CEE 461 – Pavement Engineering
(Introduction to Pavement Engineering)

University of Hawaii at Manoa
Department of Civil and Environmental Engineering
Fall Semester 2022

Course Objective: (Specific outcomes)

The objective of this class is to introduce the subject of pavement engineering. Pavement structures are engineered structures composed of several layers. Typically, the top layer consists of a bound material. The two most commonly used materials for surface layers are Portland Cement Concrete (PCC) and Asphalt Concrete (AC). A good understanding of pavement design requires an understanding of the behavior of these materials and of the underlaying base, subbase, and subgrade materials. Mechanistic-empirical analysis of pavement structures also requires an understanding of the distribution of stresses and strains under different temperature, moisture, and aging conditions.

Consequently, this class has two main parts. In the first half of the class we will look at asphalt concrete mix design (you have already seen PCC mix design in another class). For this, we will also briefly study the tests performed on asphalt cements and aggregates to obtain the engineering properties relevant for mix design. In the second half, we will concentrate on pavement design, including older empirical pavement design procedures such as AASHTO and CALTRANS (HDOT) and mechanistic-empirically based design procedures such as that of the Asphalt Institute. We will also study some of the fundamentals of mechanistic-empirical pavement design.

At the end of the class, you are expected to have acquired enough understanding of the fundamental concepts of mix and pavement design that will allow you to continue learning about this subject on your own in the future.

Instructor: **Adrian Ricardo Archilla**

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Class Hours: Monday and Wednesday: 16:30 – 17:45.

Room: POST 126

Office Hours: Monday & Wednesday: 1:30 p.m. to 2:30 p.m. or by appointment.

Text (recommended): Asphalt Institute (2015). MS-2: Asphalt Mix Design Methods, 7th Edition, Asphalt Institute. (There is an electronic version currently available at for $75 at http://bookstore.asphaltinstitute.org/catalog/book/ms-2-asphalt-mix-design-methods). If you are interested in the paperback version, the same site has a link that takes you there.) You may get a lower price with online retailers.

Evaluation: Tests will be graded in a scale from 0 to 100 points. The final grades will be calculated based on the following weighting distribution:

Class project/assignments/quizzes/attendance	20 %
Midterm	35 %
Final exam	45 %
Total	100 %

Quizzes: To incentivize regular study of the material in class, I will use some online polls and quizzes.

Grading scale: Grades will be assigned according to the following scale. However, regardless of the overall score, obtaining less than 40/100 in the final would automatically result in an F.

97.00 – 100.0 %	=	A+	68.00 – 71.99 %	=	C
94.00 – 96.99 %	=	A	62.00 – 67.99 %	=	C-
90.00 – 93.99 %	=	A-	58.00 – 61.99 %	=	D+
85.00 – 89.99 %	=	B+	54.00 – 57.99 %	=	D
80.00 – 84.99 %	=	B	50.00 – 53.99 %	=	D-
76.00 – 79.99 %	=	B-	below 50 %	=	F
72.00 – 75.99 %	=	C+			

Other Course Policies:

1) Regular attendance: You are required to attend class regularly and arrive to class on time. Failing to attend 50% of the classes results in an automatic F.
2) You must wear covered shoes for any lab work. If you show up wearing slippers, sandals, or similar footwear you will not be permitted to work in the lab and will be asked to leave.
3) Hot Mix Asphalt (HMA) preparation requires extensive preparation (heating of aggregates and asphalt binder to appropriate temperatures, mixing, compaction and other details you will learn soon). Thus, to be able to perform the tests, for example, the compaction of an HMA specimen, work needs to be done throughout the day. Thus, these tasks cannot be arranged within the scheduled class time. Each group will be required to do the preparation work for preparing their specimens (gradation analysis, specific gravity determination, batching, etc.)
4) Students are expected to observe the University of Hawaii student code of conduct (http://studentaffairs.manoa.hawaii.edu/policies/conduct_code/). Please, check it out and pay particular attention to section IV.B.
5) Do not use laptops, netbooks, tablets, or other electronic devices for activity outside of its use in this class (email, surf the web, etc.).
6) Cheating will not be tolerated. Please, review the university policies at: http://www.catalog.hawaii.edu/about-uh/campus-policies1.htm
7) The final exam is cumulative although, typically, it has more emphasis on the subjects not covered in the midterm.

Other Useful References:

In addition to the recommended manual, class notes will be posted on the class webpage (accessible through Laulima.) The following references complement the lecture materials if you decide you want to learn beyond what we discuss in class:

1. R.B. Mallick and T.El-Korchi (2013). *Pavement Engineering: Principles and Practices*, Second Edition, CRC Press, Taylor & Francis Group, Boca Raton, Florida.
2. A.T. Papagianakis and E.A. Masad (2008). *Pavement Design and Materials*, John Wiley & Sons, Inc., Hoboken, New Jersey.
3. Taylor, P.C., S.H. Kosmatka, G.F Voigt, et al. (2006). *Integrated Materials and Construction Practices for Concrete Pavement: A State-of-the-Practice Manual*, FHWA Publication No. HIF-07-004, U.S. Department of Transportation, Federal Highway Administration (Available online at http://www.cptechcenter.org/publications/imcp/)
4. Mamlouk M.S and J.P. Zaniewski (2006). Materials for Civil and Construction Engineers, Second Edition, Pearson Prentice Hall, New Jersey.
5. HAPI Asphalt Paving Guide, Hawaii Asphalt Paving Industry (http://hawaiiasphalt.org/education/pavement-guide/)
6. “Hot Mix Asphalt Materials, Mixture Design and Construction”, Second Edition, by Roberts, Kandhal, Brown, Lee, and Kennedy, NAPA Education Foundation, Maryland, 1996.
7. “Performance Graded Asphalt, Binder Specification and Testing” Superpave Series No. 1 (SP-1), Third Edition, Asphalt Institute, 2003
8. “Superpave Mix design” Superpave Series No. 2 (SP-2), Third Edition, Asphalt Institute, 2001.
9. “Pavement Analysis and Design”, Second Edition, by Yang H. Huang, Pearson Prentice Hall, 2004
10. "Life-Cycle Cost Analysis in Pavement Design," publication number FHWA-SA-98-079 (available in electronic format on the FHWA's LCCA website http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.htm).

CEE 461 – Introduction to Pavement Engineering Topics		
University of Hawaii at Manoa **Department of Civil & Environmental Engineering**		**Prof. Adrian Ricardo Archilla** **Fall 2022**
Important dates		**Subject**
		Introduction
		Aggregate Blending, Absorption, and Specific Gravity
		Aggregates: Production and Physical Properties
M	**9-5**	**Holiday: Labor Day (non-instructional day)**
		Introduction to Asphalt, Asphalt Types and Uses, Asphalt Physical Tests
		History of Asphalt Grading Systems, Superpave Performance Graded Binder Tests, Specifications and Selection
		Volumetric Analysis of HMA Mixtures
		Superpave Mix Design
		Delivery and Placement of HMA, Compaction, Pavement Failure, M&R
		CBR, R-Value, Resilient Modulus, Review
		Flexible Pavement Design: Introduction
		HMA Performance Tests
W	**10-19**	**Midterm (Tentative)**
		Specialty mixes (Porous Mixes, Stone Matrix Asphalt, etc.)
		AASHTO Design Procedure
		HDOT Design Procedure
		Asphalt Institute Design Procedure
		Stresses and Strains in Flexible Pavements
		Introduction to the Mechanistic-Empirical (ME) approach
		Design of Rigid Pavements
		Stresses in Rigid Pavements
		Other topics (time permitting): Pavement Management Systems, Pavement Preservation, etc.
		Presentations of projects
		Course Evaluation
M	**12-12**	**Final Exam – Time: 4:30-6:30 PM**

Relationship of course to student outcomes (SOs): The table below describes the emphasis onn this class related to outcomes based on the following scale:

"blank" = no emphasis; 1 = some emphasis; 2 = moderate emphasis; 3 = significant emphasis

Outcomes / Course	1	2	3	4	5	6	7
CEE 461	3	1	2	1	2	3	2

The student outcomes (SOs), also known as program outcomes, describe the skills that students are expected to have at the time of graduation. ABET SOs are listed below:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.