# ECE 69500: Datacenter and Cloud Networks Spring 2025

## 1 Course Information

**Course Number and Title:** ECE 69500, Datacenter and Cloud Networks.

**CRNs:** 20755, 20758, 20806

**Sections:** 093, 094, EP1

**Campus:** West Lafayette

**Instructional Modality:** Section 093: Face-to-Face; Sections 094, EP1: Asynchronous Online.

**Lecture Time:** Tue, Thu, 4:30–5:45pm in BHEE 224.

**Course Credit Hours:** 3

**Prerequisites:** Proficiency in a software programming language (e.g., Python) or a hardware programming language (e.g., Verilog).

**Course Web Page:** https://engineering.purdue.edu/~vshriva/courses/ece69500sp25/index.html

**Course Brightspace Page:** https://purdue.brightspace.com/d2l/home/1220628

**Course Piazza Page:** https://piazza.com/purdue/spring2025/ece69500dcn/home

## 2 Instructor(s) Contact Information

### Instructor

Vishal Shrivastav
Assistant Professor of Electrical and Computer Engineering at Purdue University
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Email: vshriva@purdue.edu
Office Hours: By Appointment via email

## 3 Course Description

The modern datacenter and the cloud has emerged as the dominant computing platform that powers most of world's consumer online services, financial, military, and scientific application domains. The goal of this course is to introduce students to the design, implementation, and management of modern datacenter and cloud networks. Lectures will cover a wide-range of topics, including datacenter architecture and topology, datacenter routing and load balancing, datacenter transport, software-defined networking, programmable data plane, in-network computing, multi-tenancy in the cloud, RDMA, resource disaggregation, and optical switching inside datacenters.

## 4 Prerequisites

Proficiency in a software programming language (e.g., Python) or a hardware programming language (e.g., Verilog). A prior undergraduate course in computer networking will be useful but not essential. The first few weeks of the course will cover all the necessary background needed for this class.

## 5 Course Topics

1. Datacenter Architecture and Topology
2. Datacenter Routing and Load balancing
3. Datacenter Transport
4. Software-defined Networking
5. Programmable Data Plane
6. In-Network Computing
7. Multi-tenancy in the Cloud
8. Datacenter Network for RDMA
9. Resource Disaggregation inside Datacenter
10. Optics inside Datacenter

## 6 Learning Resources, Technology, and Texts

**Required Material:** Lecture slides on Brightspace.

**Additional Reading:** Research papers from the syllabus.

## 7 Learning Outcomes

A student who successfully fulfills the course requirements will have demonstrated an understanding of the design, implementation, and management of datacenter and cloud networks and familiarity with the state-of-the-art technologies in these areas.

## 8 Assessments

**60% grade — Term Project**
Each student will work on a semester-long project. Students will have a choice to choose between a research track project or an implementation track project.
**Research Track (recommended for Ph.D. students):**
For research track project, students may work in groups of at most 2 students. Students can either propose their own project or talk to the instructor for project ideas. Any project with significant networking component will be acceptable. The final deliverable will include a 10–12 page technical report. The overall grading will be broken into 3 milestones:
20% – Milestone 1: Problem, Motivation, and Related Work
20% – Milestone 2: Design and Evaluation Plan
20% – Milestone 3: Final Technical Report
**Implementation Track (recommended for master, undergrad, and online students):**
For implementation track project, students must work individually with no collaboration and no use of AI tools allowed. Students will implement a full datacenter network stack on top of a bare-bones network simulator (in Python) provided to them. The overall grading will be broken into 3 milestones:
20% – Milestone 1: Implement Datacenter Topology and Routing
20% – Milestone 2: Implement Datacenter Transport
20% – Milestone 3: Implement Datacenter Load Balancing

**20% grade — Midterm Exam**
Midterm exam will be closed-book with no collaboration and no use of AI tools allowed. The syllabus will include the first five course topics.

**20% grade — Final Exam**
Final exam will be closed-book with no collaboration and no use of AI tools allowed. The syllabus will include the last five course topics.

## 9 Course Schedule

| Week | Dates | Topic |
|---|---|---|
| 1 | Jan 13 – Jan 17 | Course Introduction |
| 2 | Jan 20 – Jan 24 | Course Background I |
| 3 | Jan 27 – Jan 31 | Course Background II |
| 4 | Feb 3 – Feb 7 | Datacenter Architecture and Topology |
| 5 | Feb 10 – Feb 14 | Datacenter Routing and Load balancing |
| 6 | Feb 17 – Feb 21 | Datacenter Transport |
| 7 | Feb 24 – Feb 28 | Software-defined Networking<br>**Project Milestone 1 due** |
| 8 | Mar 3 – Mar 7 | Programmable Data Plane |
| 9 | Mar 10 – Mar 14 | In-Network Computing<br>**Midterm Exam** |
| 10 | Mar 17 – Mar 21 | **Spring Break** |
| 11 | Mar 24 – Mar 28 | Multi-tenancy in the Cloud |
| 12 | Mar 31 – Apr 4 | Datacenter Network for RDMA<br>**Project Milestone 2 due** |
| 13 | Apr 7 – Apr 11 | Resource Disaggregation inside Datacenter |
| 14 | Apr 14 – Apr 18 | Optics inside Datacenter |
| 15 | Apr 21 – Apr 25 | **Final Exam** |
| 16 | Apr 28 – May 2 | **Project Milestone 3 due** |

## 10 Grading Scale

The breakpoints for letter grades are shown below. The final letter grade will be based on each student's raw cumulative score at the end of the semester (normalized to 100 while accounting for the weight of each assessment). It may be possible that the raw cumulative score is "curved up" to adjust for the difficulty level of assessments, potentially resulting in a better final letter grade. For example, a student's raw cumulative score of 74 (B–) may be curved up to 78 (B) to adjust for the difficulty level. The adjustment factor will be decided by the instructor at the end of the semester, and will be applied uniformly to every student's raw cumulative score. Raw scores will never be "curved down".

| **Letter Grade** | A+ | A | A– | B+ | B | B– | C+ | C | C– | D+ | D | D– | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Score** (out of 100) | 95+ | 90+ | 85+ | 80+ | 75+ | 70+ | 65+ | 60+ | 55+ | 50+ | 45+ | 40+ | $\leq$40 |

## 11 Attendance Policy

This course follows the University Academic Regulations regarding class attendance, which state that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance may be taken at the beginning of a class and lateness may be noted. When conflicts or absences

can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification is not possible, the student should contact the instructor as soon as possible by email. For absences that do not fall under excused absence regulations (see below), this course follows the following procedures:

1. Student should not come to class if they are feeling ill, but they MUST email the instructor with the subject line: [course code] absence. The instructor does not need details about the student's symptoms. The student should just let the instructor know that they are feeling ill and cannot come to class. If it is an emergency situation, the student should follow the University regulations on emergent medical care (see below).
2. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time via the course Brightspace.
3. If that day's class involves assessed work such as a test or presentation, student and the instructor will plan if and how the student can make up the work, following the assignment guidelines. This plan must be done before the next class period, so again, the student should email the instructor immediately when they know that they will miss class.
4. The most important consideration in any absence is how it will affect the student's achievement of the assignment objectives and the course learning outcomes.

For cases that fall under excused absence regulations, the student or their representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent medical care. The processes are detailed, so the student should plan ahead.

## 12 Academic Integrity

Students are free to collaborate with anyone or use any available material online for completing the research track project. However, unless expressly allowed, students are expected to complete the implementation track project and exams by themselves, **without use of any AI tools**. A student is considered in violation of the academic honesty policy regardless of whether they are the one "copying" or the one "being copied from". Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. Punishments for academic dishonesty are severe, including receiving a failing grade in the course or being expelled from the university. By departmental rules, all instances of cheating will be reported to the Dean of Students. On the first instance of cheating, students involved will receive a 0 on the assignment; the second instance of cheating will result in a failing grade in the course.

**Use of Copyrighted Materials:** All course materials, including lecture slides, project, exams, and solutions are subject to Purdue's copyright policies. Students must not share, distribute, or post any material on an online web site without checking with the instructor.

## 13 Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect

among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. See Purdue's full Nondiscrimination Policy Statement.

## 14 Accessibility

Purdue University strives to make learning experiences accessible to all participants. If a student anticipates or experiences physical or academic barriers based on disability, they are encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247, as soon as possible. If the Disability Resource Center (DRC) has determined reasonable accommodations that the student would like to utilize in the class, the student must send the instructor their Course Accommodation Letter. Instructions on sharing the Course Accommodation Letter can be found by visiting: https://www.purdue.edu/drc/students/course-accommodation-letter.php. Additionally, the student is strongly encouraged to contact the instructor as soon as possible to discuss implementation of their accommodations.

Students with disabilities whose DRC Course Accommodation Letter (CAL) includes test accommodations must first release their CAL to the instructor and then schedule to take their exams with Purdue Testing Services at https://www.purdue.edu/studentsuccess/testing-services/accommodated-testing/student.php. The student must schedule at least four days (96 hours) before the exam date listed on the syllabus. In the case of finals week, the student must schedule by the Friday before quiet week. The instructor will provide Purdue Testing Services with the exam and they will proctor it and provide the result to the instructor for grading. Students must inform the instructor immediately of cases when Purdue Testing Services is at capacity or otherwise unable to proctor the exam so that the instructor can make other arrangements. Students who fail to follow this process and meet stated deadlines risk not being able to have their accommodations for that exam.

## 15 Mental Health/Wellness Statement

**If a student finds themselves beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, they should try** Therapy Assistance Online (TAO), a new web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS). TAO is available to students, faculty, and staff at any time.

**If a student needs support and information about options and resources,** they should contact or see the Office of the Dean of Students (ODOS). Call 765-494-1747.

**If a student finds themselves struggling to find a healthy balance between academics, social life, stress, etc.,** they should sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help students navigate through barriers and challenges toward their goals throughout the session. Sign up is free and can be done on BoilerConnect.

**If a student is struggling and needs mental health services: Purdue University is committed to advancing the mental health and well-being of its students.** If a student or someone they know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays.

## 16 TaskHuman Service

TaskHuman offers private, real-time, on-demand, 1-on-1 video calls with wellness coaches covering over 800+ topics such as anxiety, mindfulness, reducing stress, clean eating, time management, in-home workouts, relationship tensions, financial issues, spiritual guidance and many more. Students can access these wellness coaches from around the world 24/7. The College of Engineering has an exclusive agreement with TaskHuman which gives students FREE and UNLIMITED access to these resources. Learn more at: https://engineering.purdue.edu/ECE/TaskHuman.

**Download TaskHuman**

Scan the QR Code to download the TaskHuman App or download the TaskHuman App directly from the App Store or Google Play Store. Create an account – Go to Setting and tap on "Check for Discounts", Insert the code: **purdue63**. Don't see a topic you want or have other questions? Contact Brooke Parks, Senior Lecturer in ECE, at brookeparks@purdue.edu

## 17 Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed, and Student Support Services is available to serve students Mon–Fri, 8am–5pm.

## 18 Emergency Preparedness

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course web page and Piazza or can be obtained by contacting the instructor via email. Students are expected to check the course web page and Piazza, and read their @purdue.edu email on a frequent basis.

A link to Purdue's information on Emergency Preparation and Planning is located on the course Brightspace under "University Policies and Statements". This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. Students are encouraged to download and review the Emergency Preparedness for Classrooms document.

The first day of class, the instructor will review the **Emergency Preparedness plan for their specific classroom**, following Purdue's required Emergency Preparedness Briefing. Students are advised to make note of the following items:

1. The location to where one will proceed after evacuating the building if one hears a fire alarm.
2. The location of the Shelter in Place in the event of a tornado warning.
3. The location of the Shelter in Place in the event of an active threat such as a shooting.