



**MASC 520: Mathematical Methods
for Deep Learning**
Units: 4

Time: Spring 2023, Mon/Wed 4:00-5:50 pm
Location: RTH 115 (for on campus students)
**Location: Online, link provided on
DEN/Desire2Learn (for DEN students)**

Instructor: Paulo Branicio
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Office Hours: Tue 2:00–3:00 pm
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Teaching Assistant: Aoyan Liang
Office: VHE 609
Office Hours: Tue 9:00-11:00 am
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Live Class Information

For the Spring 2023 term, we will use the Desire2Learn system for all class activities. All live sessions will be conducted via Webex. All students will have access to recorded lectures. On-campus students are expected to attend classes in person. DEN@Viterbi students can also attend classes in person if desired. Please go to <https://courses.uscden.net> to access Desire2Learn. You must create a password if you have not used this system before. Click “Forgot your Password?”. Your username is your full USC email address. To access the Webex live class link, please go to the “Virtual Meetings” item in the course main menu. It is recommended to download and install the [WebEx Meetings app](#) for optimal viewing of lectures. Select your [audio and video settings](#) before joining your first meeting. Recordings will be available under My Tools > Panopto Videos and posted by the DEN team under the corresponding weekly modules. Please review the Panopto player for added interactive elements:

<https://demo.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=a459ffec-4937-4328-9d48-bd02d357ec53>

Course Description

MASC 520 is a foundational mathematical course for deep learning. It provides graduate students with in-depth knowledge of mathematics needed to understand deep learning. The course covers a variety of topics such as linear algebra, probability and statistics, optimization, Fourier series, Fourier transforms, ordinary and partial differential equations, and Markov Chain Monte Carlo methods. Each topic is introduced with an application of deep learning to problems in the physical sciences and engineering. Students are required to do five projects chosen from the following topics: feed-forward neural network, convolutional neural network, recurrent neural network, neural network solvers for differential equations, autoencoders, Restricted Boltzmann Machine and Deep Boltzmann Machine.

Learning Objectives

The course aims to provide graduate students with in-depth mathematical knowledge to design and implement deep learning algorithms for analyses of experiments and simulations in the physical sciences and engineering.

Prerequisite(s): None

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: None

Course Notes

All course notes will be provided on the DEN/Desire2Learn website.

Required Readings and Supplementary Materials

Deep Learning by I. Goodfellow, Y. Bengio, and A. Courville

ISBN-13: 978-0262035613

Mathematical Methods for Physicists 7th Ed by G. Arfken.

ISBN-13: 978-0123846549

Grading Breakdown

Assessment Tool (Assignment)	% of Grade
Homework	30%
Midterm	30%
Projects	40%
TOTAL	100%

Course Breakdown

- Introduction to Machine Learning
- Linear Vector Spaces, Operators, Matrices, and Tensors
- Probability and Information Theory
- Fourier Series and Fourier Transforms
- Differential Equations
- Machine Learning Basics
- Deep Networks
- Optimization for Training Deep Models
- Convolutional Neural Networks
- Recurrent Neural Networks
- Structured Probabilistic Models for Deep Learning
- Deep Generative Models

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampus-part-b/>. Other forms of academic dishonesty are equally unacceptable.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

The Office of Student Accessibility Services - (213) 740-0776
osas.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test-taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.