Problem

One control task J_c and two tasks J_1 and J_2 are executed on a preemptive CPU. The tasks have the release time zero and the following characteristics:

Task	T_i	D_i	C_i
J_1	3	3	1
J_2	4	4	1
J_c	8	8	3

(a) Determine the utilization factor and the schedule length? **[2p]**

(b) Are the tasks J_1, J_2 and J_c schedulable under earliest deadline first (EDF) scheduling algorithm? What is the worst case response time for J_1, J_2 and J_c **[4p]**

(c) Are the tasks J_1, J_2 and J_c schedulable under rate monotonic (RM) scheduling? What is the worst case response time for J_1, J_2 and J_c. **[4p]**

Hint: $2^{1/3} = 1.26$.

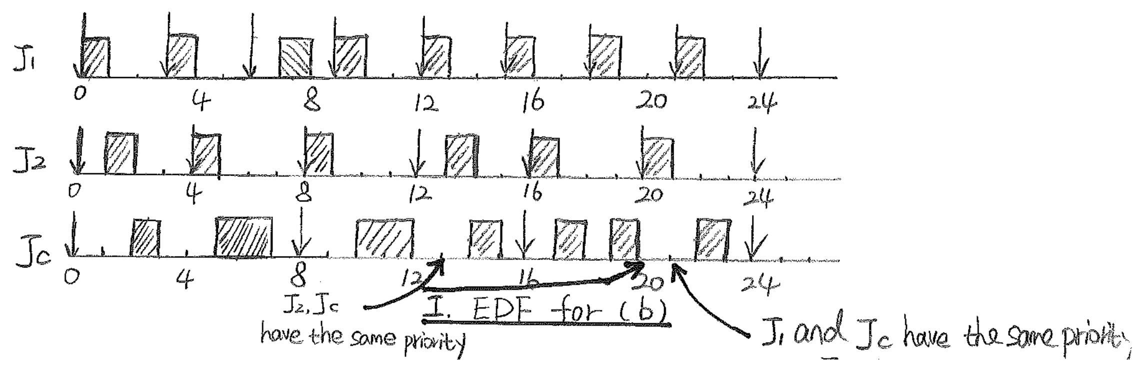
Solution

(a) The utilization factor is determined by

$$U = \sum_{i=1}^{3} \frac{C_i}{T_i} = \frac{1}{3} + \frac{1}{4} + \frac{3}{8} \approx 0.96.$$

The schedule length is $lcm(3, 4, 8) = 24$.

(b) Tasks J_1, J_2 and J_c are schedulable by EDF as the utilization factor 0.96 is less than 1. *Worst-case response time* for a task is the largest time between release and termination. For EDF, it can only be determined by drawing the corresponding schedule:



The worst response time for J_1, J_2 and J_c are 2, 2 and 7.

(c) Since the utilization factor is higher than $3(2^{1/3} - 1) = 0.78$, we cannot conclude if the tasks are schedulable by RM. Let the worst-case response time of J_1, J_2 and J_c be denoted R_1, R_2 and R_c. The fixed priority is assigned that J_1 has the highest priority, J_2 medium priority and J_c lowest priority.

For task J_1, $R_1 = C_1 = 1 \le D_1 = 3$.

For task J_2,

$$R_2^0 = C_2 = 1$$
$$R_2^1 = C_2 + [\frac{R_2^0}{T_1}]C_1 = 1 + [\frac{1}{3}]1 = 2$$
$$R_2^2 = C_2 + [\frac{R_2^1}{T_1}]C_1 = 1 + [\frac{2}{3}]1 = 2 \le D_2 = 4$$

For task J_c,

$$
\begin{aligned}
R_c^0 &= C_c = 3 \\
R_c^1 &= C_c + [\frac{R_c^0}{T_1}]C_1 + [\frac{R_c^0}{T_2}]C_2 = 3 + [\frac{3}{3}]1 + [\frac{3}{4}]1 = 5 \\
R_c^2 &= C_c + [\frac{R_c^1}{T_1}]C_1 + [\frac{R_c^1}{T_2}]C_2 = 3 + [\frac{5}{3}]1 + [\frac{5}{4}]1 = 7 \\
R_c^3 &= C_c + [\frac{R_c^2}{T_1}]C_1 + [\frac{R_c^2}{T_2}]C_2 = 3 + [\frac{7}{3}]1 + [\frac{7}{4}]1 = 8 \\
R_c^4 &= C_c + [\frac{R_c^3}{T_1}]C_1 + [\frac{R_c^3}{T_2}]C_2 = 3 + [\frac{8}{3}]1 + [\frac{8}{4}]1 = 8 \leq D_c = 8.
\end{aligned}
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Thus the three tasks are schedulable with rate monotonic, as the worst response time $R_1 = 1 \leq D_1$, $R_2 = 2 \leq D_2$, and $R_c = 8 \leq D_c$. It can also be verified by the schedule below: