TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 60850 Datacenter and Cloud Networks

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 60850 Datacenter and Cloud Networks
Sem. 2, Lecture 3, Cr. 3.

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 include the presentation and discussion of seminal papers from the field of datacenter and cloud networks, covering a wide-range of topics, including datacenter architecture and topology, routing and load balancing, datacenter transport, software-defined networking, programmable data plane, in-network computing, multi-tenancy, RDMA, resource disaggregation, and optical switching inside datacenters.

Reason: The goal of the course is to introduce students to the design, implementation, and management of modern datacenter and cloud networks, as well as provide them with a proper grounding for research in the related areas.

Course Enrollment History: Spring 2022 – 10, Spring 2023 – 5, Spring 2024 - 12

T. S. Mithu

Mithuna Thottethodi,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

ECE 69500: Datacenter and Cloud Networks Spring 2024

1 Course Information

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

CRNs: 20755, 20758, 20806

Sections: 093, 094, EP7

Campus: West Lafayette

Instructional Modality: Section 093: Face-to-Face; Sections 094, EP7: Asynchronous Online.

Lecture Time: Tue, Thu, 4:30–5:45pm in BHEE 226.

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://web.ics.purdue.edu/~vshriva/courses/ece69500sp24/index.html

Course Brightspace Page: https://purdue.brightspace.com/d2l/home/985443

Course Piazza Page: https://piazza.com/purdue/spring2024/ece69500dcn/home

2 Instructor(s) Contact Information

Instructor

Vishal Shrivastav
Assistant Professor of Electrical and Computer Engineering at Purdue University
Office: BHEE 334B, 465 Northwestern Ave., West Lafayette, Indiana 47907–2035, USA
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 Assignments and Exams

60% — 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 three milestones:
Milestone 1: Problem, Motivation, and Related Work – 20%
Milestone 2: Design and Evaluation Plan – 20%
Milestone 3: Final Technical Report – 20%
Implementation Track (recommended for master, undergrad, and online students):
For implementation track project, students must work individually with no collaboration 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 three milestones:
Milestone 1: Implement Datacenter Topology and Routing – 20%
Milestone 2: Implement Datacenter Transport – 20%
Milestone 3: Implement Datacenter Load Balancing – 20%

20% — Midterm Exam
Midterm exam will be closed-book with no collaboration allowed.

20% — Final Exam
Final exam will be closed-book with no collaboration allowed. The syllabus will only include topics covered after the midterm.

9 Course Schedule

Week	Dates	Topic
1	Jan 8 – Jan 12	Course Introduction
2	Jan 15 – Jan 19	Course Background I
3	Jan 22 – Jan 26	Course Background II
4	Jan 29 – Feb 2	Datacenter Architecture and Topology
5	Feb 5 – Feb 9	Datacenter Routing and Load balancing
6	Feb 12 – Feb 16	Datacenter Transport **Project Milestone 1 due**
7	Feb 19 – Feb 23	Software-defined Networking
8	Feb 26 – Mar 1	Programmable Data Plane
9	Mar 4 – Mar 8	In-Network Computing **Midterm Exam**
10	Mar 11 – Mar 15	**Spring Break**
11	Mar 18 – Mar 22	Multi-tenancy in the Cloud
12	Mar 25 – Mar 29	Datacenter Network for RDMA **Project Milestone 2 due**
13	Apr 1 – Apr 5	Resource Disaggregation inside Datacenter
14	Apr 8 – Apr 12	Optics inside Datacenter
15	Apr 15 – Apr 19	**Final Exam**
16	Apr 22 – Apr 26	**Project Milestone 3 due**

10 Grading Scale

The breakpoints for letter grades is shown below. Typically the final letter grade for a student will be based on their raw cumulative score at the end of the semester (normalized to 100 while accounting for the weight of each assignment and exam). However, the final raw score may be "curved up" to adjust for the difficulty level of assignments and exams, resulting in a potentially better final letter grade. For example, a raw score of 74 (B–) for a student 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 uniformly applied to each student's final raw 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. 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. More details are available on our course Brightspace under "University Policies and Statements". 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, examinations, 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 which 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 own 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. More details are available on the course Brightspace table of contents, under "University Policies and Statements".

14 Accessibility

Purdue University strives to make learning experiences as accessible as possible. If a student anticipates or experiences physical or academic barriers based on disability, they are welcome to let the instructor know so that they can discuss options. Students are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

15 Mental Health/Wellness Statement

If a student finds themselves beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, they should try WellTrack. Students can sign in and find information and tools at their fingertips, available to them 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. Call 765-494-1747. Hours of operation are Mon–Fri, 8am–5pm.

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 semester. 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, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

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 (PDF) or (Word)*.

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.