COURSE

AUTOTRONICS

Prepared by

Dr. S. Vijaya Bhaskar
Assistant Professor

DEPARTMENT OF MECHANICAL ENGINEERING

SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA

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Enathur, Kanchipuram – 631 561

Name of the Course**:** **Autotronics**

Name of the Unit **:** **Introduction - Autotronics**

Name of the Topic **:** **Automotive Electronics**

AUTOTRONICS

AIM & OBJECTIVE

- To make the students understand the evolution of electronics in automobiles and basics of charging and starting system
- To provide student with knowledge on ignition and injection systems
- To make the students learn about various sensors and actuators for controlling engine parameters
- To acquaint students with various engine control systems.
- To teach the students about various chassis and safety system operation and applications

PRE-TEST

a) A transducer is basically a device which converts
(a) mechanical energy into electrical
(b) energy or information from one form to another
(c) mechanical displacement into electrical
(d) none of these

b) Q.116.The principle of operation of LVDT is based on variation of
(a) self-inductance
(b) **mutual inductance**
(c) reluctance
(d) permeance

c) **The capacity of a battery is usually expressed in terms of**
(a) Volts
(b) Amperes
(c) Weight
(d) **Ampere hours**

d) The most commonly used power plant in automobiles is
(a) Gas turbine
(b) **I.C. engine**
(c) Battery
(d) None of these

e) In a petrol engine, the high voltage for spark plug is in the order of
(a) 1000 volts

(b) 2000 volts
(c) 11 kilovolts
(d) 22 kilovolts

f) Q.126.Which of the following devices cannot be used for measurement of temperature?
(a) RTD
(b) Thermocouple
(c) LVDT
(d) Pyrometer

g) The starter motor is driven by
(a) Chain drive
(b) Gear drive
(c) Flat belt drive
(d) V-belt drive

h) The major purpose of an electronically controlled automatic transmission is that this type of transmission
(a) Eliminates gear clutches
(b) Eliminates the gear shaft lever
(c) Reduces the number of automatic transmission components
(d) Reduces shift shock and achieves more efficient transmission of engine torque

i) The main task of a battery in automobiles is to
(a) Supply electricity to the alternator
(b) Act as a reservoir or stabilizer of electricity
(c) Supply electricity to the vehicle's electrical system at all times while the engine is running
(d) Supply a large amount of power to turn the starter motor when the engine is being started

j) The ignition coil is used to
(a) Step up current
(b) Step down current
(c) Step up voltage
(d) Step down voltage

PREREQUISITES

- Basic Automobile Engineering
- Basic Electronics Engineering

THEORY BEHIND

SYLLABUS: **AUTOTRONICS**

UNIT – I : INTRODUCTION

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT – II : IGNITION AND INJECTION SYSTEMS

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT – III : SENSOR AND ACTUATORS

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

UNIT – IV : ENGINE CONTROL SYSTEMS

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU‟s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

UNIT – V : CHASSIS AND SAFETY SYSTEMS

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars

INTRODUCTION - AUTOTRONICS

The Autotronics is referred as the modern automotive technology and also commonly known as Automotive Mechatronics. Autotronics is the combination of automobile and electronics. Also, the use of electronics science in automobile

vehicles is called autotronics. The use of electronics in the automobile field makes the system safe, improved and efficient. In a vehicle almost all significant parts are featured with electronic items.

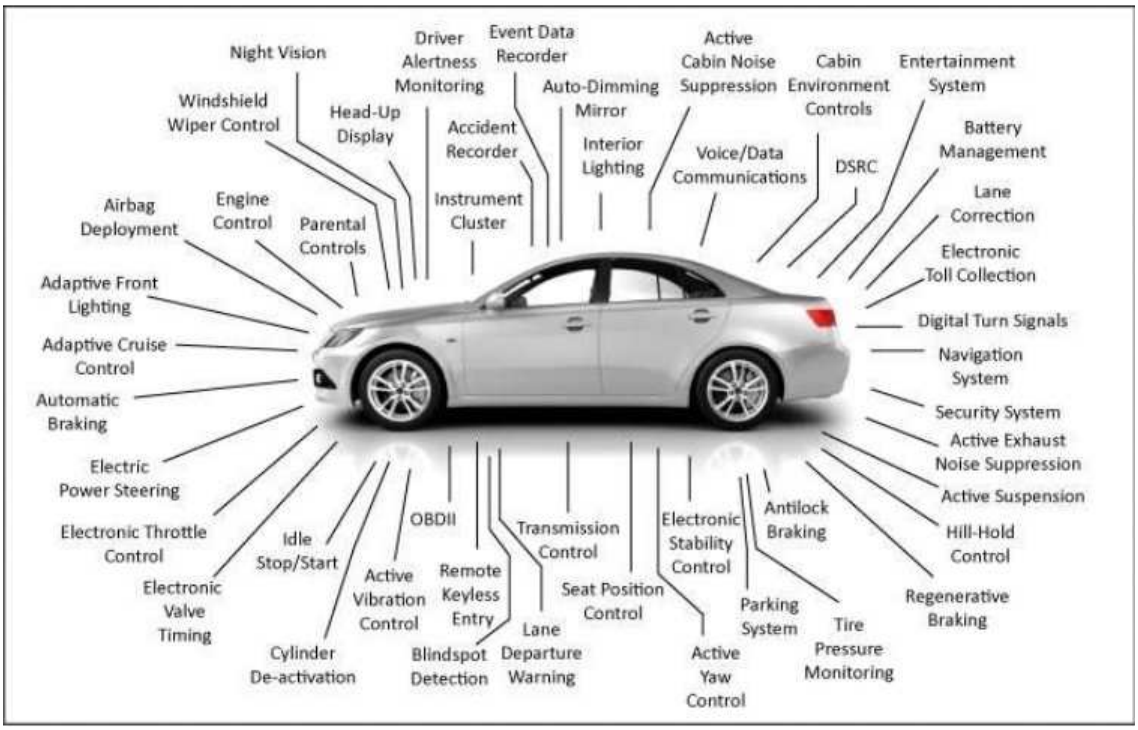

Figure 1: Automotive electronics in modern passenger car

Today's vehicles contain many electronically controlled and operated systems; and the number of systems controlled and operated electronically increases every year. Electronics have enabled manufacturers to design and produce vehicles that offer:

- improved fuel economy.
- lower emission outputs.
- improved powertrain performance (for example, easier cold starts and smoother acceleration).
- improved steering and suspension systems.
- more accurate driving and vehicle information systems.
- improved safety devices.
- increased operator comfort.

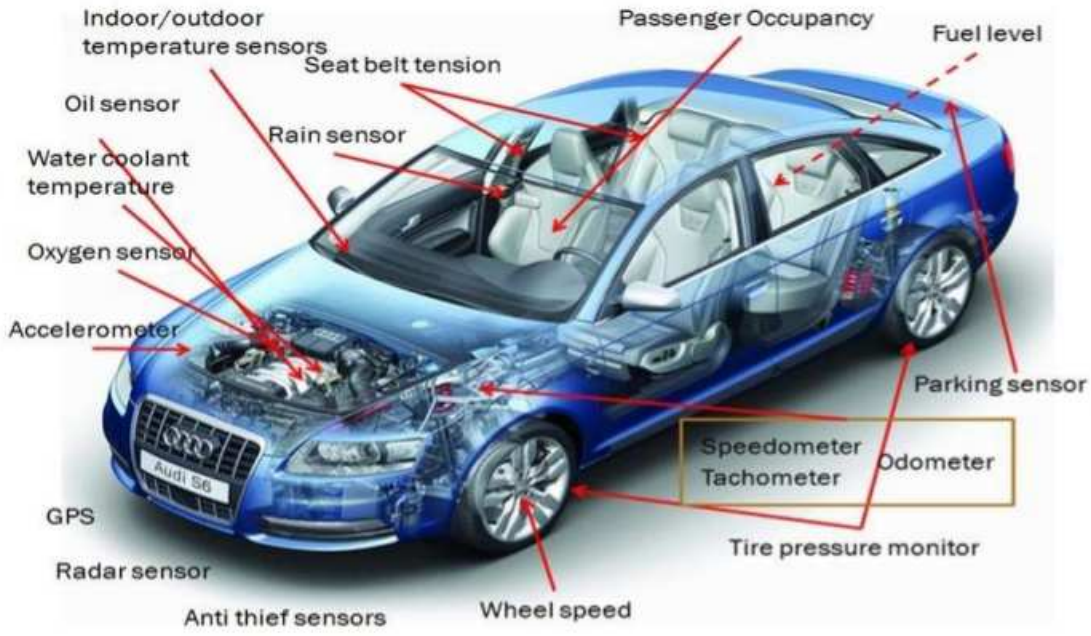

Figure 2: Sensors used in passenger car

At present, in the new generation automobiles almost 75%-85% of automobile parts are embedded with electronics system. The main areas of automobiles using autotronics are engine controlling system, airbags, antilock braking system, lightening interiors, GPS, music systems etc. The application area of autotronics is very vast, brakes, steering system, engine controlling unit, transmission and suspension in the vehicles are the main phases where autotronics are used.

EVOLUTION OF AUTOMOTIVE ELECTRONICS

Electronics have been relatively slow in coming to the automobile primarily because of the relationship between the added cost and the benefits. Historically, the first electronics (other than radio) were introduced into the commercial automobile during the late 1950s and early 1960s. However, these features were not well received by customers, so they were discontinued from production automobiles. Two major events occurred during the 1970s that started the trend toward the use of modern electronics in the automobile:

(2) the introduction of government regulations for exhaust emissions and fuel economy, which required better control of the engine than was possible with the methods being used; and

(3) the development of relatively low cost per function solid-state digital electronics that could be used for engine control and other applications.

Trends in automotive systems

	CAR Technology	**TRAFFIC**	**DRIVER SKILLS**
> 1891	mechanical system	very low	very high technical skills
> 1920	+ pneumatic systems + hydraulic systems	low	high technical skills low driving skills
> 1950	+ electric systems	increasing	good technical skills increasing driving skills
> 1980	+ electronic systems + optronic systems	Congestion starts	low technical skills high driving skills
> 2010	+ micro-electronics + biotronic systems	Congested optimization starts	very low technical skills decreasing driving skills
> 2040	+ robotics + nanotechnology	maximal and optimized	no technical skills no driving skills

Why is advancement in automotive systems important?

- The century-old automobile – the preferred mode for personal mobility throughout the developed world – is rapidly becoming a complex electromechanical system. (Google – “Autotronics”).
- Technologies are being added to automobiles to improve operational safety, reduce congestion and energy consumption, and minimize environmental impact.
- There is a huge demand for safer, smarter & energy-efficient transportation system.
- Automotive electronics plays a crucial role for realization of these mechatronic systems. Examples include hybrid powertrains, electronic

engine and transmission, controls, cruise control, antilock brakes, differential braking, and active/semi-active, suspensions.

Timeline of automotive electronics

This evolution (some might say “revolution”) of automotive electronics also is enabled by recent advances in relevant technologies, including solid-state electronics, computer technology, and control theory.

Year	Examples of automotive electronics available
1965	Solid-state radio, alternator rectifier
1970	Speed control
1975	Electronic ignition, digital clock
1980	Electronic voltage regulator, electronic engine controller, electronic instrument cluster, electronic fuel injection
1985	Clock integrated with radio, audio graphic equalizer, electronic air suspension
1990	Antilock brakes. integrated engine and speed control, cellular phones, power doors and windows
1995	Navigation systems. advanced entertainment / information systems, active suspensions
2000	Collision avoidance, autonomous cruise control, vehicle stability enhancement, CVT
2005	Hybrid electric vehicles. driver monitoring. drive-by-wire, integrated vehicle controls
2010	Driver-assist systems (e.g.. automated parallel parking). integrated telematics (i.e..location-aware vehicles via mobile devices), plug-in hybrid electric vehicles

APPLICATIONS:

Electronics are being used now in the automobile and probably will be used even more in the future. Some of the present and potential applications for electronics are

1. Electronic engine control for minimizing exhaust emissions and maximizing fuel economy
2. Instrumentation for measuring vehicle performance parameters and for diagnosis of on-board system malfunctions
3. Driveline control

4. Vehicle motion control
5. Safety and convenience
6. Entertainment/communication/navigation

The various systems are given below

1. Autotronic braking system/Electronic braking system

The braking system in such a system is denoted s EBS (electronic braking system). A braking system is defined by its stopping distance. The system with shortest stopping distance is considered the best braking system. So, the development phase in the braking system is to minimize the stopping distance of vehicle but without compromising the safety.

The ECB solve these purposes with an advance control system. The anti-lock braking system and traction control system are the essential components of ECB. ABS is responsible for maneuver control by deciding the braking pressure and wheel rotation control. Traction means providing movement or acceleration to a vehicle. So, to control the acceleration, the control on traction system should be applied. This system controls the movement of wheel and its steadiness.

2. Control of steering system

In the vehicle the power steering system is used. Which maintains the communication between pressure applied by steering system on the hydraulic pump and the speed of the automobile.

The EPS (electric power steering) uses sensors and motors, which controls the manoeuvre. Motor controls the steering motions and sensors gives signal to the wheels by analysing the speed and torque.

3. Suspension system

Suspension system makes the ride on vehicle shock free, comfortable and safe. There are three types of suspension system 1. Passive, 2. Semi active, and 3. Active suspension system.

The important task of the system is to dissipate the heat produced in the system due to friction. The conventional method of suspension is called passive suspension and

when we add electronic sensors and hydraulic system then its performance increases and it is called active suspension system.

4. Transmission control

The transmission of gearing system controls the shifting of gears. Using the electronic gear transmission improves the shifting operation and increases the fuel efficiency by reducing the losses.

5. Electronic control of fuel intake in engine

The electronic system used to analyze the amount of fuel to supply to the cylinder of engine so that the maximum efficiency can be achieved with minimum loss of energy.

MCQ POST-TEST

1. The starting system includes
   a) A battery, a starter, and an ignition switch
   b) A battery, a distributor, and an ignition switch
   c) A battery, a starter, and a distributor
   d) A distributor, a starter, and an ignition switch

2. The most accurate ignition system of a spark ignition engine is
   a) Magneto system
   b) Battery system
   c) Electronic control unit system
   d) Magneto and electronic system

3. The fuel pump in the programmed fuel injection (PFI) system is located
   a) Between the fuel filler pipe and fuel tank
   b) In the fuel tank
   c) On the distributor mounting in the engine compartment
   d) On the engine compartment bulkhead

4. The fuel pump of a programmed fuel injection (PFI) system operates for two seconds when the ignition is turned to the start position to
   a) Enable the pump's fault diagnosis function to operate
   b) Warm up and lubricate the pump
   c) Supplies a large amount of fuel and thereby creates a choke effect
   d) Pressurise the fuel system before the engine is started

5. . Tachometer in a vehicle measure
   a) Speed

b) Distance
c) Engine r.p.m.
d) Fuel consumption

6. The brake pedal during ABS operation
   a) Is pushed upward forcefully
   b) Pedal stroke becomes longer
   c) Transmits slight kickback to the driver's foot
   d) All of the above

7. Odometer is an instrument used for measurement of
   a) Power
   b) Fuel consumption
   c) Engine r.p.m.
   d) Distance

8. The temperature indicating instrument in vehicles indicates the temperature of
   a) Engine piston
   b) Engine cylinder
   c) Lubricating oil
   d) Jacket cooling water

9. How many cells are used in a 12 volt car battery?
   a) 2
   b) 4
   c) 6
   d) 8

10. The function of anti-lock brake system (ABS) is that is
    a) Reduces the stopping distance
    b) Minimizes the brake fade
    c) Maintains directional control during braking by preventing the wheels from locking
    d) Prevents nose dives during braking and thereby postpones locking of the wheels

CONCLUSION

Upon completion of this course, Students should be able to

- understand the evolution of electronics in automobiles and basics of charging and starting system
- acquire the knowledge on ignition and injection systems
- learn about various sensors and actuators for controlling engine parameters

- understand the operation various engine control systems.
- learn about various chassis and safety system operation and applications

REFERENCES

1. Ribbens, "Understanding Automotive Electronics", 7th Edition, Elsevier, Indian Reprint, 2013.
2. Tom Denton, “Automobile Electrical and Electronics Systems”, Edward Arnold Publishers, 2000.
3. Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 2001.
4. Richard K. Dupuy “Fuel System and Emission controls”, Check Chart Publication, 2000.
5. Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999.

VIDEO LINKS FOR REFERENCE

1. https://youtu.be/c0zl7449pwE
2. https://youtu.be/z94jk49JzCk

ASSIGNMENT

1. Briefly explain ABS and ESC with neat layout
2. Write a case study on the recent advancements in the automotive electronics