Exercises to "*Automotive Exhaust Sensors*"

1. Explain why the SI-engine of a car, equipped with a three-way catalyst, has to be controlled to keep a fixed air-to-fuel ratio (excess air factor $\lambda = 1.000$).

2. Explain why the catalytic converter of an SI-engine is called "Three-Way-Catalyst".

3. What kind of sensor is used to detect the excess air factor? Sketch (schematically) and describe the construction of a standard type and an improved one for future control strategies.

4. Why can an oxygen sensor be used to control the Air/Fuel-ratio of a SI-engine?

5. Sketch (schematically) the signal characteristic of a potentiometric Lambda-sensor (signal vs. λ).

6. Mention and explain conditions for the occurrence of pollutant emissions despite the use of catalytic converter.

7. Describe two advantages of a planar Lambda-sensor in comparison to a thimble-type one.

8. Sketch (schematically) and describe the construction and work-function of a wide-range Lambda-sensor.

9. What is the reason why diesel engines cannot be controlled in the same way (to an excess air factor = 1.000) as SI-engines?

10. Explain the term *on-board-diagnosis (OBD).*

11. Describe two methods to realize OBD of the three-way catalyst of a SI-engine and mention for each method an advantage and a disadvantage.

12. Describe a method to realize OBD of so called Light-off-catalysts for SI-engines.

13. Explain the abbreviations LEV, ULEV, ZEV.

14. Mention and describe 2 possibilities to optimize the cold start behavior of an SI-engine.

15. Sketch (schematically) and describe the construction and work-function of a mixed potential solid electrolyte HC- and λ-sensor.

16. Describe three methods to reduce the NO_X-emissions of diesel engines.

17. Explain the term SCR and the role and reaction mechanism of the used reducing agent.

18. Explain the term LNT and the work-function of that component in the reduction of diesel engine emissions.

19. Sketch (schematically) and describe the work-function of a two-cell amperometric NO_X- + O_2-sensor.

20. Explain the role of a HC- or NH_3-sensor in the exhaust gas aftertreatment of diesel engines.

21. Where are NH_3- or HC-sensors installed in the exhaust aftertreatment system of diesel engines and why?

22. Explain the differences between the lean-burn and $\lambda = 1$ mode of a GDI engine and the tasks of the pre and main catalyst in each mode.

23. Which kind of O_2-sensor is typically used for the λ-control of GDI engines?