1. **(25 points) Cyclic executive design**: NASA has sent you an urgent call to redesign one of Mars Curiosity rover's modules that has stopped taking commands from NASA command headquarters. Scientists working on the project have redesigned the tasks and have the following specification for the three periodic tasks that run on the module. The task set is shown below: {t: task, r: arrival time, e: execution time, p: period, D: deadline}. Design a clock-driven cyclic schedule: (i) determine the hyper-period (ii) determine the frame size, (iii) provide a timing chart and (iv) provide a cyclic (executive) schedule pseudo code. Show all the formal expressions (rules) used in the design. (Validation for D is not necessary since Pi = Di).

ti	ri	ei	pi	Di
t1	0	2	4	4
t2	0	1	12	12
t3	0	1	6	6

Cyclic executive:

BMW 7 series ECU

Design a cyclic executive given the task table.

Step 1: $\sum \frac{e_i}{p_i} \leq 1$ Utilization rule

$\sum \frac{e_1}{p_1} + \frac{e_2}{p_2} + \frac{e_3}{p_3} = \frac{2}{4} + \frac{1}{12} + 1/6$

$= 0.5 + 0.08 + 0.13$

$= 0.71 \leq 1$ ✓

Step 2: Calc. hyperperiod

formula: $lcm(p_i) = lcm(4, 6, 12) = 12$

largest common multiple

Step 3: frame size $\geq \max(e_i) \geq \max(2, 1, 1)$

frame size of 2. ~~frame size~~ $= 2, 3, 4, 5 \ldots$

× Step 4: $2f - \gcd(f, P_i) \leq D_i$ when $p_i = D_i$

Step 5: draw the time chart.

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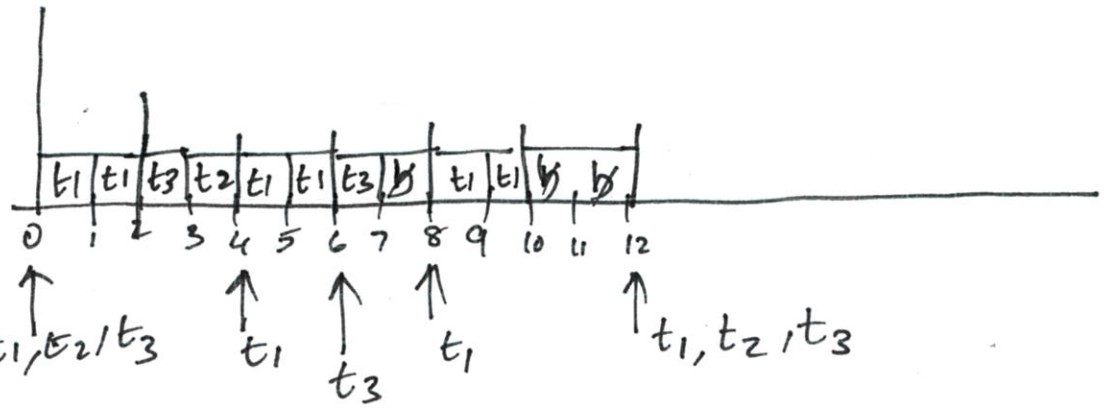

(1) ⟷ hyper period

(2) frame size

(3) note the arrival of tasks on the chart

(4) draw the schedule on the chart. (-5)

(5) write the cyclic schedule

```
{
  {t1, t1}
  {t2, t2}
  {t1, t1}
   {t3, b}
    {t1, t1}
     {b, b}
}
```

demos ⟵ Table of function pointers
scheduler in the main function
for loop .. for loop