Sufficient Real-Time Analysis for an Engine Control Unit
Time Triggered Tasks

- Fixed Period \( p \)

- Fixed Deadline \( d \)

Engine Triggered Tasks

Task A

Deadline Task A

Task A

0°  180°  360°  540°  Angle[°]
Engine Triggered Tasks

![Diagram showing Engine Triggered Tasks]

- Tasks A, B, and C are illustrated in a circular diagram.
- Task B is represented at specific angles: 90°, 270°, and 450°.
- Task C is represented at specific angles: 45°, 135°, 180°, 405°, 495°, and 540°.

These tasks are triggered at the indicated angles.
**Variant Execution Time**

```c
TASK(Variant_execution)()
{
    f1();
    if(rpm < 3000) {
        f2();
    }
    f3();
}
```

**Influence of Engine Speed**

*Engine Speed = 1500 rpm*

*Engine Speed = 3000 rpm*
Influence of Engine Speed

Engine Speed => Occurrence of Events

Engine Speed => Deadline

Engine Speed => WCET

Response-Time Analysis

\[ \sum = 2 \]

Task A

Task B

\[ \Delta t \]

high priority

low priority
Influence of Acceleration

Starting at engine speed 1200 rpm

With acceleration \( a = 167 \frac{r}{s^2} \)

Range of Engine Speed

\( d^-(\omega_s) \)
\( r^+ (\omega_s) \)

\( \omega_s \quad \omega_s \quad \omega_s \quad \omega_s \)

\( \omega_{min} \quad \omega_{max} \)
**Deadline**

\[ \omega_s = 1200 \text{ rpm} \]

\[ \frac{1}{2} \cdot a \cdot t^2 + \omega_s \cdot t = \frac{1}{2} \implies t \approx 22.8 \text{ ms} \]

**Number of Events**

- number of rotations:
  \[ \rho(\Delta t, a, \omega_s) = \frac{1}{2} \cdot a \cdot \Delta t^2 + \omega_s \cdot \Delta t \]

- number of events:
  \[ \eta(\Delta t, a, \omega_s) = [\rho(\Delta t, a, \omega_s)] \]

  \[ \eta(\Delta t, a, \omega_s) = [2 \cdot \rho(\Delta t, a, \omega_s)] \]
Camshaft Task

Execution Time
**Execution Time**

\[ WCET(\omega_s) \]

Engine Speed [rpm]

**Range of Engine Speed**

\[ d^-(\omega_s) \]
\[ r^+(\omega_s) \]

\[ \omega_{min} \]
\[ \omega_{max} \]

engine speed [rpm]
Quantisation

Results

![Graph showing engine speed and task ratio](image)