

# FINAL EXAM TOPICS

for

**Environmental Engineer BSc**

at

National University of Public Service  
Faculty of Water Sciences



2020.

BAJA

## **Environmental Engineer (BSc)**

# PROTECTION OF ENVIRONMENTAL ELEMENTS AND ENVIRONMENTAL TECHNOLOGIES (A1)

*For all specialization*

- 1. Environmental loads and their reduction**
  - fundamental reasons
  - effects and their extents, examples
  - environmental elements to be protected
  - definition and interpretation of ecosystem
  - ecological restoration and nature conservation
  - methods for averting harms
  
- 2. Aquatic environment and its properties**
  - biotic and abiotic factors
  - occurrence and importance of N and P compounds
  - water contaminants and the mechanisms of their effects
  - impact of pollutants on water utilization
  - natural cleaning processes in surface waters
  
- 3. Water quality, quality assessment**
  - assessment methods, general considerations
  - water quality indicators: physical, chemical, hydrobiological parameters
  - scope, application and methods of the Water Framework Directive
  - classification according to the Water Framework Directive
  
- 4. Water quality databases**
  - information demands
  - design of sampling programs
  - evaluation and processing of water quality data
  - water quality databases
  
- 5. Acceptable loading of water bodies**
  - Correlation between organic load and oxygen balance
  - effects on biotopes and biocoenosis
  - important correlations of the oxygen balance and its mathematical models
  - type of limit values
  - penalties and fines for wastewater discharge and environmental loads
  
- 6. Point and extensive water contaminations**
  - main types of pollution
  - aim and tools of water quality control
  - protection by technological and other methods
  - dilution, storage, re-routing, retention
  - overview, evaluation and classification of technological and non-technological water quality control methods
  
- 7. Treatment, utilization and disposal of liquid manure**
  - quality and quantity, environmental impact of liquid manure
  - necessity of treatment, treatment methods
  - disposal possibilities and limitations
  - technological solutions and their common parameters
  
- 8. Waste classification, waste management frameworks**
  - principles
  - classification of wastes, qualitative and quantitative properties
  - Sampling and evaluation, parameters to be analyzed
  - Waste management policies and strategies

**9. Collection and transport of solid municipal waste**

- requirements and tools of collection – pre-treatment – transport – storage – administration
- methods, aim, advantages and disadvantages of selective collection
- advantages and disadvantages of regional and decentralized waste treatment
- aim and layout of transfer stations

**10. Physical and chemical waste treatment and disposal**

- preparation, component separation, phase separation
- neutralization, coagulation, oxidation, reduction, hydrolysis, electrochemical processes, embedding, solidification

**11. Thermic waste treatment processes**

- classification, application possibilities and aims of thermic processes
- advantages and disadvantages of incineration plants, furnace types and furnace selection
- air pollution from waste incineration, reduction methods

**12. Aerobic organic waste treatment processes (composting)**

- aim, application, influencing factors, advantages and disadvantages of composting
- composting technologies
- required measurements and input parameters for the dimensioning of composting facilities, calculation steps
- aspects of design and operation

**13. Anaerobic organic waste treatment processes (anaerobic digestion)**

- aim, application fields, influencing factors of anaerobic digestion
- advantages and disadvantages of anaerobic digestion of wastes with high organic material content
- dry and wet digestion technologies
- required measurements and input parameters for the dimensioning of anaerobic digestion facilities, calculation steps
- aspects of design and operation

**14. Municipal landfills**

- Site selection, different types, and possible layouts of landfills
- design principles, protection technology, water management and treatment, biogas treatment and utilization
- recultivation of landfills

**15. Collection, transport, storage and disposal of hazardous waste**

- properties of hazardous waste
- requirements for collection, storage and transport
- possibilities for temporary and final disposal, operation of facilities

**16. Fundamental tasks in soil protection**

- demand for sustained soil fertility
- protection against erosion, deflation
- physical, chemical and biological soil improvement methods and tasks

**17. Irrigation with wastewater, soil as recipient**

- role of the soil in handling contaminations
- self-cleaning processes in the soil (physical, chemical, biological), role of the vegetation
- effect of the most common contaminations on the soil
- calculation of acceptable contaminant load of soils, dimensioning soil as recipient

**18. Contaminants in the soil and in the groundwater**

- transport and transformation of contaminant substances
- transport and modeling of the reactons
- typical transport processes
- methods to restirct contaminant transport

**19. Point-like contaminations and contamination elimination in soil and grounwater**

- contaminant sources, common contaminants
- exploration and loaclisation of the conatmination
- evaluation based on allowed load, risk asesment, decision support
- applicable technologies, considerations for technology selection

**20. Subsurface oil contamination**

- properties of oil contaminations, investigation
- transport of oil in soil and groundwater
- damage assessment, planning of the elimination, in situ and ex situ methods for oil conatminations

**21. Air as an environmental element**

- contaminants and their sources
- constant and variable constituents
- types of pollutions (point, diffuse)
- effect of pollutants on health and environment
- inorganic and organic contaminant classification with examples
- acid rain development and effect on environment

**22. Emission, transmission, immission**

- fundamental definitions, emission types and their properties
- determination by measurement and calculation
- principles of emission limits
- contaminant transport in air, influencing factors
- methods for immission determination
- role of background contamination
- green house effect, ozone hole

**23. Properties of flue gas emissions**

- fuels, common flue gas composition
- determination of flue gas composition (measurement, calculation)
- flue gas quality as a function of burning process parameters (burner, excess air, etc.)
- air pollution from power stations, residential heating, traffic, waste incineration
- methods of air pollution control, active and passive methods

**24. Industrial air pollution**

- pollution types (dust, chemicals, odour)
- correlation of technology and emission
- active and passive methods to reduce chemical contaminations
- solvent extraction from exhaust gases
- dust removal methods, cyclones, filters, chambers, electrostatic filters, wet processes

**25. Common gas purification processes**

- NO<sub>x</sub> reduction (SNR, SNCR, SCR) process advantages and disadvantages
- SO<sub>2</sub> reduction methods
- combined SO<sub>2</sub> and NO<sub>x</sub> reduction methods
- reduction of dioxin emission in waste incineration

**26. Legal measures of air quality protection**

- legislation goals, principles, limits, and limit determination
- tools of law making
- emission register, aim and data collection methods
- on-line and off-line monitoring and their role
- important laws and international agreements

**27. Environmental impact of noise and vibration**

- fundamental definitions, origin of sound and noise
- spreading of noise and vibration
- descriptive parameters, characteristic curves, impact on health, limit values and principles
- legislation regarding noise and vibration

**28. Noise reduction methods**

- active and passive methods
- soundproofing and their layout
- soundproofing of residential buildings, industrial facilities and individual machines

- reduction of traffic noise

**29. Environmental impact assessment**

- aim, necessity and methodology
- listing, localisation, conflicts, solution possibilities, investigation methods
- impact assessment methods, decision support processes
- contents and methods of detailed impact assessment, examples

**30. Environmental monitoring systems**

- data and information demand of environmental monitoring, protocols and methods
- sampling of environmental elements
- parameters to be measured
- design of monitoring network and sampling interval
- data evaluation
- environmental databases

**31. Water management**

- Structure of water management
- Legislative aspects of water management
- Permits

**32. Water balance management**

- Elements of water balance
- Water bases
- Hydrological water balance diagrams
- Water storage – demand relation

**33. European Water Framework Directive**

- Aim, content and execution

# **WATER AND WASTEWATER TREATMENT SPECIALIZED STUDIES**

## ***For water and wastewater treatment specialization***

### **1. Structure and design of drinking water distribution networks**

- functional parts of distribution networks
- systems with and without elevated tanks, regional distribution networks
- determination of water demands, demand variations over time and location, parameters of drinking water demand

### **2. Subsurface water intake**

- types of subsurface water bodies, typical contaminants
- types of wells, well structures, hydraulic calculation of wells, drawdown curve
- reservoir and aquifer protection, protective area

### **3. Surface water intake**

- typical contaminants and their variations over time and location
- typical intake structures: rivers, lakes, reservoirs
- selection of water acquisition site location and protective measures
- screen bars and sieves

### **4. Clarification – thickening**

- sedimentation process: discrete and hindered settling, thickening curve
- hydraulic aspects of sedimentation tank
- sizing of clarifiers, structures and settling tank upgrade

### **5. Coagulation-flocculation**

- removal of floc size particles, floc destabilization process
- mixing demand
- phase separation and process units

### **6. Cake filtration**

- theory of cake filtration
- sieves for macro- and micro filtration
- screens, drum filters

### **7. Filtration in porous media**

- rapid filtration: pressure and water quality changes along the filter, regulation of filtration rate, filter backwash
- slow filtration, pressure and water quality changes, operating principles, structural layout



## **8. Disinfection**

- aim of disinfection
- oxidation by chlorine, breakpoint curve
- application of chlorine dioxide
- application of ozone
- UV disinfection
- disinfection by-product formation, prevention and reduction

## **9. Degassing, aeration, acidity reduction**

- origin of methane and aggressive carbon dioxide, reduction
- Henry's law, effect of partial pressure, physical and chemical fundamentals of gas liquid equilibrium, lime-carbonic acid equilibrium
- structures and equipment for aeration and degassing

## **10. Iron and manganese removal**

- origin of iron and manganese, necessity of reduction
- fundamental chemistry of iron and manganese removal
- technologies for iron and manganese reduction
- treatment of iron and manganese slurry

## **11. Arsenic removal**

- occurrence of arsenic in natural waters
- necessity of arsenic removal
- technologies for arsenic removal, placement in process trains, process flow diagrams

## **12. Ammonium removal**

- occurrence of ammonium in natural waters, nitrogen forms
- necessity of ammonium removal
- technologies for ammonium removal, placement in process trains, typical block diagrams

## **13. Water softening**

- water hardness, fundamental definitions, aim of softening
- introduce at least four process for water softening

## **14. Materials, structures and construction of drinking water distribution networks**

- requirements and legislation of materials for drinking water distribution, common structural loads
- common pipe materials and designation, fittings and joints
- structures of water towers, piping layout, maintenance
- pipe laying methods (earthworks, compaction), verification tests

- 15. Primary (mechanical) wastewater treatment - screens and grit chambers**
  - purpose of screens, screen types, dimensioning of screens
  - grit chambers and grease trap structures and their dimensioning
- 16. Primary (mechanical) wastewater treatment – primary settlers**
  - primary settler structure types and layouts
  - dimensioning of primary settlers, removal efficiency
- 17. Activated sludge process**
  - constituents of activated sludge, structure, correlation of recirculation and solid retention time
  - biomass production (Monod and Andrews kinetics)
  - dimensioning based on ATV 131
- 18. Nitrogen removal from wastewater**
  - nitrogen forms, mechanisms of nitrogen reduction, required conditions (nitrification, denitrification)
  - necessity of nitrogen reduction
  - possible reactor configurations
  - sidestream technologies (anaerobic ammonium oxidation)
- 19. Phosphorus removal from wastewater**
  - phosphorus fractions
  - necessity of phosphorus reduction
  - chemical phosphorus removal and reactor configurations
  - excess biological phosphorus removal and reactor configurations (A/O, A2/O, UCT, etc.)
- 20. Fixed film wastewater treatment**
  - properties of fixed film systems, life cycle and transport processes of the biofilms
  - rotating contractors and biofilters
  - moving bed bioreactor systems and their layouts
  - integrated fix film activated sludge systems
- 21. Sizing of aeration systems for wastewater treatment**
  - sizing of aerators: correlation between oxygen demand of bioreactors and required airflow (AOTR, SOTR)
  - surface aerators
  - submerged aerators
  - theory and measurement of oxygenation capacity verification, execution of the measurement
- 22. Wastewater treatment in sequenced batch reactors (SBR)**
  - properties, dimensioning and operation of SBR systems
  - role of equalizing tanks in SBR processes

- 23. Secondary settlers in wastewater treatment**
- layout, dimensioning principles (hydraulic considerations)
  - sludge volume index, sedimentation curve
  - operation of secondary settlers, duty point analysis
- 24. Sludge treatment in wastewater treatment plants**
- properties of primary and secondary sludge
  - structures and material balance of the thickening process
  - structures, machinery and material balance of dewatering
  - side stream processes for sludge mass reduction (Cannibal, OSA)
- 25. Stabilization of wastewater sludge**
- aim and methods of stabilization
  - process and structures of aerobic sludge stabilization
  - process and structures of anaerobic sludge stabilization
  - biogas production, composition, utilization
- 26. Wastewater sludge utilization and disposal**
- exploitable materials in the sludge
  - process and layout of composting solutions
  - drying and incineration of sludge
  - final disposal of wastewater sludge
- 27. Natural wastewater treatment processes**
- properties of extensive wastewater treatment
  - classification of natural wastewater treatment processes
  - constructed wetland layouts
  - lagoon layouts
- 28. Membrane technologies in water and wastewater treatment**
- principles of membrane separation, pore size, removable materials
  - membrane system setups, layout of membrane units in drinking water treatment
  - membrane materials, production methods
  - maintenance and cleaning of membrane