Tutorial 2

Scheduling

Real Time Scheduling: Rate Monotonic

Q. Verify the schedulability and construct the schedule according to the RM policy for the following set of periodic tasks. Here C_i and T_i are the execution time and periods respectively.

	C_i	T_i
τ_1	2	6
τ_2	2	8
τ_3	2	12

Ans.

Utilization (U) = 2/6 + 2/8 + 2/12 = 0.75

Processor utilization upper bound $U_{max} = n(2^{1/n} - 1) = 0.78$

$U < U_{max}$ ➔ The task set is RM schedulable

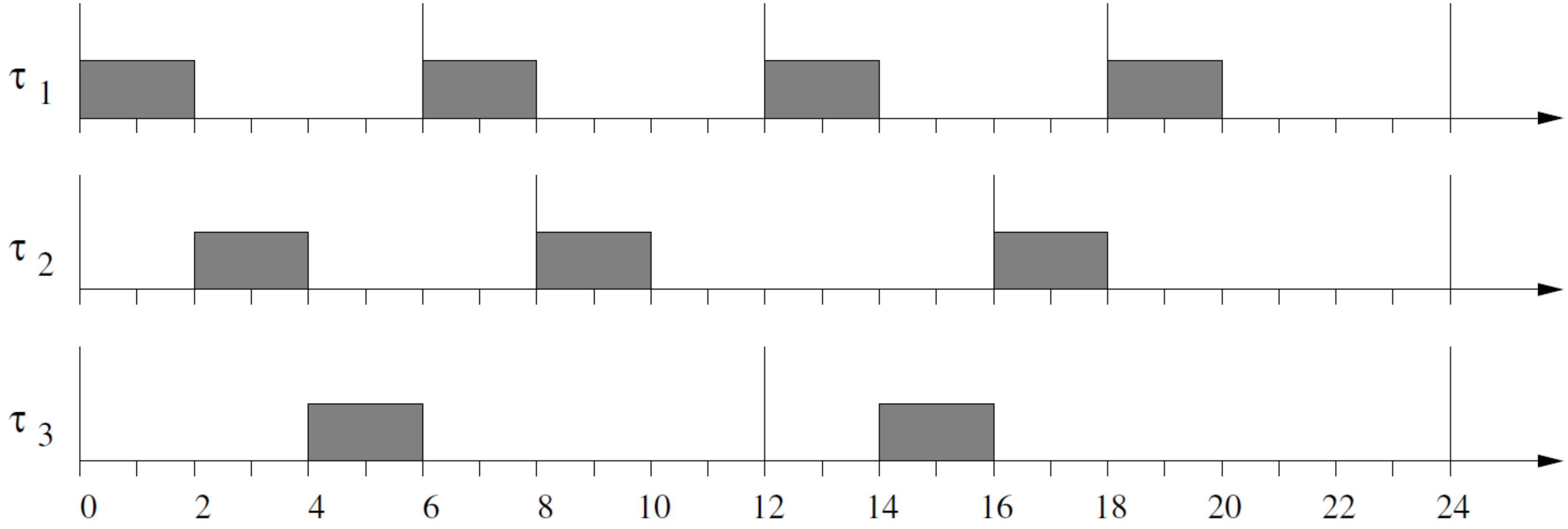
Real Time Scheduling: Rate Monotonic

Q. Write down the RM schedule for the given task set.

Hyper-period = lcm (6,8,12) = 24

	C_i	T_i
τ_1	2	6
τ_2	2	8
τ_3	2	12

Task Set



RM Schedule

RM Schedule: T_1^1 T_2^1 T_3^1 T_1^2 T_2^2 T_1^3 T_3^2 T_2^3 T_1^4

Real Time Scheduling: Rate Monotonic

Consider the following set of tasks

Tasks	C_i	T_i
τ_1	2	5
τ_2	4	7

Utilization (U) = 2/5 + 4/7 = 0.97

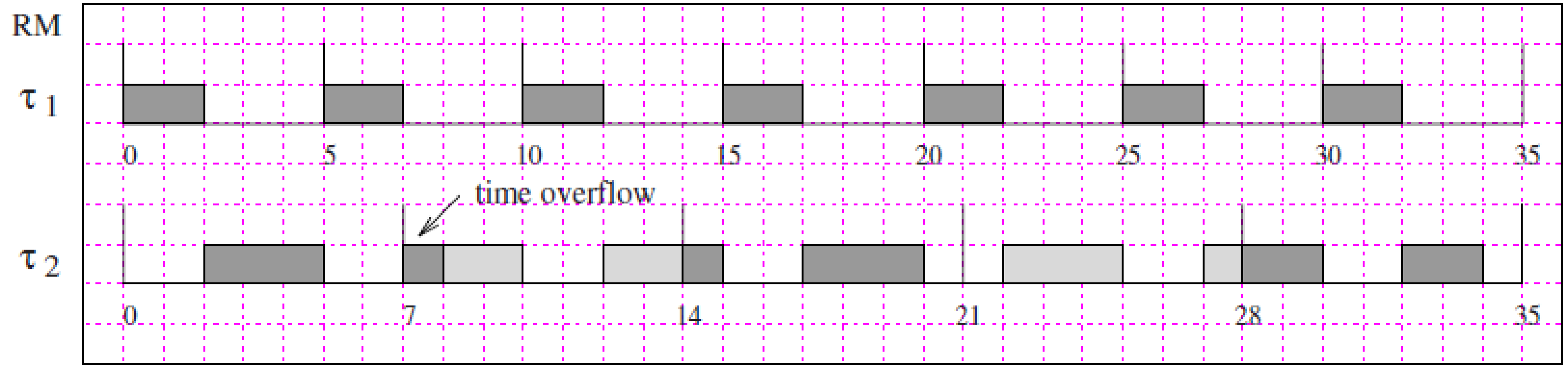
Processor utilization upper bound $U_{max} = n(2^{1/n} - 1) = 0.83$

$U > U_{max}$ ➔ The task set **may not be RM schedulable**

Lets check !!

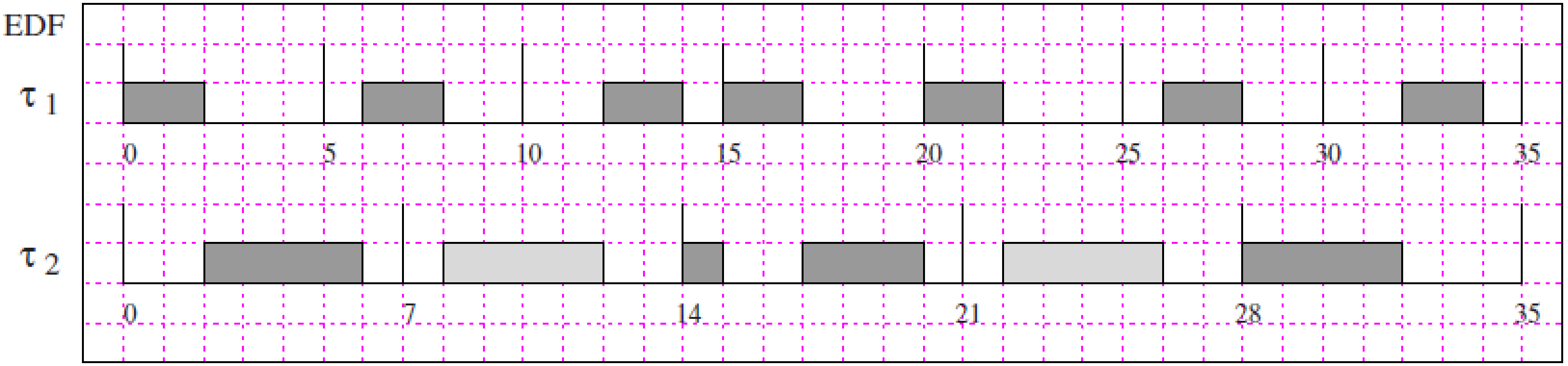
Real Time Scheduling: Earliest Deadline First (EDF)

Hyper-period = lcm (5, 7) = 35



(a)

Tasks	C_i	T_i
τ_1	2	5
τ_2	4	7



(b)

Exercise - 1

Q. Check if the following task set is RM schedulable? If not, is it EDF schedulable?

Tasks	Execution Time	Period
T1	20	100
T2	30	150
T3	90	200

Real Time Scheduling

Q. Check if the following task set is RM schedulable?

Tasks	Execution Time	Period
T1	20	100
T2	30	150
T3	90	200

Ans.

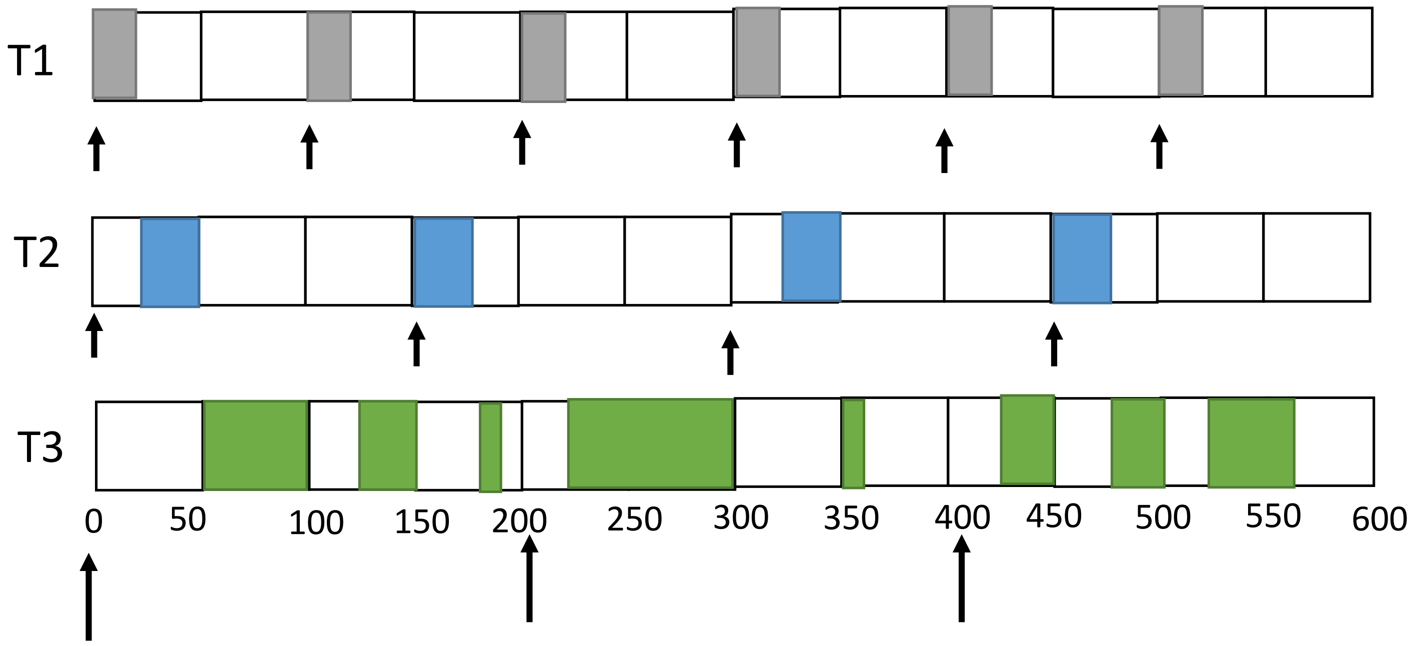
Utilization (U) = 20/100 + 30/150 + 90/200 = 0.85

Processor utilization upper bound $U_{max} = n(2^{1/n} - 1) = 0.78$

$U > U_{max}$ ➔ RM schedulable may not be feasible

Real Time Scheduling

Hyper-period = LCM(100,150,200) = 600



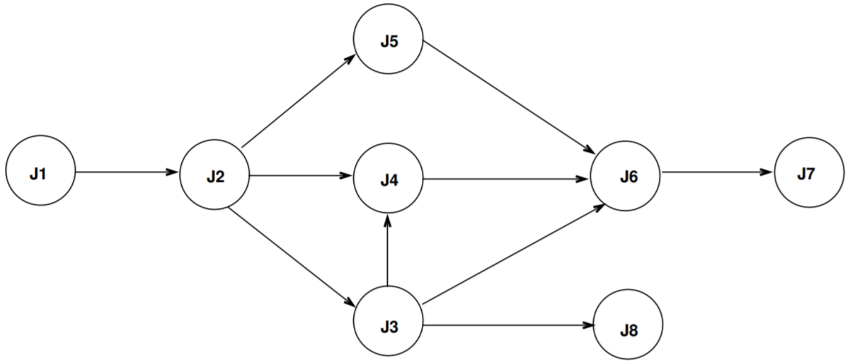
Tasks	Execution Time	Period
T1	20	100
T2	30	150
T3	90	200

RM Schedule: $T1^1$ $T2^1$ $T3^1$ $T1^2$ $T3^1$ $T2^2$ $T3^1$ $T1^3$ $T3^2$ $T1^4$ $T2^3$ $T3^2$ $T1^5$ $T3^3$ $T2^4$ $T3^3$ $T1^6$ $T3^3$

LDF Scheduling

Given the precedence graph in following figure and the following table of task execution times (C_i) and deadlines (D_i), determine a Latest Deadline First (LDF) schedule.

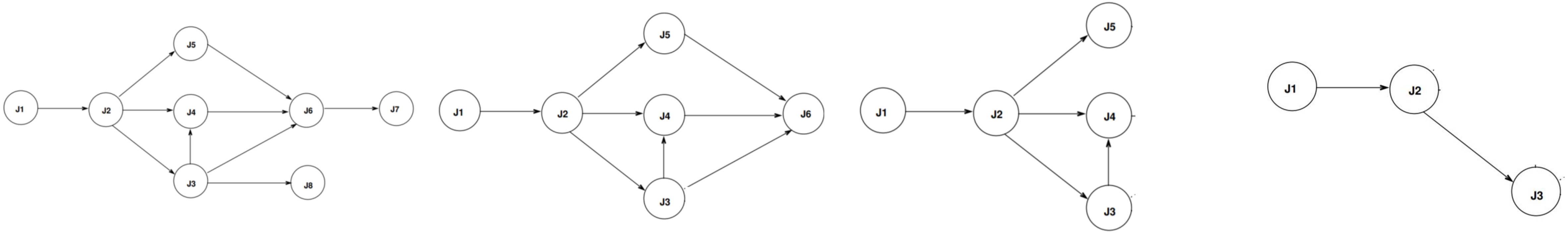
	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_i	3	4	2	3	3	2	2	1
D_i	5	8	11	15	12	18	19	20



Schedule: J_1 J_2 J_3 J_5 J_4 J_6 J_7 J_8

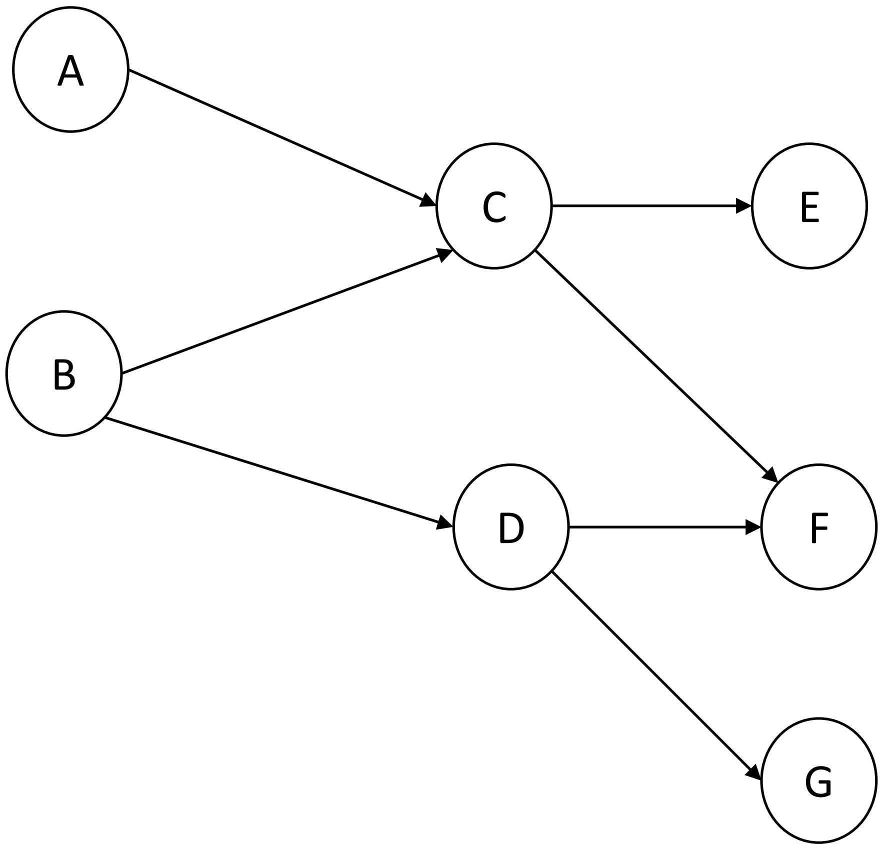
LDF Scheduling

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_i	3	4	2	3	3	2	2	1
D_i	5	8	11	15	12	18	19	20



Schedule: J_1 J_2 J_3 J_5 J_4 J_6 J_7 J_8

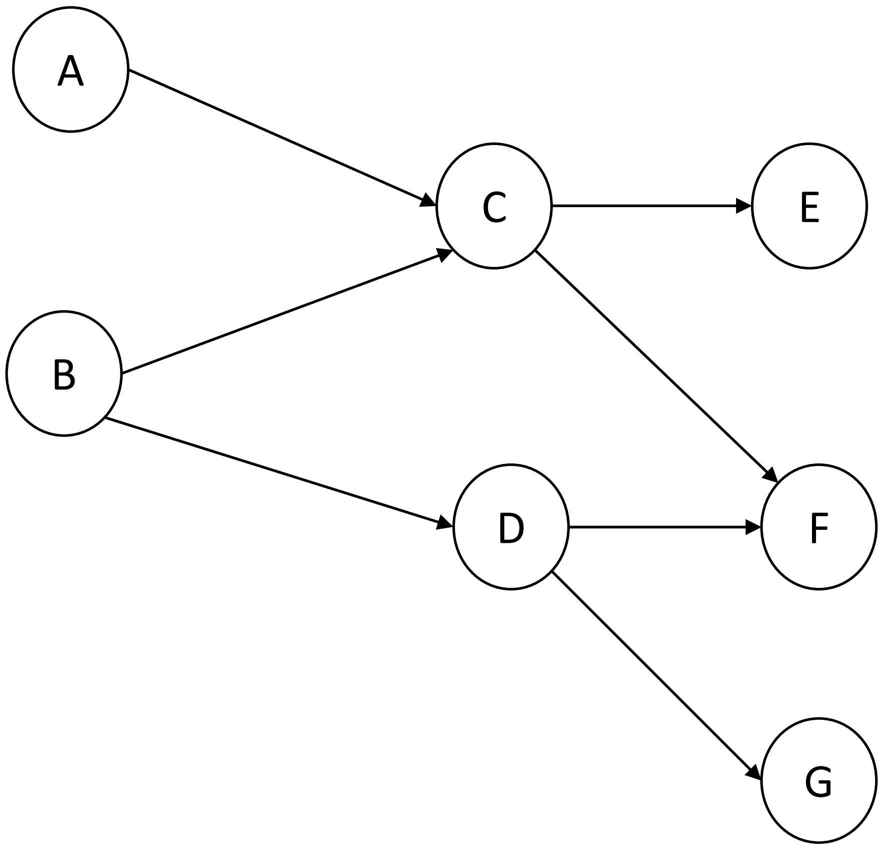
EDF* Scheduling



All tasks arrive at t=0. They all have deadline d=20. Their execution times are given below. Determine the EDF* schedule.

	A	B	C	D	E	F	G
C_i	3	2	4	3	2	5	1

EDF* Scheduling



	A	B	C	D	E	F	G
C_i	3	2	4	3	2	5	1

$$d'_i = \min(d_i, \min_{j \in D(i)} (d'_j - e_j)) \, .$$

$d'_E = 20$
$d'_F = 20$
$d'_G = 20$
$d'_C =$ min(20, 20-2,20-5) =15
$d'_D =$ min(20, 20-5,20-1) =15
$d'_B =$ min(20, 15-4,15-3) =11
$d'_A =$ min(20, 15-4) =11

EDF* schedule: A,B,C,D,E,F,G

Exercise – 2

Q. Consider two tasks to be scheduled periodically on a single processor using Rate Monotonic (RM) scheduling policy. Task T1 has periodicity $p1 = 4$ and task T2 has periodicity $p2 = 6$. If execution time of T1 is $e1 = 1$

a. what will the execution time of T2 to get a near maximum processor utilization?

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Sol. $\frac{e1}{p1} + \frac{e2}{p2} \leq 1 \Rightarrow \frac{1}{4} + \frac{e2}{6} \leq 1 \Rightarrow e2 \leq 4.5$
If e2 = 4.5 => Not RM schedulable (Check)
If e2 = 4 => RM schedulable

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a. **What will the execution time of T2 to get a near maximum processor utilization?**
b. **Considering context switch overhead as 0.2 time units, comment on how it will affect the schedule**

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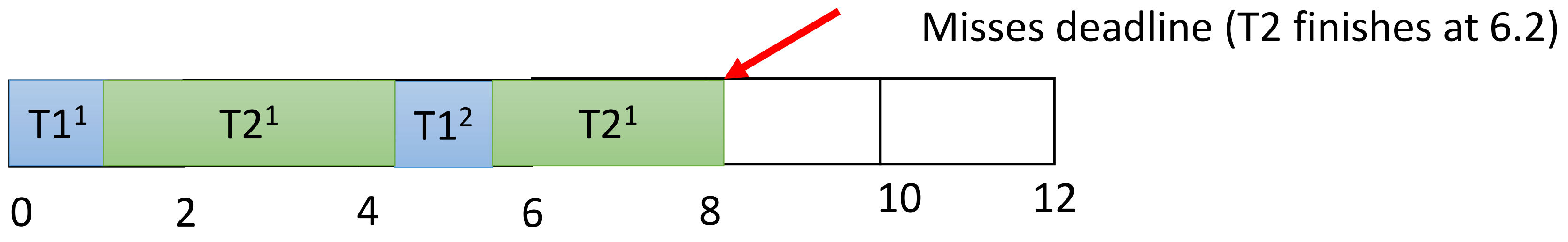
Sol. Not RM schedulable



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c. **Had we used Earliest Deadline First (EDF) scheduling policy instead of RM with the same set-up, how would context switch have affected the schedule?**

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b. Considering context switch overhead as 0.2 time units, comment on how it will affect the schedule

c. Had we used Earliest Deadline First (EDF) scheduling policy instead of RM with the same set-up, how would context switch have affected the schedule?

Sol. EDF schedulable