Master of Science in Sustainability Science

SUSC PS5360 SUSC Agroecology: A Natural Climate Solution
Location: TBD
Time: TBD
3 credits

Instructor: Yushu Xia, Lamont Assistant Research Professor, yushuxia@ldeo.columbia.edu

Office Hours: Monday, 3:00-4:00 PM or by appointment
Response Policy: Email communication is preferred. Response can be expected within 1 business day.

Course Overview

Natural climate solutions (NCS) refer to actions aimed at protecting, better managing, and restoring nature to achieve climate goals. Adopting sustainable, climate-smart agricultural practices following agroecology principles provides a cost-effective NCS pathway to mitigate climate change, while also ensuring food security and environmental sustainability. This course will introduce the principles of agroecology, the key concepts of carbon and nitrogen dynamics, as well as the commonly adopted agroecological practices across various agricultural landscapes, including croplands, grasslands, and agroforestry systems. A combination of lectures, discussions, and field activities will be utilized to demonstrate how agroecological practices can be monitored in terms of their influence on ecosystem services.

This course will prepare students to apply principles of sustainability science to improved soil and agricultural management, addressing the growing need for better adoption of land based NCS. This course will also delve into the technological aspects of NCS monitoring that will help working professionals in conservation, environmental, and sustainable business organizations develop the necessary skills to evaluate the outcomes of sustainable land management practices to inform management decisions, policy making, and incentive-based programs. Designed to meet the degree requirements for Area 2 (Methods of Earth Observation and Measurement) and Area 5 (Sustainability Policy or Management) for the M.S. in Sustainability Science Program, this elective course aims to connect scientific methods with decision-making processes to prepare students to be leaders in sustainability and make impacts on both local and large-scale climate issues.

No prerequisite course is required but a basic understanding of sustainability principles and environmental science concepts is beneficial. The course will be delivered on the Morningside campus for the Spring semester on Mondays from 6:10 to 8PM, with an additional field day and a final presentation at the Lamont campus. If registration is not full, this course will also be open to other relevant programs, such as M.S. in Sustainability Management; M.S. in Earth and Environmental Engineering; M.A. in Climate + Society; M.A. in Ecology, Evolution and Environmental Biology; and Ph.D. in the Department of Earth and Environmental Sciences.

Learning Objectives

Upon successful completion of this course students will be able to:

L1: Articulate the principles of agroecology and NCS through sustainable land management examples that address food security, environmental sustainability, and climate change challenges.

L2: Synthesize commonly adopted agroecological practices in cropland, grassland, and agroforestry management, along with their major strengths and limitations.

L3: Analyze the benefits of agroecological practices on ecosystem services from the perspectives of carbon and nitrogen cycles in interconnected ecosystems.

L4: Demonstrate how soil, water, and vegetation measurements can inform management decisions by designing an integrated monitoring system for quantifying management outcomes.

L5: Effectively assess and communicate the challenges associated with agricultural incentive programs and propose possible solutions that will bridge technical advances with management decisions.

Required Readings

SCIENTIFIC ARTICLES

- Aguilera, E., Lassaletta, L., Gattinger, A., and Gimeno, B.S., 2013. Managing soil carbon for climate change mitigation and adaptation in Mediterranean cropping systems: A meta-analysis. *Agriculture, ecosystems & environment*, 168, 25-36. https://doi.org/10.1016/j.agee.2013.02.003
- Bai, Y., and Cotrufo, M.F., 2022. Grassland soil carbon sequestration: Current understanding, challenges, and solutions. *Science*, 377, 603-608. http://doi.org/10.1126/science.abo2380
- Blagodatsky, S., and Smith, P., 2012. Soil physics meets soil biology: towards better mechanistic prediction of greenhouse gas emissions from soil. *Soil Biology and Biochemistry*, 47, 78-92. https://doi.org/10.1016/j.soilbio.2011.12.015
- Collier, S.M., Ruark, M.D., Oates, L.G., Jokela, W.E., and Dell, C.J., 2014. Measurement of greenhouse gas flux from agricultural soils using static chambers. *JoVE (Journal of Visualized Experiments)*, 90, 52110. https://www.jove.com/t/52110/measurement-greenhouse-gas-flux-from-agricultural-soils-using-static
- Engel, S., and Muller, A., 2016. Payments for environmental services to promote "climate‐smart agriculture"? Potential and challenges. *Agricultural Economics*, 47, 173-184. https://doi.org/10.1111/agec.12307
- Follett, R.F., 2001. Soil management concepts and carbon sequestration in cropland soils. *Soil and tillage research,* 61, 77-92. https://doi.org/10.1016/S0167-1987(01)00180-5
- Fowler, D., Coyle, M., Skiba, U., Sutton, M.A., Cape, J.N., Reis, S., et al., 2013. The global nitrogen cycle in the twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368, 20130164. https://doi.org/10.1098/rstb.2013.0164
- Gomez, C., Rossel, R.A.V., and McBratney, A.B., 2008. Soil organic carbon prediction by hyperspectral remote sensing and field vis-NIR spectroscopy: An Australian case study. *Geoderma*, 146, 403-411. https://doi.org/10.1016/j.geoderma.2008.06.011
- Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., et al., 2017. Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114, 11645-11650. https://doi.org/10.1073/pnas.1710465114
- Gupta, D., Gujre, N., Singha, S., and Mitra, S., 2022. Role of existing and emerging technologies in advancing climate-smart agriculture through modeling: A review. *Ecological Informatics*, 71, 101805. https://doi.org/10.1016/j.ecoinf.2022.101805
- Lal, R., 2004. Agricultural activities and the global carbon cycle. *Nutrient cycling in agroecosystems*, 70, 103-116. https://doi.org/10.1023/B:FRES.0000048480.24274.0f

- Novick, K.A., Biederman, J.A., Desai, A.R., Litvak, M.E., Moore, D.J., Scott, R.L., et al., 2018. The AmeriFlux network: A coalition of the willing. *Agricultural and Forest Meteorology*, 249, 444-456. https://doi.org/10.1016/j.agrformet.2017.10.009
- Ntawuruhunga, D., Ngowi, E.E., Mangi, H.O., Salanga, R.J., and Shikuku, K.M., 2023. Climate-smart agroforestry systems and practices: A systematic review of what works, what doesn't work, and why. *Forest Policy and Economics*, 150, 102937. https://doi.org/10.1016/j.forpol.2023.102937
- Oldfield, E.E., Eagle, A.J., Rubin, R.L., Rudek, J., Sanderman, J., and Gordon, D.R., 2022. Crediting agricultural soil carbon sequestration. *Science*, 375, 1222-1225. http://doi.org/10.1126/science.abl7991
- Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G.P., and Smith, P., 2016. Climate-smart soils. *Nature*, 532, 49-57. https://doi.org/10.1038/nature17174
- Smith, P., Soussana, J.F., Angers, D., Schipper, L., Chenu, C., Rasse, D.P., et al., 2020. How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal. *Global Change Biology*, 26, 219-241. https://doi.org/10.1111/gcb.14815
- Tomich, T.P., Brodt, S., Ferris, H., Galt, R., Horwath, W.R., Kebreab, E., et al., 2011. Agroecology: A review from a global-change perspective. *Annual Review of Environment and Resources*, 36, 193-222. https://doi.org/10.1146/annurev-environ-012110-121302
- Van Groenigen, J.W., Huygens, D., Boeckx, P., Kuyper, T.W., Lubbers, I.M., Rütting, T., et al., 2015. The soil N cycle: new insights and key challenges. *Soil*, 1, 235-256. https://doi.org/10.5194/soil-1-235-2015
- Weiss, M., Jacob, F., and Duveiller, G., 2020. Remote sensing for agricultural applications: A meta-review. *Remote sensing of environment*, 236, 111402. https://doi.org/10.1016/j.rse.2019.111402
- Wezel, A., Casagrande, M., Celette, F., Vian, J.F., Ferrer, A., and Peigné, J., 2014. Agroecological practices for sustainable agriculture. A review. *Agronomy for sustainable development*, 34, 1-20. https://doi.org/10.1007/s13593-013-0180-7
- Xia, Y., McSweeney, K., and Wander, M.M., 2022. Digital mapping of agricultural soil organic carbon using soil forming factors: A review of current efforts at the regional and national scales. *Frontiers in Soil Science*, 2, 890437. https://doi.org/10.3389/fsoil.2022.890437

REPORTS, BOOK CHAPTERS, AND FACT SHEETS

- Intergovernmental Panel on Climate Change (IPCC). 2019. Chapter 2: Land-climate interactions (Executive summary) In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. Geneva, Switzerland. pp. 133-136. https://www.ipcc.ch/srccl/chapter/chapter-2/
- Moebius-Clune, B.N., Moebius-Clune, D.J. Gugino, B.K. Idowu, O.J. Schindelbeck, R.R. Ristow, A.J., et al., 2017. Comprehensive Assessment of Soil Health – The Cornell Framework, Edition 3.2. Cornell University. Geneva, NY. pp. 12-54. https://cornell.app.box.com/s/ryy6xgtwok5l85zzy9fgms1276drud0y
- Parkin, T.B., and Venterea, R.T. 2010. Chamber-based trace gas flux measurements. In: *USDA-ARS GRACEnet Project Protocols*. Beltsville, MD. pp. 1-39. https://www.ars.usda.gov/ARSUserFiles/np212/Chapter%203.%20GRACEnet%20Trace%20Gas%20Sampling%20Protocols.pdf
- Sasha Kravchenko. 2012. Soil organic carbon cycle. *Fact sheet and video about soil organic carbon*. United States Department of Agriculture and National Institute of Food and Agriculture. Online at: https://store.extension.iastate.edu/product/14376
- The World Bank. 2024. Climate-smart agriculture. In: *Understanding poverty*. Online at: https://www.worldbank.org/en/topic/climate-smart-agriculture
- United States Department of Agriculture (USDA) NRCS modified from Thien, S.J. 1979. A flow diagram for teaching texture by feel analysis. Journal of Agronomic Education. Online at: https://www.nrcs.usda.gov/sites/default/files/2022-11/texture-by-feel.pdf
- USDA. 2022. Conservation Reserve Program. In: *Farm Service Agency Fact Sheet*. Online at: https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2022/conservation-reserve_program-fact_sheet_2022.pdf

Recommended Readings

SCIENTIFIC ARTICLES

- Lokupitiya, E., and Paustian, K. 2006. Agricultural soil greenhouse gas emissions: a review of national inventory methods. *Journal of Environmental Quality*, 35, 1413-1427. https://doi.org/10.2134/jeq2005.0157
- Minasny, B., Malone, B.P., McBratney, A.B., Angers, D.A., Arrouays, D., Chambers, A., et al., 2017. Soil carbon 4 per mille. *Geoderma*, 292, 59-86. https://doi.org/10.1016/j.geoderma.2017.01.002
- Smith, P., Ashmore, M.R., Black, H.I., Burgess, P.J., Evans, C.D., Quine, T.A., et al., 2013. The role of ecosystems and their management in regulating climate, and soil, water and air quality. *Journal of Applied Ecology*, 50, 812-829. https://doi.org/10.1111/1365-2664.12016
- Xia, Y., and Wander, M., 2022. Management zone‐based estimation of positive and negative nitrous oxide flux in organic corn fields. *Soil Science Society of America Journal*, 86, 1043-1057. https://doi.org/10.1002/saj2.20416
- Zolkos, S.G., Goetz, S.J., and Dubayah, R. 2013. A meta-analysis of terrestrial aboveground biomass estimation using lidar remote sensing. *Remote sensing of environment*, 128, 289-298. https://doi.org/10.1016/j.rse.2012.10.017

REPORTS, BOOK CHAPTERS, AND FACT SHEETS

- Dawson, C. 2023. Is this the future of farming? EurekAlert! Online at: https://www.eurekalert.org/news-releases/985868
- European Commission Directorate-General for Environment. 2023. Agroecological practices may enhance food production by increasing ecosystem services. Online at: https://environment.ec.europa.eu/news/agroecological-practices-may-enhance-food-production-increasing-ecosystem-services-2023-03-15_en
- Dondini, M., Martin, M., De Camillis, C., Uwizeye, A., Soussana, J. F., Robinson, T., et al., 2023. Global assessment of soil carbon in grasslands: From current stock estimates to sequestration potential. In: *FAO Animal Production and Health Paper No. 187*. Rome, Italy. pp. 1-46. https://doi.org/10.4060/cc3981en
- Moore, H. 2016. Can agroecology feed the world and save the planet? The Guardian. Online at: https://www.theguardian.com/global-development-professionals-network/2016/oct/09/agroecological-farming-feed-world-africa
- Terasaki Hart D.E., Cook-Patton S.C. Garcia, E., Cardinael, R., Sprenkle-Hyppolite, S., and Rosenstock, T., 2023. It's time to embrace the potential of agroforestry as a climate solution. The Nature Conservancy. Online at: https://www.nature.org/en-us/what-we-do/our-insights/perspectives/agroforestry-natural-climate-solutions-potential/
- USDA Natural Resources and Conservation Service 2014. Soil nitrogen. Soil health - guides for educators. pp. 1-10. Online at: https://www.nrcs.usda.gov/sites/default/files/2022-10/Soil%20Nitrogen.pdf

Assignments and Assessments

Class participation (15%) (L1, L2, L3, L4, L5):

Active class participation is crucial for fostering engaging discussions and enhancing learning outcomes. Weekly readings will be assigned and will help develop class discussions. Participation includes class attendance, contribution of questions, and active discussions in class. Classroom participation makes up 15% of the final grade.

Quizzes (15%) (L1, L2, L3):

Three quizzes, each with six multiple choice questions, will be given during the course to evaluate the student's comprehension of course materials. The purpose of these quizzes is to assess understanding rather than memorization. These quizzes will cover topics discussed in lectures and readings. Each quiz will contribute to 5% of the final grade. The extra question included in each quiz will be used for calculating extra credit.

Mid-term essay (20%) (L1, L2, L3):
The student will provide a short essay (800 to 1500 words) for a comparative analysis. The objective of this assignment is to evaluate the student's ability to critically analyze and compare two peer-reviewed journal articles with contrasting findings. Through this comparative analysis, students will gain an improved understanding of the current knowledge and data gaps in the assessment of agroecological practices. The student can choose to compare the articles given below as an example or find other agroecology-related articles for comparison. The mid-term essay will make up 20% of the final grade. The essay will be evaluated based on the understanding of the original papers, the identification of causes for differences in conclusions, the clarity of arguments, and the quality of writing. Extra points (up to 3 points) will be awarded to outstanding essays that synthesize arguments from additional references to support their viewpoint. Feedback will be provided within two weeks of the essay submission deadline, either during office hours or by appointment.

Example: (Article 1) Lobell, D.B. and Villoria, N.B., 2023. Reduced benefits of climate-smart agricultural policies from land-use spillovers. *Nature Sustainability*, 6, pp. 941-948. https://www.nature.com/articles/s41893-023-01112-w; (Article 2) Fuglie, K., Lewandrowski, J. and Marshall, E., 2023. Addressing 'leaks' in climate-smart agriculture. *Nature Sustainability*, 6, pp. 885-886. https://www.nature.com/articles/s41893-023-01162-0

Final conceptual flowchart (20%) (L1, L2, L3, L4, L5):
This assignment will evaluate the student's understanding of the course materials and their ability to synthesize information into a conceptual flowchart. The student will create a flowchart that connects key concepts, theories, and agroecological practices discussed in the course. The flowchart should visualize a modeling system and/or a monitoring framework for assessing various agroecological practices. The final conceptual flowchart will be due the second-to-last week of the class and will make up 20% of the final grade. Evaluation will be based on the completeness of elements included in the flowchart and the effort made to connect different elements of the class material. Feedback will be provided within one week of the flowchart submission deadline, either during office hours or by appointment.

Group project (30%) (L1, L2, L3, L4, L5):
This assignment provides an opportunity for students to engage in collaborative group work focused on investigating a specific aspect of agroecology that connects scientific theory with communicating sustainability. Groups consisting of 2-3 students will select a topic related to agroecology, either from the provided list below or by proposing their own topic for investigation. The selected topic should be confirmed and finalized with the instructor before Spring Break to ensure its novelty and relevance. The group project presentations will be scheduled for Saturday afternoon during the final exam week in hybrid mode (in person or on Zoom). Each group will have a total presentation time of 20 minutes, followed by a 5-minute question-and-answer session and a 5-minute feedback session from the instructor. The presentation will make up 15% of the final grade. The group essay, to be submitted before the final week, should be in a review or meta-analysis format (minimum of 5 pages) and will make up 15% of the final grade. The presentation and group paper will be evaluated based on their presentation quality, thoroughness of the

review/meta-analysis, novelty of the findings, and relevance to addressing land management-based sustainability challenges.

Example topics:

1. Agroecology: Challenges and opportunities for smallholder farmers.
2. Managing soils to mitigate climate change: Challenges and opportunities for the Global South.
3. When does soil organic carbon sequestration lead to increased greenhouse gas emissions?
4. How does nitrogen management practice influence yield-based greenhouse gas emissions?
5. Identify data gaps for understanding climate benefits associated with organic farming systems.
6. Digital soil mapping: can we detect soil organic carbon stock changes at a scale relevant to management?
7. Are we ready for carbon credits in agroforestry systems?
8. Agroecological practices in urban agriculture: Can we monitor the outcomes?
9. Modeling greenhouse gas emissions from improved grassland management: Challenges and future directions.
10. Can climate-smart water management benefit from cost-effective, sensor-based technology?

Grading

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

Assignment/Assessment	% Weight	Individual or Group/Team Grade
Class participation	15	Individual
Quizzes	15	Individual
Mid-term essay	20	Individual
Final conceptual flowchart	20	Individual
Group project presentation	15	Group

Group project paper	15	Group

Course Schedule/Course Calendar

Date	Topics and Activities	Readings	Assignments
1	Concepts of Agroecology and Natural Climate Solutions	Griscom (2017) (6 pages), IPCC (2019) (4 pages), The World Bank (2024) (1 page), Smith (2020) (18 pages), Tomich (2011) (30 pages)	
2	The carbon and nitrogen cycle in agricultural system	Kravchenko (2012) (1 page), Minasny (2017) (28 pages), Fowler (2013) (13 pages)	
3	Principles in carbon and nitrogen management (including guest lecture)	Lal (2004) (14 pages), USDA (2014) (10 pages), Van Groenigen (2015) (22 pages)	
4	Agroecology in Croplands I	Follett (2001) (16 pages), Moore (2016) (1 page), Wezel (2014) (20 pages)	Quiz 1
5	Agroecology in Croplands II	Aguilera (2013) (12 pages), European Commission (2023) (1 page)	
6	Agroecology in grasslands	Bai and Cotrufo (2022) (6 pages), FAO (2023) (46 pages)	
7	Agroecology in agroforestry systems	Ntawuruhunga (2023) (20 pages), Terasaki Hart (2023) (1 page)	Confirmation of group project topic
No class: Spring break			
8	Evaluate agroecological practices with field and lab data I	Collier (2014) (8 pages), Moebius-Clune (2016) (43 pages), Novick (2018) (13 pages)	Mid-term essay due; Quiz 2
	Evaluate agroecological practices with field and lab data II: Field day	Parkin and Venterea (2010) (39 pages), USDA (1979) (2 pages)	
9	Sensor-based system for monitoring agroecological practices	Gomez (2008) (9 pages), Weiss (2020) (19 pages), Xia and Wander (2022) (15 pages), Zolkos (2013) (10 pages)	
10	Model-based system for monitoring agroecological practices	Blagodatsky and Smith (2012) (15 pages), Lokupitiya (2006) (15 pages), Gupta (2022) (20 pages), Xia (2022) (19 pages)	
11	An integrated system for monitoring agroecological practices	Smith (2020) (23 pages), Paustian (2016) (9 pages), Dawson (2023) (1 page)	
12	Incentive-based programs for agroecological practices	Engel and Muller (2016) (12 pages), Oldfield (2022) (4 pages), USDA (2022) (2 pages)	Quiz 3
13	Future of agroecology (including guest lecture)		Final conceptual flowchart due
14	Group Project Presentation		Group project due

Adapted from: **The Course Syllabus: A Learning-Centered Approach, 2nd Edition,** Judith Grunert O'Brien, Barbara J. Millis, Margaret W. Cohen. ISBN: 978-0-470-60549-3. Available as an E-Book from Wiley at: https://www.wiley.com/en-us/The+Course+Syllabus%3A+A+Learning+Centered+Approach%2C+2nd+Edition-p-9780470605493

Course Policies

Participation and Attendance
Students are expected to come to class on time and be thoroughly prepared. The instructor will keep track of attendance and look forward to an interesting and lively discussion. If you miss time in class, you miss an important opportunity to learn, and the class misses your contributions. More than one absence will affect your grade by 15%. Justified absences will be granted for extreme circumstances and pending documentation, when possible, requested by the instructor. In any case, absences should be notified to the instructor in advance, when possible.

Late work
Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down a third of the grade for every day it is late (e.g., from a B+ to a B).]

Citation & Submission
All written assignments must use standard citation format (e.g., MLA, APA, Chicago), cite sources, and be submitted to the course website (not via email).

School and University Policies and Resources

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

> The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

Adapted from: **The Course Syllabus: A Learning-Centered Approach, 2nd Edition,** Judith Grunert O'Brien, Barbara J. Millis, Margaret W. Cohen. ISBN: 978-0-470-60549-3. Available as an E-Book from Wiley at:
https://www.wiley.com/en-us/The+Course+Syllabus%3A+A+Learning+Centered+Approach%2C+2nd+Edition-p-9780470605493

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at https://sps.columbia.edu/students/student-support/academic-integrity-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Diversity Statement
It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: https://health.columbia.edu/content/disability-services.

Class Recordings
All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process. Students are not permitted to allow anyone to view or listen to class sessions, recordings, or any course materials, and students will not copy, forward, or share said recordings/materials.

SPS Academic Resources
The Division of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: https://sps.columbia.edu/students/student-support/student-support-resources.

Columbia University Information Technology
Columbia University Information Technology (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access University-provided and discounted software downloads.

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online.

The Writing Center
The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit http://www.college.columbia.edu/core/uwp/writing-center.

Career Design Lab

The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to https://careerdesignlab.sps.columbia.edu/