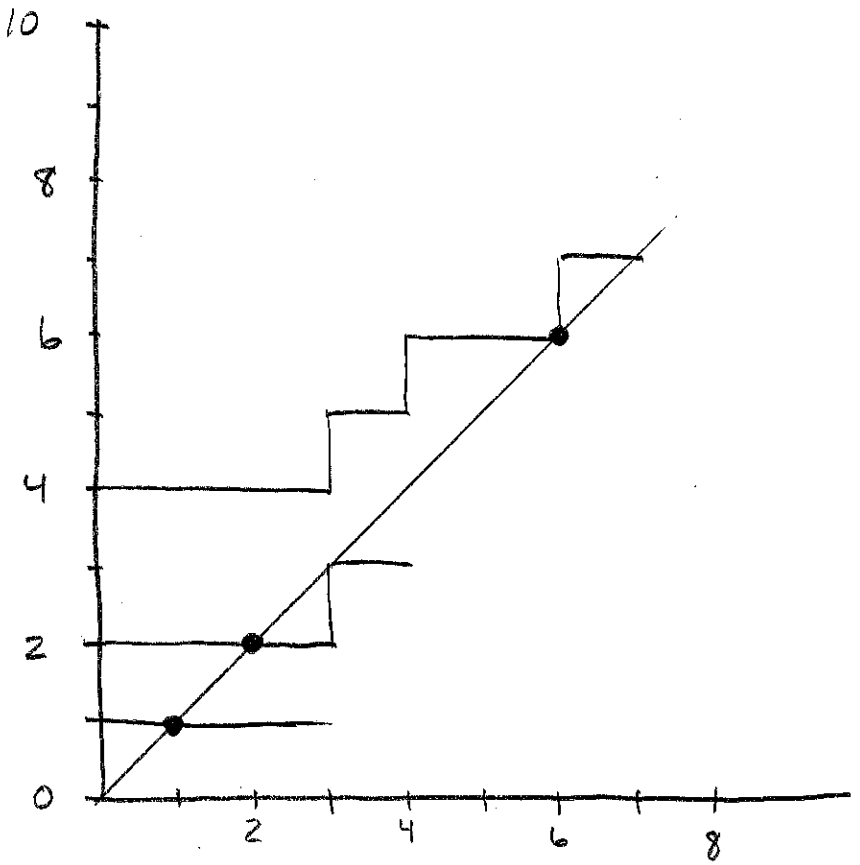
$$0.869 \overset{?}{\leq} n(2^{1/n} - 1) = 3(2^{1/3} - 1) = 0.778$$

We cannot tell if these tasks are schedulable under DM using this method, so we use time Demand Analysis.

$$W_1(t) = 1$$

$$W_2(t) = 1 + \left\lceil \frac{t}{3} \right\rceil$$

$$W_3(t) = 2 + \left\lceil \frac{t}{3} \right\rceil + \left\lceil \frac{t}{4} \right\rceil$$



These tasks are schedulable under DM.