### **BIOFUELS**

### Part 1. Biotechnology

#### **Basics of microbiological and biochemical processes**

- 1. What kind of mikroorganisms culture can be conducted in chemostat?
- 2. Bacteria cell capsule characteristic and it's role.
- **3.** Bacterial plasmids characteristic and it's role.
- 4. What the endospores are and what kind of bacteria are able to form them?
- 5. Describe shortly the Krebs cycle point out the main processes.
- 6. Chemiosmotic theory in respiration process.
- 7. Stages of photosynthesis.
- 8. Stages of screening of microorganisms suitable for industrial processes.

### **Biofuel production technologies**

- 9. List the types of biomass that is used to produce biofuels.
- 10. What are the ways to produce biodiesel? Which is the most popular?
- 11. What is syngas and how can biodiesel be made from it?
- 12. What factors influences biogas production via methane fermentation?
- 13. What are the ways of algae harvesting?

### Molecular biology in microbial biocenoses monitoring

- **14.** What is the purpose of DNA extraction? List the types of methods used to extract nucleic acids.
- **15.** What makes the polymerase chain reaction so popular and useful tool in applied molecular biology?
- **16.** What is the purpose to use fluorescence in situ hybridization in monitoring of microbials? What resources are necessary to perform it?
- 17. What are biodiversity indicators used for? What data is needed to determine such indicators.

### **Energy Crops**

- 18. What is the definition of biomass in energy production and examples of it.
- **19.** Energy crops by type of plants.
- 20. List types of final material prepared from energy plants and briefly describe them.
- **21.** Willow as energy crop characteristic.
- 22. Industrial hemp advantages and dissadvantages of cultivation as biomass source.
- 23. Giant miscantus as source of biomass.
- 24. Risks connected with energy plants cultivation.

## Part 2. Power engineering

#### **Combustion processes and technologies**

- 1. What is the difference between premixed and non-premixed combustion? Give examples.
- **2.** Define the excess air and equivalence ratios. Why the excess air (equivalence) ratio should not be too large nor too small?
- 3. What is the difference between deflagration and detonation?
- 4. Explain the meaning of flammability limits. How temperature and pressure affect the limits?
- 5. What is a burner? Give examples of burner types.
- 6. Describe the processes occurring during combustion of single solid fuel particle.

### **Fuel processing technologies**

- 7. Explain the differences between gasification, pyrolysis and combustion?
- 8. How syngas can be used?
- 9. Describe the Integrated Gasification Combined Cycle (IGCC).
- **10.** Give examples of the main gasification reactor types?
- **11.** Describe the underground gasification of coal.
- **12.** Describe the torrefaction process.

### **Thermal Technology**

- 13. Formulate an energy balance equation
- 14. List the methods of energy input and output
- 15. Formulate the first law of thermodynamics as applied to the closed system
- 16. Formulate the entropy definition equation
- 17. Present the Carnot cycle in the T-s diagram?
- **18.** Define ideal and semi-ideal gas
- 19. Enumerate the combustible elements found in fuels and give them combustion reactions

#### **Technologies for power and heat production**

- **20.** What are the primary energy sources and options for their conversion into the final energy forms?
- **21.** How is the energy efficiency defined? What are ranges of energy efficiency for conventional and alternative energy conversion technologies?
- 22. Characterize selected type of a geothermal heating station
- 23. What is the photothermal conversion? Describe selected type of a solar thermal power plant.
- 24. Characterize the thermodynamic cycle and principle of operation for a spark ignition engine.
- **25.** Describe the thermodynamic cycle for a vapour compression heat pump. What is a difference if it would be a refrigeration unit?
- 26. Describe a selected type of water cooled nuclear reactor.

- 27. Describe the difference between spark ignition (SI) and compression ignition engine (CI).
- **28.** How the compression ratio of piston engine is defined, and how this parameter influences on engine performance?

### The use of biofuels in electric energy production

- **29.** What kind of biofuels are preferred for spark ignition engine gensets? Please justify your answer.
- **30.** What parameter is more important taking in to account the use of chosen fuel for internal combustion engine: the calorific value of air fuel mixture or a lower heating value of the fuel? Please justify your answer.
- **31.** What is the difference between CO<sub>2</sub> emission from the genset fuelled with biogas and natural gas?
- 32. What is the reason that most of the SI engine gensets are fuelled with a lean air-fuel mixture?
- **33.** Describe at least three power generation systems (based on heat engine) operated with biofuels.
- **34.** For which fuel: hydrogen, natural gas or biogas a higher compression ratio can be used (considering SI engine), what is the reason for this?

### **Experimental Methodology**

- **35.** How is the measurement uncertainty determined by means of type A method and the type B method?
- **36.** Histogram as a graphical presentation of measurement results. Present the method of constructing the histogram based on the set of measurement results.
- **37.** Present and discuss the algorithm of scientific hypothesis verification using the results of the experiment.
- **38.** List and discuss conditions that should be taken into account when planning experiments and measurements.
- **39.** List and discuss parameters of mathematical statistics that are used in the analysis of the quality of measurement results.

# Part 3. Optional subjects

### **Basics of vital processes (optional subject)**

- 1. What is metabolism and what 3 types of processes it consists of?
- 2. Photosynthesis describe the process and its role in plants and algae.
- **3.** Describe eukaryotic cell cycle.
- 4. Name and shortly describe how gene expression works.
- **5.** Explain DNA base pairing rule.

### Monitoring of bacterial biocenoses (optional subject)

- **6.** What is the average size of bacteria.
- **7.** How bacteria are quantified by fluorescence in situ hybridization (without going into detail about the FISH technique itself).
- 8. How can live bacteria be distinguished from dead ones?
- **9.** List min. 4 methods of determining the activity of microorganisms and give the principle of determination for one of them.
- **10.** What are the rules of monitoring.