Nanotechnology in Water Research

ABE 6266

Class Periods: M, W, F, 10:40 – 11:30 AM
Location: 283 Frazier-Rogers Hall
Academic Term: Spring 2025

Instructor:

Dengjun (Kevin) Wang, Ph.D., Assistant Professor
Department of Agricultural and Biological Engineering (ABE)
University of Florida
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Faculty Profile: https://abe.ufl.edu/people/faculty/dengjun-wang/
Email: **dengjun.wang@ufl.edu**
Phone: (352) 294-7969
Office Hours: M, W, F, 11:30 AM – 12:00 PM (*walk in policy, no appointment needed*). Appointment is needed for other time slots via email communication.

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- Chongyang Wang (Ph.D. student); c.wang2@ufl.edu; 235 Frazier-Rogers Hall (Office); office hours can be scheduled via email or Canvas communication.

Course Description: 3 Credits.

- *Applications of nanotechnology in water: nano-enabled sorbents, membranes, and sensors for water treatment, water quality monitoring, and environmental remediation*
- *Application of nanotechnology in agriculture: nanofertilizers and nanopesticides*
- *Fate & transport of nanomaterials in the subsurface*
- *Artificial Intelligence (AI)-enabled data analysis to further nanotechnology applications*

This course will provide an overview of the state-of-the-art knowledge on the broad applications of nanotechnology in water, soil, and other agricultural, engineered, geological, and environmental systems. Engineered nanomaterials (e.g., as sorbents), nanosensors, nanofertilizers, and nanopesticides will be discussed to highlight the potentials of nanotechnology in: (1) water treatment, (2) water quality monitoring, (3) environmental remediation, and (4) pest control and crop yield enhancement in agriculture. Recent advancements of nanotechnology for the remediation of new emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) and microplastics will be discussed. Finally, AI-enabled large dataset analysis to further nanotechnology applications will be discussed.

Course Pre-Requisites / Co-Requisites:

None.

Course Objectives:

- Gain fundamental knowledge of the terminology of nanotechnology and characterization techniques of nanomaterials
- Understand the impact/potential of nanotechnology in water treatment, water quality monitoring, environmental remediation, and nano-enabled agriculture
- Train skills to employ AI models for large dataset analysis in nanotechnology
- Develop skills in using nano-engineering tools necessary for the practice in environmental nanotechnology, water quality, and environmental remediation
- *Tours at UF Nanoscale Research Facility (NRF), guest lectures from leaders in environmental nanotechnology, hands-on laboratory experiments, and final project presentation (poster form), along with other conventional teaching avenues will be employed to facilitate achieving the course objectives.*

Materials and Supply Fees:

None.

Required Textbook:

- **Environmental Nanotechnology: Applications and Impacts of Nanomaterials, Second Edition**
  By Mark Wiesner and Jean-Yves Bottero
  Published on October 7, 2016, Second Edition, McGraw Hill
  ISBN-10: 0071828443
  ISBN-13: 978-0071828444
  Link: https://www.amazon.com/Environmental-Nanotechnology-Applications-Impacts-Nanomaterials/dp/0071828443

Recommended Textbook (Optional):

- **Nanotechnology for Water Treatment and Purification**
  By Anming Hu and Allen Apblett
  Published on 28 July, 2014, Springer Cham
  ISBN (hardcover): 978-3-319-06577-9
  ISBN (softcover): 978-3-319-37470-3
  DOI: 10.1007/978-3-319-06578-6
  Link: https://link.springer.com/book/10.1007/978-3-319-06578-6

Recommended Reading Materials:

1. Tratnyek, P.G., Johnson, R.L., 2006. Nanotechnologies for environmental cleanup. ***Nano Today,*** 1: 44–48.

2. Mauter, M.S., Elimelech, M. 2008. Environmental applications of carbon-based nanomaterials. ***Environmental Science & Technology,*** 42: 5843–5859.

3. Alvarez, P.J.J., Chan, C.K., Elimelech, M., Halad, N.J., Villagran, D., 2009. Emerging opportunities for nanotechnology to enhance water security. ***Nature Nanotechnology,*** 13: 634–641.

4. Hodges, B.C., Cates, E.L., Kim, J.H. 2009. Challenges and prospects of advanced oxidation water treatment processes using catalytic nanomaterials. ***Nature Nanotechnology,*** 13: 642–650.

5. Vikesland, P.J. 2018. Nanosensors for water quality monitoring. ***Nature Nanotechnology,*** 13: 651–660.

6. Perreault, F., de Faria, A.F., Elimelech, M. 2015. Environmental applications of graphene-based nanomaterials. ***Chemical Society Reviews,*** 44: 5861–5896.

7. Wang, D., Saleh, N.B., Byro, A., Zepp, R., Sahle-Demessie, E., Luxton, T. P., Ho, K.T., Burgess, R. M., Flury, M., White, J.C., Su, C. 2022. Nano-enabled pesticides for sustainable agriculture and global food security. ***Nature Nanotechnology,*** 17: 347–360.

8. Lowry, G.V., Giraldo, J.P., Steinmetz, N.F., Avellan, A., Demirer, G.S., Ristroph, K.D., Wang, G.J., Hendren, C.O., Alabi, C.A., Caparco, A., da Silva, W., González-Gamboa, I., Grieger, K.D., Jeon, S.J., Khodakovskaya, M.V., Kohay, H., Kumar, V., Muthuramalingam, R., Poffenbarger, H., Santra, S., Tilton, R.D., White, J.C. 2024. Towards realizing nano-enabled precision delivery in plant. ***Nature Nanotechnology,*** 19: 1255–1269.

9. Huang, X., Auffan, M., Eckelman, M.J., Elimelech, M., Kim, J.H., Rose, J., Zuo, K., Li, Q., Alvarez, P.J.J. 2024. Trends, risk and opportunities in environmental nanotechnology. ***Nature Reviews Earth & Environment,*** 5: 572–587.

10. Joyce, P., Allen, C.J., Alonso, M.J., Ashford, M., Bradbury, M.S., Germain, M., Kavallaris, M., Langer, R., Lammers, T., Peracchia, M.T., Popat, A., Prestidge, R.B., Rijcken, C.J.F., Sarmento, B., Schmid, R.B., Schroeder, A., Subramaniam, S., Thorn, C.R., Whitehead, K.A., Zhao, C.X., Santos, H.A. 2024. A translational framework to DELIVER nanomedicines to the clinic. ***Nature Nanotechnology,*** 19: 1597–1611.

11. Li, J., Li, X., Da, Y., Yu, J., Long, B., Zhang, P., Bakker, C., McCarl, B.A., Yuan, J.S., Dao, S.Y. 2022. Sustainable environmental remediation via biomimetic multifunctional lignocellulosic nano-framework. ***Nature Communications,*** 13: 4368.

12. Zhang, W., Zhang, D., Liang, Y. 2019. Nanotechnology in remediation of water contaminated by poly- and perfluoroalkyl substances: A review. ***Environmental Pollution,*** 247, 266–276.

13. Yadav, M., Osonga, F.J., Sadik, O.A. 2024. Unveiling nano-empowered catalytic mechanisms for PFAS sensing, removal and destruction in water. ***Science of the Total Environment,*** 912: 169279.

14. Goh, P.S., Kang, H.S., Ismail, A.F., Hkor, W.H., Quen, L.K., Higgins, D. 2022. Nanomaterials for microplastic remediation from aquatic environment: Why nano matters? ***Chemosphere,*** 299: 134418.

15. Šimůnek, J., Šejna, M., Brunetti, G., van Genuchten, M.Th. The HYDRUS Software Package for Simulating the One-, Two, and Three-Dimensional Movement of Water, Heat, and Multiple Solutes in Variably Saturated Media, Technical Manual I, Hydrus 1D, Version 5.0, PC Progress, Prague, Czech Republic, 334p., 2022.

16. Silva, J. A. K., Šimůnek, J., McCray, J.E. 2022. Comparison of methods to estimate air-water interfacial areas for evaluating PFAS transport in the vadose zone, ***Journal of Contaminant Hydrology,*** 247: 103984.

17. Guo, B., Zeng, J., Brusseau, M. 2020. A Mathematical Model for the Release, Transport, and Retention of Per- and Polyfluoroalkyl Substances (PFAS) in the Vadose Zone. ***Water Resources Research,*** 56, e2019WR026667.

18. Zhu, J.J., Boehm, A., Ren, Z.J. 2024. Environmental Machine Learning, Baseline Reporting, and Comprehensive Evaluation: The EMBRACE Checklist. ***Environmental Science & Technology,*** 58: 19909–19912.

Required Computer:

UF student computing requirement: https://news.it.ufl.edu/education/student-computing-requirements-for-uf/

Course Schedule:

Topic 1: Nanotechnology: An Introduction
Topic 2: Benefits of Environmental Nanotechnology
Topic 3: Characterizations of Nanomaterials (*include Tour at Nanoscale Research Facility*)
Topic 4: Applications of Nanotechnology in Water Treatment: Sorbents
Topic 5: Applications of Nanotechnology in Water Treatment: Membranes (**Exam 1**)
Topic 6: Applications of Nanotechnology to Water Treatment: Catalysts (*include Guest Lecture*)
Topic 7: Applications of Nanotechnology in Water Treatment: Sensors (*include Guest Lecture*)
Topic 8: Applications of Nanotechnology in Environmental Remediation (*include Guest Lecture*)
Topic 9: Nanotechnology for the Remediation of Emerging Contaminants (*PFAS and Microplastics*)
Topic 10: Applications of Nanotechnology in Agriculture: Nanofertilizers (**Exam 2**)
Topic 11: Applications of Nanotechnology in Agriculture: Nanopesticides (*include Guest Lecture*)
Topic 12: Fate & Transport of Nanomaterials in the Subsurface (*Include Lab Experiments*)
Topic 13: Fate & Transport of Nanomaterials: Model Simulation (*HYDRUS Simulation*)
Topic 14: AI-Enabled Large Dataset Analysis in Nanotechnology (**Final Poster Presentation**)

Important Dates (Tentative):

02/14/2025 Exam 1 (10:40 – 11:30 AM, 283 Frazier-Rogers Hall)
03/28/2025 Exam 2 (10:40 – 11:30 AM, 283 Frazier-Rogers Hall)
04/30/2025 Final Project Poster Presentation (10:40 AM – 12:00 PM, 283 Frazier-Rogers Hall)

Attendance Policy, Class Expectations, and Make-Up Policy:

- **Attendance Policy:** Students are responsible for satisfying all academic objectives as defined by the instructor. Absence counts starting from the first class. Acceptable reasons for absence from or failure to participate in class may include illness, serious family emergencies, special curricular requirements (professional conferences, field trips, etc.), military obligation, severe weather conditions, religious holidays and participation in official university activities, such as music performances, athletic competition or debate. Absences from class for court-imposed legal obligations (e.g., jury duty or subpoena) must be excused. More information on class attendance policy can be found here: Excused absences must be consistent with university policies in the Graduate Catalog (https://gradcatalog.ufl.edu/graduate/) and require appropriate documentation. Additional information can be found here: https://gradcatalog.ufl.edu/graduate/regulations/. Please email the instructor, Dr. Wang at dengjun.wang@ufl.edu, if you are not sure about whether your absence reason will be approved or not, at least one day prior to the class.
- **Class Expectations:** The instructor will facilitate class discussions. Students are highly encouraged to participate in various class discussion activities by addressing questions, asking questions, and initiating group discussions during the class lecturing. Bonus points will be provided to simulate classroom discussions.
- **Make-Up Policy:** The student needs to email the instructor, Dr. Wang at dengjun.wang@ufl.edu, about the date of the make-up exam. Contents of the make-up exam will be changed to ensure a fair competition environment for all students.

Evaluation of Grades:

Assignment	Total Points	Percentage of Final Grade
Homework Sets (10)	100 each	30%
Exam 1	100	20%
Exam 2	100	20%
Final Poster Presentation	100	30%
		100%

Grading Policy:

Percent	Grade	Grade Points
≥ 90.0	A	4.00
87.0 – 89.9	A-	3.67
84.0 – 86.9	B+	3.33
80.0 – 83.9	B	3.00
77.0 – 79.9	B-	2.67
74.0 – 76.9	C+	2.33
70.0 – 73.9	C	2.00
67.0 – 69.9	C-	1.67
60.0 – 66.9	D	1.33
0.00 – 59.9	E	0.00

More information on UF grading policy may be found at:

UF Graduate Catalog
Grades and Grading Policies

Students Requiring Accommodations:

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation:

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording:

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy:

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment:

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed,

color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Coordinator
• HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
• Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use:

All faculty, staff, and students at the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy:

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html.

Campus Resources:

Health and Wellness:

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources:

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://elearning.ufl.edu/.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/getting-help/; https://distance.ufl.edu/state-authorization-status/#student-complaint.*