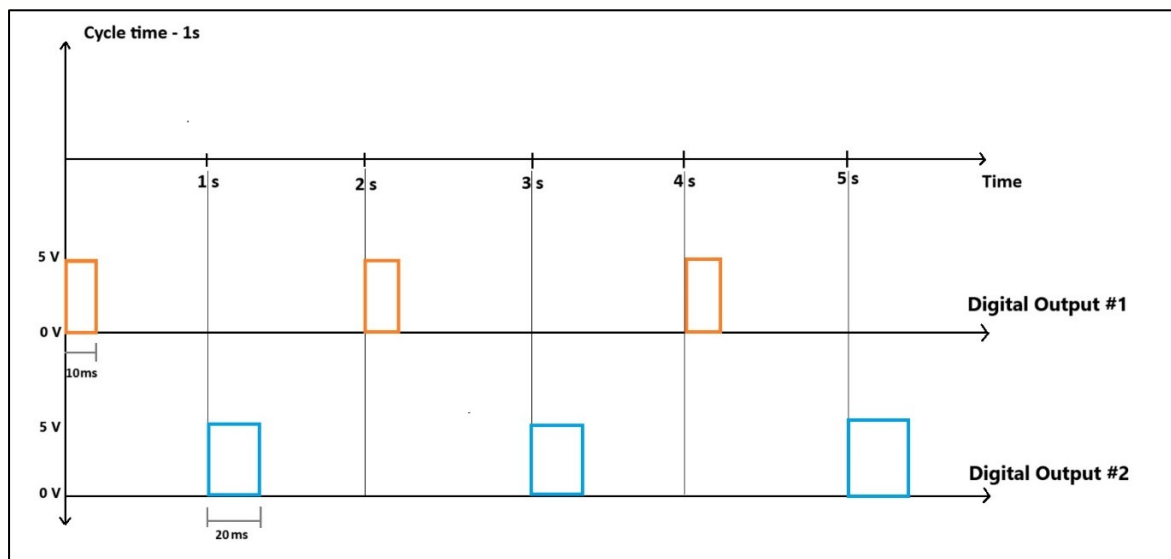


Problem Statements

1. Generate a periodic interrupt of 1ms duration with Arduino. There should be two digital outputs #1 and #2 in Arduino. The digital output #1 when enabled must be HIGH for 10ms and turn off. The digital output #2 must be enabled 20ms and turn off in a similar fashion. The interrupt service routine should have a condition to check when 1 second is elapsed. Every 1 second the digital outputs should alternate in producing signals. Refer picture for clarity.



2. Determine the time period and frequency of a square wave pulse (50 percent duty cycle) using input capture mode of timer in Arduino.
3. Determine the RPM of crank shaft position sensor by measuring the period of missing teeth signal with the above input capture mode method. The Trigger wheel has a 24-2 tooth pattern. Image below is just for representation.



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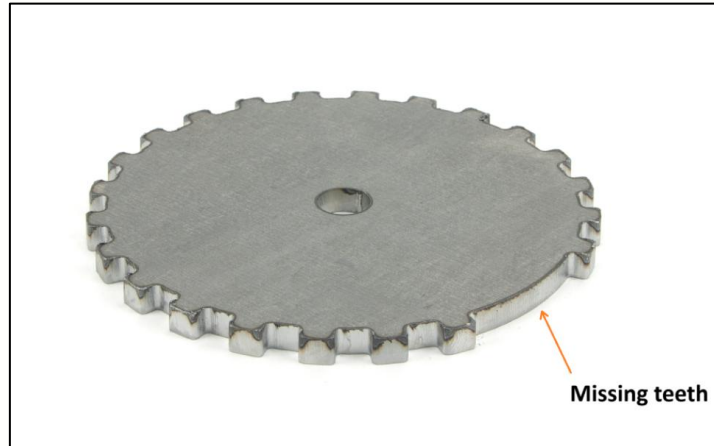
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4. Determine the Pressure in the intake manifold. The transfer function of a T-Map sensor is given below. Use ADC pin to read the voltage and determine the mapped pressure value.

Transfer function of pressure sensor

$$U_{out} = (c_1 \cdot P_{abs} + c_0) \times U_s$$

Where,

U_{out} = signal output voltage in V

U_s = supply voltage in V, take as 5V

p_{abs} = absolute pressure in kPa

c_0 = -0.1/105

c_1 = 0.85/105 kPa⁻¹

The operating range of sensor is 0.5 and 4.5V. Write an Arduino code to read sensor value and display matched pressure value.

- 1.) Use fixed-point representation for storing voltage and pressure values to a precision of 1-digit. Example - XX.X can be represented as XXX in integer and stored in a variable. You are allowed to use float variables to check your derived formula to see if it works, but the final code should have fixed datatype.

5. A 4-cylinder, 1000 cc engine operates at 3000 RPM with a manifold pressure of 50 kPa absolute. The engine's volumetric efficiency is 80%.
1. Calculate the engine's air intake rate (in L/min).
 2. The engine runs on a 14.7:1 air-fuel ratio for stoichiometric combustion. Calculate the required fuel flow rate in cc/min.
 3. The available injector is rated at 180 cc/min. Calculate the estimated injector duty cycle.
 4. Suppose the engine experiences hesitation during acceleration. Identify one possible cause based on your calculations and recommend a solution.

Additional Details for Step 4:

- Assume the engine's intake temperature is 35°C, and air density is approximately 1.15 kg/m³.
 - Consider factors like injector sizing, pulse width limits, and fuel delivery timing.
6. A 4-stroke, single-cylinder engine operates at 1500 RPM. The engine's crankshaft has a sensor that generates one pulse for every 10 degrees of crankshaft rotation.
1. Calculate the time taken (in milliseconds) for one complete revolution of the crankshaft.
 2. Determine the time interval (in milliseconds) between two consecutive pulses generated by the crankshaft sensor.
 3. During testing, the sensor occasionally skips a pulse, causing ignition timing errors. Suggest a practical method to identify this issue using basic electronic components or coding logic (e.g., Arduino/MCU-based solution).

Assumptions:

- The engine follows the 720° crank angle cycle for a complete 4-stroke cycle.
- Assume the RPM remains constant during the calculation.



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