Mechatronic engineering
Complex systems
Mechatronics of vehicles
State exam topics

Group A

A1. Essential sensors used in vehicles
a.) number of revolutions, velocity
b.) temperature, distance, pressure
c.) mass and volume flow rate
d.) acceleration and angular acceleration

I. *Give different examples of temperature measurements in the vehicle system, specify the type of sensor and the standard range of measurements of the application.*
II. *On what principle we can detect acceleration, deceleration on board, and which systems to measure.*
III. *Where and on what principle can we measure pressure in the vehicle in the order of mbar or bar?*

A2. Philosophy and structure of engine control units, their influence on fuel injection

I. *What subsystems do engine controllers work with?*
II. *What operating conditions are regulated?*
III. *What characteristics do you take into account when injecting fuel?*

A3. Central unit: input signals, types, corresponding sensors (impulse, analog…)

I. *Give examples of analog input signals from a control unit (e.g. engine controller).*
II. *Give an example of pulse input signals from a control unit*
III. *Give an example of two-value (switch) input signals from a control unit*

A4. Central unit: output signals.
a.) types, corresponding actuators
b.) features of valve control and regulation

I. *Gives examples of two-valued output signals from a control unit (e.g. engine controller).*
II. *Two main methods of injection and comparison of its properties (solenoid valve, piezoelectric)*
III. *Role of EGR regulation*

A5. Conventional batteries ignition build-up
a.) the role and solution of pre-ignition
b.) modern, fully electrical ignition.

I. *Why does the ignition spark have to be created before the upper deadlock?*
II. *What depends on the degree of pre-ignition and knock-free combustion control?*
III. *Characteristics of ignition with lock angle control and current limitation*

A6. Switch on/off the RC and RL charging of direct current circuits

I. *Why does the ignition spark have to be created before the upper deadlock?*
II. *What depends on the degree of pre-ignition and knock-free combustion control?*
III. *Characteristics of ignition with lock angle control and current limitation*

A7. Characteristic voltage-levels of vehicles, trends of electric energy, one, two and three wires systems

I. *Formation and causes of on-board voltage levels for motor vehicles*
II. *Design and boundaries of single-wire systems*
III. *Apps that require a three-wire system*

A8. Structure of generators

I. *Generators are standard rotor designs.*
II. *Claw pole rotor design*
III. *Typical electrical construction of vehicle generators*

A9. Electronic voltage regulators

I. *Why the generator needs voltage control and where they intervene. (for excitation and PM machines)*
II. *Why is there no need for current control – load curves of generators?*
III. *Electronic voltage regulator structure and operation*

A10. Batteries
a.) types, typical nominal voltage values per cell
b.) explanation of capacity, charging and discharging characteristics
c.) self-discharge, number of cycles, lifetime

I. *Chemical process of lead batteries when charging and discharging*
II. *Typical resting and operating voltage values per cell.*
III. *Capacity interpretation, filling and discharge characteristics, normal value of self-discharge, cycle number, service life*

A11. One and three phase rectifiers, their use in vehicles

I. Half- and Full wave rectifier – with control and uncontrol
II. Three-phase half wave rectifier
III. Three-phase full wave rectifier

A12. DC-DC converters (voltage reduction and increase in case of R and RL charging) (PWM)

I. Reduction dc voltage without transformer with switch-operated circuit at R and RL loads
II. Reduction/increase of DC disconnection (transformer) by switching (H bridge, PWM, DC)
III. Example of increasing dc voltage with switch-operated circuit

A13. DC drives – with electronically variable terminal voltage
a.) realization of the start and the change of direction of rotation
b.) possibilities of changing number of revolutions

I. H bridge circuit and operating conditions
II. DC motor soft start with H switching with PWM control
III. DC engine electronic speed control from armature side

A14. AC and BLDC drives (motor+electronics+software) – DC-AC converters

I. Starting/braking/constant speed control – typical accelerations
II. Possibilities of changing number of revolutions
III. Structure and properties of the intermediate DC circuit frequency converters, effect of changing voltage-frequency

A15. Transmission cables, wire harnesses. Current capacity and voltage drop
Fuses, circuit breakers, surge arresters, chokes
Properties of signal transmission cables

I. Characteristics of powertrain cables used in vehicles in accordance with environmental conditions.
II. Two main tasks of melting fuses and other options for smart fuses/switches
III. Structure, characteristics of signal transmission cables, typical cables of specific systems

A16. BUS systems
   a.) types and parameters (LIN, CAN…), advantages
   b.) fundamental terms of data transfer – communication of transmitter and receiver units, traits
   c.) general issues of signal transfer (speed-wire length, reflexion, transmitting medium)

I. *LIN and CAN bus voltage levels - NRZ encoding characteristics*
II. *LIN and CAN bus telegram frame construction and characteristics*
III. *Solving bus access at LIN and CAN buses*

A17. Sources of noise on board, internal and external noises
   a.) elements of protection against disturbance
   b.) overvoltage protection, ESD
   c.) electromagnetic compatibility, EMC

I. Links between independent circuits
II. Causes of surge
III. Causes and prevention of electrostatic recharge

Group B

B1. Elements of transmission from engine to wheels (gearbox, clutch, differential)

I. Typical design of the drivetrain, specifying the role of each part
II. Tasks and types of clutches
III. Differential structure and function

B2. T=f(n) characteristic curve of internal combustion engines Gearbox influence on T=f(n) characteristic

I. Relationship between internal combustion engine speed for maximum torque and power (shellfish diagram, flexibility)
II. Coupling of traction curve and workpoint with gearbox
III. Transmission automation, planetary application

B3. Driving resistances, tractive force need, tire grip

I. Components and characteristics of running resistance
II. Determine maximum acceleration
III. Causes of wheel adhesion change

B4. Sideward dynamics of the vehicle Road holding in corners

I. Vehicle driving characteristics in crosswinds
II. Lateral tilt on a bend
III. Road keeping on a bend – the role of centripetal force.

B5. Conventional brake systems

I. Design of discs and drum brakes,
II. Construction of the hydraulic system of brakes
III. Retarder role and types

B6. Basics of ABS

I. Typical ABS operating area for different adhesion characteristics
II. Switching and operating the abs one-wheel hydraulic sizing circuit (pressure holding, reduction, holding, increase)
III. Types of ABS sensors and their principle of operation

B7. Shock absorption in vehicles
a.) dual-mass, quarter model
b.) conventional, semi-active and active dampers

I. *Vehicle quarter model structure, equations and typical resonance frequencies*
II. *Implementation, characteristics and characteristics of passive shock damping*
III. *Change the characteristics of shock damping using electronics*

B8. Steering of vehicles
a.) power steering
b.) speed and required force

I. *Hydraulic and electrical assistance comparison - performance demand*
II. *Relationship between power requirements, variable gear ratio, and speed*
III. *Sensors and their operating principles for electric steering*

B9. Basics of ESP

I. *What values are calculated in the ESP vehicle model*
II. *What values are measured on board the vehicle*
III. *Possible corrections for under and oversteered vehicles*

B10. Sensors and actuators of ESP

I. *Example of steering angle sensor construction and operation*
II. *Y-way acceleration and angular acceleration measurement principle*
III. *What interventions are being carried out if, based on the difference in calculations and measurements, it is necessary to*

B11. Automatic tire pressure control

I. *What are the benefits of applying rubber pressure control?*
II. *Direct system construction and recoverable information*
III. *Structure of an indirect system, its operating principle and the information that can be obtained*

B12. Air-bags, automatic seat belt tightening systems

I. *Advantages and solutions of automatic belt tensioners*
II. *Typical time chart of airbag operation*
III. *Control of automatic belt tensioners and airbags on the basis of electrical characteristics*

B13. Active lighting system – automatic adjustments, windscreen and headlamp wiper

I. Possibility of controlling conventional headlamps for body fluctuations caused by road conditions, vehicle load and acceleration/braking.
II. Advantages and systems of matrix lighting
III. Construction and operation of window and headlamp washers

B14. Window regulators, power door lock

I. Typical electronics for electric window lifter
II. Window jacks end-position and entrapment control
III. Central lock electronics and methods of control.

B15. Climate control system. Cooling/heating/ventilating system components

I. Thermal, ventilation requirements and causes of the passenger compartment
II. Cabin comfort sensors and their operating principle
III. Air conditioning construction and operation

B16. Adaptive cruise control, reversing control
a.) Distance measuring system – radar and ultrasonic
b.) Camera systems

I. Distance and speed measurement with FMCW radar, ultrasound
II. ACC adaptive speed control block diagram, collaborative systems.
III. Use a camera for lane departure monitoring. Examples of additional camera applications

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