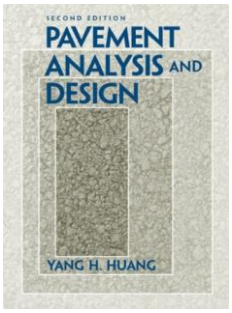
CE 5351 Mechanistic Pavement Analysis and Design

Lecture Sessions: MW 6 pm-7:20 pm
Class Room Building, CRBL C201
Spring 2018



Instructor: Reza Ashtiani, Ph.D. (reza@utep.edu)
Office: A-217
Office Hours: Students are always welcome
Text: Pavement Analysis and Design, by Yang H. Huang, Second Edition, Publisher: Pearson-Prentice Hall, 2004.
Class Website: www.rezasalehi.com/CE-5153

OBJECTIVES OF COURSE

The objective of this course is to provide civil engineering graduate students with an understanding of the analysis and design of highway/airfield pavements. The main focus of the course will be on the analysis and design of rigid and flexible pavements using the TXDOT design methods as well as the AASHTO's new Mechanistic Empirical Pavement Design Guide (MEPDG). The course requires students to have sufficient background knowledge in civil engineering materials such asphalt, Portland Cement Concrete (PCC), and unbound granular materials.

This course has been developed to provide students with the needed knowledge to analyze and design flexible and rigid pavements. Upon successful completion of this course, the student will have gained knowledge in the following areas:

- ***Material Characterization:*** Characterize the mechanical properties of unbound and stabilized granular layers. Apply measured soil properties to pavement design. Explain the behavior of granular materials under moving traffic loads and discuss factors that influence their performance. Identify foundation types used for pavements and their properties. Determine the inotropic elastic material properties required for characterization of asphalt concrete and Portland cement concrete pavement.

- ***Pavement Response Calculation:*** Calculate stresses, strains, and deflections in flexible pavements using layered elastic solutions. Calculate wheel load and temperature stresses in concrete pavements using nonlinear and anostropic equations.

- ***Traffic Analysis:*** List the types and axle configurations of typical highway trucks and their corresponding standard loads. Discuss the concept of Equivalent Single Axle Load (EASL) and axle load spectra. Convert mixed traffic into an equivalent single axle load for the design of flexible and rigid pavement systems.

- ***Pavement Design:*** Design new flexible pavements using the AASHTO method, Asphalt Institute method, TXDOT design procedure and proposed new Mechanistic-Empirical Pavement Design Guide (MEPDG). Design new rigid pavements using the AASHTO method, PCA method, TXDOT, and MEPDG design procedure. List the processes required to design a flexible and rigid pavement system.

- ***Pavement Distress Identification:*** Identify different modes and types of distresses common to flexible and rigid pavements. Discuss the repair methods and preventive measure for elimination or mitigation of the pavement distresses.

- ***Analysis of Pavement Performance:*** Apply asphalt concrete fatigue algorithms and unbound layer rutting equations for the design of flexible pavements. Utilize existing concrete fatigue transfer functions to relate load repetitions to fatigue cracking.

SCHEDULE

A tentative lecture schedule is on the class website. Reading assignments from your text and handouts will be assigned in class at the end of each lecture session. Prepared notes will occasionally be handed out in class to supplement, or in some cases to substitute for, reading material from the book. Be sure to save the notes because you will be tested over at least some of the material in them.

GRADING

Your grade for this course will be determined on the basis of ***1050 points*** as follows:

1. Final comprehensive examination (400 points)
2. Homework Assignments (300 points)
3. Term Project (300 points)
4. Critical Assessment (attendance and involvement in discussions) (50 points)

In accordance with University regulations, students who miss examinations will receive grades of zero. Exceptions to this rule will be made only on a carefully considered individual basis and only if the student contacts the instructor ***before*** the exam. If you know in advance that you are going to miss an exam, it is ***your*** responsibility to inform the instructor before the exam.

GRADE STRUCTURE

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

Letter Grade	Percentage	Performance
A	90-100	Excellent Work
B	80-89	Very Good Work
C	70-79	Average Work
D	60-69	Below Average Work
F	0-59	Failing Work

HOMEWORK

All homework problems will be assigned in the class. The due date for homework submission is one week after the assigned date before 7:30 pm. Past experience clearly shows that a student's grade is strongly dependent upon the effort that is put into working and understanding the homework. Homework solutions will be available on due dates. Please note that each student is responsible to submit the homework assignment individually.

COURSE PORTFOLIO

Students are required to prepare an electronic course portfolio documenting all materials relevant to the course. The portfolio shall contain Power Point lecture notes, class notes, handouts, exams, homework assignments, study notes, and any relevant materials accumulated during the semester. I believe that you will benefit from the portfolio years later when you need to review the learned subjects for advanced courses or professional engineer licensure exam.

POLICY ON CHEATING

Students are expected to be above reproach in all scholastic activities. Students who engage in scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the university. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student, or the attempt to commit such acts (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22). Scholastic dishonesty harms the individual, all students, and the integrity of the university. Policies on scholastic dishonesty will be strictly enforced.

COURSE/INSTRUCTOR EVALUATION

An online course/instructor evaluation will be conducted near the end of the semester.

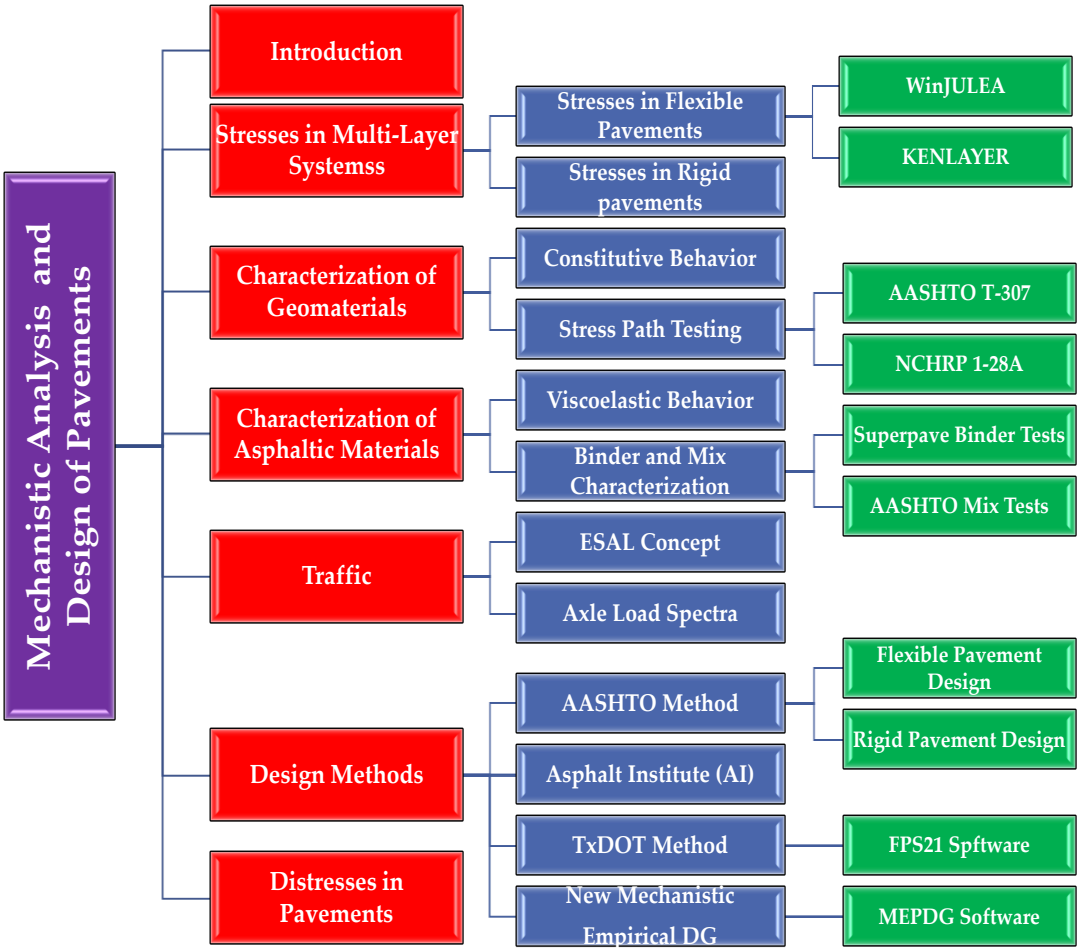
FINAL COMMENT

Good luck to all of you in this course. Please do not hesitate to ask questions in class, or if necessary, to see your professor outside of class. Any specific comments that students have on how the course might be improved are particularly welcomed, especially during the semester.

CE5351
Mechanistic Pavement Analysis and Design

TENTATIVE CLASS OUTLINE

Topic No.	*Description*
1	***Introduction:*** General definitions of multi-layer systems, flexible pavements and rigid pavements. Overview of the pavement design process.
2	***Pavement Responses:*** Calculation of stresses, strains and deformations of rigid and flexible pavement layers subjected to traffic loads. Isotropic, linear and nonlinear solutions for multi-layer systems. Identification of critical stresses/strains that control the performance of flexible pavements. Stability analysis of the unbound and stabilized aggregate layers. Overview of response calculation software such as WinJulia, KENLAYER, KENPAVE, FPS21 and TTI-Pave.
3	***Material Characterization:*** Viscoelastic characterization of asphalt materials. Stress sensitivity, nonlinearity and anisotropy of unbound granular materials. Influence of particle geometry on the performance of pavement layers. Moisture sensitivity and nonlinear behavior of subgrade soils.
4	***Traffic Loading:*** Equivalent Single Axle Load (ESAL), load equivalency, and axle load spectra concept. Stress path testing of geomaterials to simulate moving wheel loads.
5	***Structural Design of Pavements:*** Mechanistic Empirical Design Guide (MEPDG), TXDOT method (TxME), Asphalt Institute method, AASHTO method. Overview of new AASHTOWare and FPS21 software.
6	***Distresses in Pavements:*** Identification and characterization of major distresses such as fatigue cracking, rutting and thermal cracking. Failure mechanisms and models, shakedown theory, Plastic-Elastic strain ratio method, Three parameter Lytton's model.
7	***Pavement Performance:*** Analysis of damage in pavements, present serviceability concept, influence of climatic conditions on pavement performance, relationship between pavement structure and fatigue performance. International Roughness Index (IRI) concept.


Mechanistic Analysis and Design of Pavements
Introduction
Stresses in Multi-Layer Systemss
Stresses in Flexible Pavements
Stresses in Rigid pavements
WinJULEA
KENLAYER
Characterization of Geomaterials
Constitutive Behavior
Stress Path Testing
AASHTO T-307
NCHRP 1-28A
Characterization of Asphaltic Materials
Viscoelastic Behavior
Binder and Mix Characterization
Superpave Binder Tests
AASHTO Mix Tests
Traffic
ESAL Concept
Axle Load Spectra
Design Methods
AASHTO Method
Asphalt Institute (AI)
TxDOT Method
New Mechanistic Empirical DG
Flexible Pavement Design
Rigid Pavement Design
FPS21 Spftware
MEPDG Software
Distresses in Pavements