

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	TEHNOLOGIJE ČIŠČENJA ODPADNIH VODA
Course title:	WASTEWATER TREATMENT TECHNOLOGIES

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Varstvo okolja in ekotehnologije, 2. stopnja	Modul: Ekotehnologije	1. in 2.	/
Environmental Protection and Eco-technologies, 2 nd level	Module: Ecotechnologies	1 st and 2 nd	/

Vrsta predmeta / Course type: Modularni predmet / Modular course

Univerzitetna koda predmeta / University course code: TČOV

Predavanja Lectures	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
20	4	12	4	80	4

Nosilec predmeta / Lecturer: prof. dr. Milenko Roš

Jeziki / Languages:	Predavanja / Lectures:	Slovenščina / Slovenian
	Vaje / Tutorial:	Slovenščina / Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Opravljene izpite iz predmeta "Čiščenje odpadnih vod"

Prerequisites:

Passed exam "Wastewater Treatment"

Vsebina:

- Cilj predmeta je študenta usposobiti za poglobljeno razumevanje, načrtovanje, vrednotenje in optimizacijo sodobnih sistemov čiščenja komunalnih in industrijskih odpadnih vod v kontekstu trajnostnega razvoja in krožnega gospodarstva....

Poglavitne teme:

- Oskrba z vodo in odvajanje ter upravljanje z onesnaženo vodo (vodooskrba in ravnanje z odpadnimi vodami v urbanih in ruralnih naseljih), interpretacija kakovosti odpadnih vod, vključno s hranili, mikroonesnaževali, mikroplastiko in drugimi novodobnimi onesnaževali,
- sodobni tehnološki postopki procesov nitrifikacije, denitrifikacije, odstranjevanje fosforja, anammox, fizikalno-kemijske in membranske tehnologije, napredni oksidacijski postopki,
- izbira in integracija posameznih tehnoloških sklopov v celovite sisteme čiščenja (primarno, sekundarno, terciarno, kvartarno čiščenje),
- vrednotenje učinkovitosti tehnologij z vidika obratovanja, porabe energije, ogljičnega odtisa in vplivov na okolje,

Content (Syllabus outline):

- The aim of the course is to enable students to gain an in-depth understanding of, plan, evaluate, and optimize modern municipal and industrial wastewater treatment systems within the context of sustainable development and the circular economy.

Main topics:

- Water supply, drainage, and contaminated water management (water supply and wastewater management in urban and rural settlements)
- Interpretation of wastewater quality, including nutrients, micropollutants, microplastics, and other emerging pollutants
- Using modern technological processes of nitrification, denitrification, phosphorus removal, anammox, physical-chemical and membrane technologies, advanced oxidation processes
- Selection and integration of individual technological components into comprehensive treatment systems (primary, secondary, tertiary, and quaternary treatment)
- Evaluation of the effectiveness of technologies in terms of operation, energy consumption, carbon footprint, and environmental impact

- masne in energijske bilance ter optimizacija procesov,
- obravnava obdelave blata in stranskih tokov ter vključevanje principov krožnega gospodarstva (ponovna raba vode, hranil in energije),
- načrtovanje in kritična presoja sistemov monitoringa, vodenja in avtomatizacije čistilnih naprav.

- Mass and energy balances and process optimization
- Treatment of sludge and side streams and integration of circular economy principles (reuse of water, nutrients, and energy)
- Planning and critical assessment of monitoring, control, and automation systems for treatment plants

Temeljna literatura in viri / Textbooks:

Obvezna / Required:

1. Roš, M., Zupančič, G.D.: Zbirka nalog: Čiščenje odpadnih voda, Visoka šola za varstvo okolja, Velenje, 2016.
2. Roš, M.: Sodobni postopki čiščenja odpadnih voda, Fitmedia, Celje, 2015.
3. Roš, M., Uranjek, N.: Sodobni pristopi k čiščenju odpadnih vod in obdelavi blat iz čistilnih naprav. Velenje: Fakulteta za varstvo okolja, 2024.

Priporočena / Recommended:

1. Metcrafft&Eddy: Wastewater Engineering, Treatment and Reuse, McGraw-Hill, Boston, 2013.
2. Henze, M., van Loosdrecht, M.C.M, Ekama, G. A., Brdjanovic, D.: Biological Wastewater Treatment, IWA Publishing, London, 2008.
3. Davis, M.L.: Water and Wastewater Engineering, McGraw Hill Professional, 2010.
4. Spellman, F.R., Mathematics Manual for Water and Wastewater Treatment Plant Operators: Water Treatment Operations, CRC Press, Boca Raton, 2023.

Cilji in kompetence:

Predmetno specifični cilji in kompetence:

- Razumevanje sistemov oskrbe z vodo ter odvajanja in čiščenja odpadnih voda v urbanih in ruralnih okoljih.
- Razumevanje sodobnih bioloških, fizikalno-kemijskih in membranskih postopkov čiščenja ter naprednih procesov odstranjevanja hranil in mikroonesnaževal.
- Razumevanje integracije posameznih tehnoloških postopkov v primarno, sekundarno, terciarno in kvartarno stopnjo čiščenja.
- Pridobljena znanja pri interpretaciji kakovosti voda ter vrednotenju učinkovitosti tehnologij z vidika obratovanja, porabe energije, ogljičnega odtisa in vplivov na okolje.
- Pridobljena znanja za izdelavo masnih in energijskih bilanc ter optimizacijo procesov čiščenja.
- Razumevanje obravnave blata in stranskih tokov ter vključevanja principov krožnega gospodarstva.
- Razumevanje sistemov monitoringa, vodenja in avtomatizacije čistilnih naprav ter njihove vloge pri optimizaciji obratovanja.

Splošne kompetence:

- kompetence in znanje za oceno kvaliteto vode,
- za izbiro ustreznega načina in tehnologije čiščenja oz. ravnanja z vodami,
- sposobnost izračuna osnovnih tehnoloških parametrov za velikost in obratovanje naprav za obdelavo vode/odpadne vode.

Objectives and competences:

Specific competences:

- Understanding water supply, wastewater disposal, and treatment systems in urban and rural environments
- Understanding modern biological, physico-chemical, and membrane treatment processes as well as advanced processes for removing nutrients and micropollutants
- Understanding the integration of individual technological processes into primary, secondary, tertiary, and quaternary treatment stages
- Ability to interpret water quality and evaluate the effectiveness of technologies in terms of operation, energy consumption, carbon footprint, and environmental impact
- Ability to prepare mass and energy balances and optimize treatment processes
- Understanding sludge and side stream treatment and the integration of circular economy principles
- Understanding monitoring, control, and automation systems for wastewater treatment plants and their role in optimizing operations

General competences:

- Competence and knowledge to assess water quality in order to select the appropriate method and technology for water treatment or management
- Ability to calculate the basic technological parameters sizing and operating water or wastewater treatment plants.

Predvideni študijski rezultati:**Znanje in razumevanje:**

Študent bo ob zaključku predmeta sposoben:

- razumevanja delovanja sistemov oskrbe z vodo in čiščenja odpadnih voda, vključno z naprednimi biološkimi, fizikalno-kemijskimi in membranskimi procesi ter interpretacijo kakovosti voda in onesnaževal,
- izdelati osnovne masne in energijske bilance,
- vrednotiti učinkovitost tehnologij ter izbirati tehnološke sklope za trajnostno zasnovane sisteme priprave in čiščenja vode.

Prenosljive/ključne spretnosti in drugi atributi:

- spretnosti analitičnega in sistemskega razmišljanja za reševanje inženirskih problemov,
- kritične presoje okoljskih ter osnovnih energetskih in obratovalnih vidikov,
- sposobnost strokovne komunikacije za delo v interdisciplinarnih okoljih.

Intended learning outcomes:**Knowledge and understanding:**

At the end of the subject, students will be able to:

- understand the functioning of water supply and wastewater treatment systems, including advanced biological, physicochemical, and membrane processes, and interpret water quality and pollutants;
- prepare basic mass and energy balances;
- evaluate the effectiveness of technologies and select technological components for sustainably designed water treatment and purification systems.

Transferable/key skills and other attributes:

- analytical and systematic thinking skills for solving engineering problems;
- critical assessment of environmental, basic energy, and operational aspects;
- professional communication skills for working in interdisciplinary environments.

Metode poučevanja in učenja:**Oblike dela:**

- predavanja (prisotna in/ali spletna),
- laboratorijske in terenske vaje,
- projektno in samostojno delo študentov,
- industrijski ogledi in študije primerov.

Metode dela:

- interaktivna razlaga in vodenje diskusij,
- analiza praktičnih primerov in študij primerov,
- skupinsko delo in ekipni projekti,
- vključevanje strokovnjakov iz prakse,
- priprava, predstavitev in zagovor seminarskih ali projektnih nalog.

Learning and teaching methods:**Forms of teaching:**

- lectures (in-person and online)
- laboratory and field exercises
- student projects and independent work
- industrial tours and case studies

Teaching methods:

- interactive explanations and facilitate discussions
- analysis of practical examples and case studies
- group work and team projects
- involvement of field experts
- preparation, presentation, and defense of seminar or project assignments

Načini ocenjevanja:

Pogoj za pristop k izpitu:

- pisni izpit,
- kolokvij iz vaj,
- priprava, predstavitev in zagovor seminarske naloge.

Končna ocena pri predmetu

Na vajah je obvezna vsaj 90-odstotna prisotnost. Študent mora izdelati poročila o vajah in opraviti kolokvij ter pripraviti in zagovarjati seminarsko nalogo, potem lahko pristopi h končnemu izpitu.

Delež (v %) /**Weight (in %) /****Assessment:**

60
25
15

A prerequisite for access to the exam:

- written exam
- colloquium of lab exercises
- preparation, presentation, and defense of a seminar paper

Final evaluation

At least 90% attendance at lab exercises is required. Students must first competent report on their lab work, pass the colloquium of lab exercises, and prepare, present, and defend a seminar paper before they can apply for the final written exam.

Ocenjevalna lestvica: <ul style="list-style-type: none"> ▪ zadostno 6: 60–67 % ▪ dobro 7: 68–75 % ▪ prav dobro 8: 76–83 % ▪ prav dobro 9: 84–90 % ▪ odlično 10: 91–100 % 		Grading scale: <ul style="list-style-type: none"> ▪ Sufficient D (6): 60–67% ▪ Good C (7): 68–75% ▪ Very good B (8): 76–83% ▪ Very good B+ (9): 84–90% ▪ Excellent A (10): 91–100%
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Materialni pogoji za izvedbo predmeta:

- Predavalnica z multimedijско opremo in tablo.
- Laboratorij, opremljen za izvajanje osnovnih parametrov onesnaženja odpadne vode.

Material conditions for subject realization:

- Classroom with multimedia equipment and blackboard
- Laboratory equipped for basic wastewater parameter analyses

Obveznosti študentov:

- Obvezna udeležba na vajah
- Kolokvij iz vaj
- Izdelana seminarska naloga s predstavitvijo in zagovorom
- Pisni izpit

Student's commitments:

- Mandatory attendance at exercises
- Colloquium on lab exercises
- Preparation, presentation, and defense of seminar paper
- Written exam

Reference nosilca predmeta:
Pedagoško delo:

- nosilec predmeta Čiščenje odpadnih vod na različnih fakultetah (Fakulteta za kemijo in kemijsko tehnologijo, Ljubljana, Fakulteta za znanosti o okolju, Nova Gorica, Fakulteta za strojništvo, Maribor, Visoka šola za varstvo okolja, Velenje),
- mentor in somentor mnogim diplomantom, magistrantom in doktorandom.

Znanstveno-raziskovalno delo:

- Vodenje raziskovalnih, znanstvenoraziskovalnih in razvojnih projektov v okviru raziskovalne skupnosti RS

Strokovno delo in izbrane publikacije:

- Roš, M. Oznake in poimenovanja na področju biološkega čiščenja odpadnih vod. 1. izd. Ljubljana: Slovensko društvo za zaščito voda, 1995
- Roš, M. Sodobni postopki čiščenja odpadnih vod. Celje: Fit media, 2015. 208 str., ilustr. Zbirka Zelena Slovenija.
- Roš, M., Rihter Pikel, J., El Khair, H., Uranjek, N. Microplastic removal and wastewater recycling with membrane & ozone technology. [S. l.]: Generis Publishing, cop. 2021.
- Roš, M., Uranjek, N. Sodobni pristopi k čiščenju odpadnih vod in obdelavi blat iz čistilnih naprav. Velenje: Fakulteta za varstvo okolja, 2024.

Priznanja in nagrade:

- Nagrada sklada Borisa Kidriča za publikacije na področju metodologije kemijsko-bioloških preiskav odpadnih voda (1982).

Lecturer's references:
Pedagogic activities:

- Lecturer in Wastewater Treatment at various faculties (Faculty of Chemistry and Chemical Technology, Ljubljana, Faculty of Environmental Sciences, Nova Gorica, Faculty of Mechanical Engineering, Maribor, College of Environmental Protection, Velenje)
- Mentor and co-mentor to many undergraduate, master's, and doctoral students.

Scientific and research work:

- Management of research, scientific, and development projects within the Slovenian research community

Professional work and selected publications:

- Roš, M. Labels and names in the field of biological wastewater treatment. 1st ed. Ljubljana: Slovenian Water Protection Society, 1995
- Roš, M. Modern wastewater treatment processes. Celje: Fit media, 2015. 208 pp., ill. Zelena Slovenija collection.
- Roš, M., Pihter pikl, J., El Khair, H., Uranjek, N. Microplastic removal and wastewater recycling with membrane & ozone technology. [S. l.]: Generis Publishing, cop. 2021.
- Roš, M., Uranjek, N. Contemporary approaches to wastewater treatment and sludge processing from treatment plants. Velenje: Faculty of Environmental Protection, 2024. 367 pp

Awards:

- Boris Kidrič Fund Award for Publications in the Field of Methodology of Chemica Roš, M.I and Biological Wastewater Testing (1982).

- Krkina nagrada za delo z naslovom: Odpadne vode v obratu Fermentacije, Tovarne zdravil KRKA, Novo mesto (1972).
- 15Krkina nagrada za nalogo Čiščenje industrijskih odpadnih voda (1975).
- Srebrno priznanje za inovacijo: Čistilna naprava za odpadne vode "NIKO Železniki"; Gospodarska zbornica Slovenije, Savinjsko-Šaleška območna zbornica Velenje (2003).
- Dunbarjeva medalja Evropskega združenja za vodo v priznanje izjemnemu prispevku k razvoju uporabne tehnologije na področju čiščenja odpadnih voda in varstva okolja.

- Krka Award for the work titled: Wastewater in the Fermentation Plant, KRKA Pharmaceutical Factory, Novo mesto (1972).
- Krka Award for the project "Treatment of Industrial Wastewater" (1975).
- Silver Award for Innovation: Wastewater Treatment Plant "NIKO Železniki", Chamber of Commerce and Industry of Slovenia, Savinja-Šaleška Regional Chamber Velenje (2003).
- Dunbar Medal from the European Water Association in recognition of outstanding applied technical development in the field of wastewater treatment and the environment protection.

Izbrani znanstveni članki / Selected scientific papers:

- Roš, M., Vrtovšek, J. Pre-fermentation of a low-strength meat-processing wastewater in an upflow sludge blanket reactor. *Water environment research*. 2001, 72, 142-145.
- Zupančič, G.D., Grilc, V., Roš, M., Uranjek Ževart, N., 2008. Municipal waste sludge digestion in an autothermal aerobic sequencing batch reactor. *Water science and technology*, 58, 1237-1243.
- Zupančič, G.D., Uranjek Ževart, N., Roš, M., 2008. Full-scale anaerobic co-digestion of organic waste and municipal sludge. *Biomass & bioenergy*, 132,162-167.
- Rihter Pikl, J., Uranjek, N., Roš, M. Composting of excess sludge from the wastewater treatment plant with the green waste of hops. *European international journal of science and technology*. 2019, str. 1-12.
- Rihter Pikl, J., Lobnik, A., Roš, M., El Khlar, H., & Uranjek, N. (2024). Microfibrres and coliforms determination and removal from wastewater treatment effluent. *Cleaner Engineering and Technology*, 22, 1-7.
- Roš, M., El Khlar, H., Sinjur, A. Innovative detection and identification of microfibrres. *Green energy and environmental technology*. 2025, vol 4, 1-14.