Automotive Fundamentals & Electronic Engine Control Evolution of Automotive Electronics

- Electronics began with emission and fuel economy regulations in 1970s
- Enabled better control, reliability, and diagnostics

- Applications: Engine control, motion control, infotainment, safety, etc.
- Now ~20% of vehicle cost

Physical Configuration of Automobiles

- Traditional chassis + body layout
- Front engine, rear-wheel drive; now frontwheel drive is common

Subsystems: Engine, drivetrain, suspension, brakes, steering, etc.

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Major Automotive Systems Overview

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- Drivetrain: Transmission, differential, axle
- Engine
- Suspension

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- Steering
- Brakes
- Instrumentation
  Electrical/Electronic
- Motion Control, Safety
- Comfort, Navigation, Entertainment

Internal Combustion Engine Components

- Engine block, cylinder, pistons, crankshaft

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- Cylinder head with intake/exhaust valves
- Connecting rods, camshaft, rocker arms

Four-Stroke Cycle

- 1. Intake: Air-fuel mix enters
- 2. Compression: Mix compressed
- 3. Power: Spark ignites mix
- 4. Exhaust: Burnt gases expelled

Engine Control System

- Driver uses accelerator → controls throttle plate
- Throttle regulates air intake
- ECU adjusts fuel injectors & ignition for emissions & performance

Ignition System Basics

- Spark plug initiates combustion
- High-voltage coil generates spark (20-40kV)
- Distributor routes spark to correct cylinder
- Timing is critical for efficiency

Diesel Engine Notes

- Compression-ignition (CI) engine
- No spark plug; uses heat of compression
- Electronic control for injection timing, emissions

Drive Train Overview

- Transmission: Gear ratios
- Drive shaft: Transfers torque
- Differential: Allows wheel speed variation in turns

Suspension, Brakes, Steering

- Suspension: Springs & dampers absorb shocks
- Brakes: Disc/drum; ABS integration
- Steering: Mechanical or power-assisted

Starter Battery Operating Principle

- Converts chemical energy to electrical
- Powers starter motor & electronics
- Rechargeable (usually lead-acid)

Basics of Electronic Engine Control

- Motivated by need to reduce emissions & increase fuel economy
- Engine control integrates: air/fuel ratio, spark timing, EGR
- Combines sensors, ECU, actuators

Control System Block Diagram

- Inputs: Sensors (MAP, TPS, O2, RPM, etc.)
- Controller: ECU with algorithms & memory
- Outputs: Injector pulse width, ignition timing, EGR control

Engine Performance Terms

- Torque: Rotational force
- Power: Rate of energy conversion
- Air-Fuel Ratio: Stoichiometric ~14.7:1
- EGR: Reduces NOx

Engine Mapping and Strategies

- Mapping defines control parameters for different operating points
- Maps: ignition timing, fuel delivery, boost pressure, etc.
- Strategies optimize performance, emissions, and economy

Electronic Fuel Control System

- Fuel injectors electronically actuated
- Pulse width determines fuel volume
- Feedback via Lambda (O2) sensor

Intake Manifold Pressure Analysis

- Manifold Absolute Pressure (MAP) indicates engine load
- Helps determine fuel requirement & spark timing

Electronic Ignition System

- Replaces mechanical distributor
- Precise spark timing control
- Components: Crank/Cam sensors, Ignition coil, ECU

Summary

- Electronics have revolutionized vehicle design
- Engine control is critical for emissions & efficiency
- Integration of sensors, ECU, and actuators is essential

References

- Textbook 1: William B. Ribbens, "Understanding Automotive Electronics"
- Textbook 2: Bosch, "Automotive Electrics and Automotive Electronics"