TECHNICAL UNIVERSITY "GH. ASACHI" IASI
Faculty of Electronics and Telecommunications
Year of study: V
Specialization: Electronics

Program of study for the course

AUTOMOTIVE ELECTRONICS

Prerequisites: (recommended): Sensors and transducers, Microcontrollers, Physics

Examination:
Oral examination
Exam 75%, lab activity 25%

Course outline:

Semester	No. hours/week				Examination	Total no. hours				Total
	C	S	L	P		C	S	L	P	
9	3	--	2	--	Oral	42	--	28	--	70

Description of the course: To understand the operating principles of vehicles main systems and using the electronic control for better performances, safety and reliability.

Keywords: spark ignition engine, combustion, fuel metering, injection system, lambda sensor, catalytic converter, spark ignition advance, ignition system, braking system, antiskid, airbag, pyrotechnical airbag inflator, squib, pretensioned seat-belt system, crash sensors, accelerometer, air conditioning / heating control, trip computer, cruise control, diesel engine, nozzle, electronic diesel control, in-line pump, distributor-type injection pump, unit injector system, common-rail, particles filter.

Course syllabus:

1. *Spark ignition engine. Principles, characteristics* ……..……..…… 4 hours
Specific terms. Four-stroke engine working. Exchange of gases. Mixture formation system imposed rules. Ignition and combustion processes. Normal combustion in spark ignition engine. Fuel metering. Pollutant emissions, emissions limits.

2. *Control structures for spark ignition engines* ……..…… 1 hour
Classic structures. Closed-loop control systems. Advanced control systems.

3. *Electronic ignition control* ……. 5 hours
Breakerless transistorized ignition. Induction-type generators. Hall-type pulse generators. Electronic switching of primary current of ignition coil. Block diagram of control system. Electronic ignition control circuit. Electronic dwell-angle control. Closed-loop dwell-angle control. Primary current limiting. Switching-off with engine

stopped. Electronic ignition system. Signal processing in the electronic control unit. Knock control.

4. *Electronic fuel injection control in spark ignition engines* ……..…. 5 hours
Overview. Mixture-formation systems. Electronic injection systems. Air supply. Air filters. Superchargers. Intake air control. Electronic idle-speed control. Electronic throttle control (ETC). Electronic boost-pressure control. Exhaust-gas recirculation (EGR). Evaporative-emissions control systems. Variable-length intake manifold. Fuel-supply system. Fuel metering. Adaptation to operating conditions.

5. *Emissions-control technology* …….. 2 hours
Generalities. Combustion process. Exhaust-gas constituents. Lambda closed-loop control. Lambda oxygen sensor. Operation of lambda closed-loop control. Catalytic exhaust treatment. Catalytic converter. Emissions limits in the EC.

6. *Electronic idle-speed control* ……. 1 hour
Overview. Operation of electronic idle-speed control unit. Idle-speed control with electronic throttle control.

7. *Braking control* ……. 4 hours
Introduction. Vehicle braking fundamentals. Tire-to-road interface. Vehicle dynamics during braking. Brake system components. Antilock systems (ABS). Objectives. Antilock components. Antilock control logic fundamentals. Some economics aspects. An example of an ABS system.

8. *Air bag and seat-belt tightener system* ……... 4 hours
Introduction. Components of the system and electronic control unit. The airbag. Warning lamp. Right side seat switch. Pyrotechnical air bag inflator (gas generator). Squib. Crash detection sensors. Electronic control unit. Seat-belt tightener. Operation of seat-belt tightener system. Multipoint electromechanical sensing systems or distributed air bag systems. Single-point electronic sensing systems or central air bag.
Micromachined accelerometers. Overview. Characteristics. Operation. Self-test function. Perspectives of air bag systems.

9. *Cruise control* ……... 1 hour
System's operation. System's using. Components. Actuators. Main switch and warning lamp. "Set" and "Resume" switches. Brake pedal switch. Clutch pedal and automatic transmission switch. Speed sensor. Electronic control unit. An example of cruise control (GM). Structure of control system. Operation of control unit. Considerations on safety. Adaptive cruise control.

10. *Trip computer* ……..….... 1 hour
Trip computer basics. Basic system configurations. A trip computer example from Bosch. Components. Operation. The microcomputer.

11. *Electronic automatic heater* ……... 1 hour
Introduction. Control system structure. Operation. Electronic control unit.

12. *Air conditioner / heater control (HVAC)* ……..3 hours
Introduction. Refrigeration principle. An example of air conditioning system (GM). Cycling electromagnetic clutch system. Refrigerant. Compressor. Condenser. Expansion tube. Evaporator. Accumulator. Cycling pressure switch. Overpressure switch. Electronic control unit. Actuators. Fans.

13. *Electronic controls for Diesel engines*…… 10 hours
Diesel engine. Mixture formation. Direct injection. Divided-chamber combustion systems. Combustion process. Combustion problems and limits. Exhaust emissions. Control of mixture formation. Start of pump delivery and start of injection

(synchronization). Injection time (injection quantity). Discharge intensity. Injection pressure. Direction of injection jet. Multiple-hole nozzle. Air-fuel ratio. Electronic glow-control unit. Glow plug. Flame plug. Preheating system using. Typical glow sequence. Electronic Diesel control system (EDC). Open-loop and closed-loop control. Data processing. Electronic control of in-line fuel-injection pump (PE). In-line control-sleeve injection pump. Nozzles and nozzle holders. Distributor-type injection pump (VE). Unit injectors (PDE) system. Common-rail injection system. Structure of common-rail system. High pressure pump. Rail pressure sensor. Pressure regulation. Injector. Electronic control unit. Exhaust control. Exhaust emissions from diesel engines. Emissions control. Engine measures. Possibilities to reduce pollutant level. Exhaust-gas recirculation (EGR). HDI engine, an example of pollutant problem solving.

Lab syllabus:

1. Main systems of the vehicles. Four-stroke spark ignition engine. Operation. Ignition system. Cooling system – *2 hours*;
2. Main systems of the vehicles. Transmission. Suspension. Brake system. Electrical system – *2 hours*;
3. Compression ignition engine. Characteristics– *2 hours*;
4. Air-supply systems. Turbochargers systems – *2 hours*;
5. Ignition systems (I) – Classic systems – *2 hours*;
6. Ignition systems (II) - Transistorized ignition systems – *2 hours*;
7. Ignition systems (III) - Electronic ignition control. Knock control – *2 hours*;
8. Mono-Jetronic (Bosch) System (I) – Overview. Fuel supply. Data acquisition – *2 hours;*
9. Mono-Jetronic (Bosch) System (II) – Data processing. Electronic control unit (ECU). Fuel injection. Mixture adaptation – *2 hours*;
10. Mono-Jetronic (Bosch) System (III) – Data processing. Lambda closed-loop control. Mixture adaptation. Idle-speed control. Voltage compensation. "Limped home" mode and diagnosis. Injection central unit. Mono-Motronic engine management system – *2 hours*;
11. TDi system (Turbo-Diesel direct injection) (I) – Overview. Injector. Sensors – *2 hours*;
12. TDi system (Turbo-Diesel direct injection) (II) – Actuators. Control systems – *2 hours*;
13. TDi system (Turbo-Diesel direct injection) (III) – Control systems. Diagnosis – *2 hours*;
14. Final discussions – *2 hours.*

References:

1. ARAMĂ, C.; GRÜNWALD, B. — *Motoare cu ardere internă. Procese şi caracteristici,* Editura Tehnică, Bucureşti, 1966;
2. DIMITRIU, L. — *Electronică pentru automobile,* Rotaprint, Universitatea Tehnică "Gh. Asachi" Iaşi, 2003;
3. DIMITRIU, L.; PANTILIMONESCU, FL.; NICULESCU, T. — *Sisteme Electronice de control pentru automobile. Injecţia de benzină şi aprindrea,* Editura Militară, Bucureşti 1995;

4. * * - *BOSCH Automotive Handbook*, Third Edition, Stuttgart, 1993;
5. BONCOI, J; TURCOIU, T; TIME, AL. — *Echipamente de injecţie pentru motoare cu ardere internă,* Editura Tehnică, Bucureşti 1987;
6. ADLER, U. — *BOSCH - Technical Instruction, Electronic Gasoline Fuel Injection System with Lambda Closed-Loop Control MOTRONIC,* Robert Bosch GmbH, Stuttgart 1985, Delta Press Ltd.;
7. ADLER, U. — *BOSCH - Technical Instruction, Electronic Gasoline Fuel Injection System with Lambda Closed-Loop Control L-Jetronic,* Robert Bosch GmbH, Stuttgart 1985, Delta Press Ltd.;
8. ADLER, U.; BAUER, H. — *Engine Electronics. Bosch Technical Instruction,* Robert Bosch GmbH, 1985;
9. ADLER, U.; BAUER, H. — *Pkw-Bremsanlagen. Techniche Unterrichtung,* Robert Bosch GmbH, 1991;
10. ADLER, U.; BAUER, H. — *Schaltzeichen und Schaltplane fur Kraftfahrzeuge. Techniche Unterrichtung,* Robert Bosch GmbH, 1990;
11. ADLER, U.; BAUER, H. — *Generatoren. Techniche Unterrichtung,* Robert Bosch GmbH, 1993;
12. ADLER, U.; BAUER, H. — *Elektronisches Benzineinspritzsystem mit Lambda-Regelung L-Jetronic. Techniche Unterrichtung,* Robert Bosch GmbH, 1985;
13. ADLER, U.; BAUER, H. — *Elektronisches Benzineinspritzsystem mit Lambda-Regelung Mono-Jetronic. Techniche Unterrichtung,* Robert Bosch GmbH, 1991;
14. ADLER, U.; BAUER, H. — *Mechanisch-elektroninisches Benzineinspritzsystem mit Lambda-Regelung KE-Jetronic. Techniche Unterrichtung,* Robert Bosch GmbH, 1985;
15. ADLER, U.; BAUER, H. — *Mechanisches Benzineinspritzsystem mit Lambda-Regelung K-Jetronic. Techniche Unterrichtung,* Robert Bosch GmbH, 1985;
16. ADLER, U.; BAUER, H. — *Elektronik und Mikrocomputer. Techniche Unterrichtung,* Robert Bosch GmbH, 1991;
17. ADLER, U.; BAUER, H. — *Abgastechnik fur Ottomotoren. Techniche Unterrichtung,* Robert Bosch GmbH, 1990;
18. ADLER, U.; BAUER, H. — *Zundkerzen. Techniche Unterrichtung,* Robert Bosch GmbH, 1990;
19. JURGEN RONALD – *Automotive Electronics Handbook*, McGraw-Hill, Inc., New-York, 1995, ISBN 0-07-033189-8.
20. STRATULAT, M.; COPAE, I. — *Alimentarea motoarelor cu aprindere prin scânteie. Scheme comentate de carburatoare, injecţia de benzină şi lemente auxiliare,* Editura Tehnică, Bucureşti, 1992.
21. NEGURESCU, N.; PANĂ, C.; POPA, M.G. – *Motoare cu ardere internă. Procese,* Editura MATRIX ROM, Bucureşti, 1995
22. PANĂ, C.; POPA, M.G.; NEGURESCU, N. – *Motoare cu ardere internă. Cinematică, dinamică, echilibraj,* Editura MATRIX ROM, Bucureşti, 1997