Time: 9:00 AM -10:30 AM Tuesday, Thursday
Location: ARMS 1103

Instructor:
Prof. Vikas Tomar, Ph.D. **Phone**: 4-3423 (765-494-3423 for off-campus)
2033 ARMS **e-mail**: tomar@purdue.edu

Office hours:
Recitation time to be decided based on common agreement

USE PIAZZA for Homework and Exam Discussions (all exams are in the form of a take-home project and require project report submission. Besides office hours online consulting sessions will be provided for exams as well)

VERY IMPORTANT: All E-Mail Attachments must be in PDF format.
Try to Keep Emails short and to the point. If you need to say or explain something in extreme details then use attachments.

EMERGENCY
Public announcement from Purdue
(Please enroll at: http://www.purdue.edu/emergency/)
PLEASE NOTE THAT Purdue's home page (www.purdue.edu) is the official source of emergency information.

Pre-requisite/Needed Qualifications:
Necessary Background:
(1) Mechanics of Materials and Structural Analysis
Review Websites:
Undergraduate Mechanics
http://web.mst.edu/~mecmovie/
Graduate Mechanics
http://solidmechanics.org/
(2) Linear Algebra:
Review Website
http://www.sosmath.com/matrix/matrix.html
(3) MATLAB Tutorial
- http://www.mathworks.com/academia/student_center/tutorials/launchpad.html

(4)
ABAQUS basic software runs

Required text: Course Notes and Handouts

Goals:
Focus of this course is on exploring applications of data science to mechanics of materials related models and experiments. Emphasis is on (a) hands on use of finite element related models for formulating data science problems (e.g. n-point correlation functions to describe material microstructures, data science procedures to formulate material constitutive behavior etc.) and (b) on correlating design of experiments with automated data extraction in high throughput experiments such as indentation experiments and sensor data fusion type of experiments. A third part of course is focused on analyzing available options in high volume data processing and analytics with emphasis on mechanics of materials applications. In a typical 14 week semester, data science analyses procedures

using mechanics of materials simulations will be typically done in 7 weeks, and experimental data science procedures will be focused upon for 7 weeks.

Objectives AND Envisioned Outcomes:

By the end of course students are expected to understand fundamental insights into the following questions:

1. How different data science procedures are related to mechanics of materials simulations and how students can benefit from them in their own research?
2. How they can design high throughput experimental data collection to feed into data science based improvements?
3. How a combination of simulations and high throughput experiments can be useful for engineering problem solving?

The course is expected to fill gap between data science method development and realistic applications of data science by adopting a practical approach/

Topics:

Month of Jan 2021

Introduction to Data Science and Various Mechanical of Materials Models Experiments, ABAQUS model runs to be used in the class for the machine learning Models, Experimental Data Classification needed for Data Science
Jan 19, 21
Jan 26, 28

Month of Feb 2021

Use of data analyses tools: Python and Anaconda, Basic SQL, Basic Panda, Matplotlib, scikit-learn; project-1 due end of February. We work on project 1 through recitation. Project 1 is due at the end of Feb.
Feb 2, 4
Feb 9, 11
Feb 16, 18
Feb 23, 25

Month of March 2021

Integrating anaconda/python/NumPy, scikit-learn, matplotlib with machine learning Based on regression, regularization, decision trees, Naïve Bayes, Support Vector Machines, Principal Component Analyses, Model Evaluation Metrices
March 2, 4
March 9, 11
March 16, 23
March 25, 30

Month of April 2021

We work on GANs based deep learning and revise the concepts for machine learning so far. We also focus on data quality and what it implies for accuracy of predictions in mechanics of materials problems.
April 1, 6
April 13, 15
April 20, 22

April 27, 29

ADDITIONS, AMENDMENTS, OR CORRECTIONS TO THIS SYLLABUS MAY BE MADE THROUGHOUT THE SEMESTER VIA IN CLASS ANNOUNCEMENTS, HANDOUTS, OR E-MAIL.

Assessment:
The course has one data analysis project, one machine learning project, and one deep learning project which is the final project. Final project is your final exam.

Grading:
Data Analysis Project: 30%; Machine Learning Project: 30% Deep Learning Project: 40%

Grades scale.

$$\begin{bmatrix} A+ & A & A- \\ B+ & B & B- \\ C+ & C & C- \\ D+ & D & D- \end{bmatrix} = \begin{bmatrix} 97\% & 93\% & 90\% \\ 87\% & 83\% & 80\% \\ 77\% & 73\% & 70\% \\ 67\% & 63\% & 60\% \end{bmatrix}$$

Please confirm your scores (i.e., homework assignments and exams) in Brightspace throughout the semester. Students' final letter grades will be based on their scores in Brightspace.

The above scale may be adjusted down but not up. For example, 95 is a guaranteed A while 89 may possibly be an A- depending upon the curve of grading.

ALL SUBMISSIONS MUST BE IN PDF FORMAT.

Late submissions will not be accepted and zero grades will be given. Depending upon the personal grievance/problem individual exception may be given depending upon the gravity of situation (contact instructor at least one lecture in advance of the submission date).

(New!) Academic Guidance in the Event a Student is Quarantined/Isolated

Special exception will be given to quarantined/isolated students if they cannot submit homework/exams. The corresponding exams/homeworks will not be counted in overall grades and corresponding score will be weighted based on remaining submissions.

If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager can be reached at acmq@purdue.edu and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation. The Office of the Dean of Students (odos@purdue.edu) is also available to support you should this situation occur.

Report Submission Format:
ALL EXAMS ARE IN THE FORM OF A PROJECT.

FORMAT FOR EXAM PROJECT REPORT (see posted sample reports on Brightspace):

- Turn in a 10 page maximum excluding the title page and table of contents.
- The 10 page limit also excludes appendix.
- Please submit in acrobat pdf format. No other format is acceptable.
- Please put extraneous information such as codes, long data tables, and data execution etc. in appendix.
- At most 4 figures (figures also means plots with at most two parts e.g. (a) (b) of each figure) are allowed in 10 pages (extra plots in appendix ok).
- Information put in appendix is for your own mental satisfaction. I don't look in appendix.

The report should have:

1. Cover page with title, student name (not counted in the 10 page limit)
2. Table of contents page (not counted in the 10 page limit)
3. An abstract page (counted in 10 page limit are bullets 3 to 8)
4. Objective or introduction: Describe briefly what the reader will see in your report.
5. Setup or procedure: Describe briefly how you create your FEM model.
6. Describe the model.
7. Results and Discussions:
8. Conclusion: Brief synopsis of what you have one in previous steps with most focus on your findings.

Students attending this class have a fair experience in writing the report. However, for uniformity, the following layout must be followed in report outline. Suggested format is US-Letter sized page with 1" margin on all side, Times New Roman 12 sized font with single spacing.

Software:

We will use conda and pandas environment for datasceince with multiple packages accessible thorugh that. ABAQUS for materials simulations will also be focused upon.

Policies:

The *University Regulations Handbook* reads: "Students are expected to be present for every meeting of the classes in which they are enrolled." Regular attendance will not be taken, but if you must miss a class, you are responsible for the lecture material, assignments and / or announcements made.

Late homework will generally not be accepted except in the case of illness or serious emergency (see COVID-19 discussion on page-3). Contact the instructor *before the due date* (if possible) to arrange an acceptable due date.

Illnesses and emergencies should be documented with an appropriate authority (such as a doctor etc.)

Grading corrections:

Any disputes over grading should be brought to the instructor.

Attendance

I will try giving video link to lectures. All homework and exam submissions are online. All exams are take-home exams.
Students should stay home and contact the Protect Purdue Health Center (496-INFO) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts 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 conflict, when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at 765-494-1747. Our course Brightspace includes a link on Attendance and Grief Absence policies under the University Policies menu.

Classroom Guidance Regarding Protect Purdue

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace prior to and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights.

Related Considerations:

1. ***A listing of recommended safe practices for the specific class or laboratory setting (other PPE or safety behavior) can be found at the links below.***
    - **Overarching SOP for Classrooms, Instructional Laboratories, and Experiential Courses**
2. ***References Supporting Protect Purdue Compliance:***
    - **Office of the Dean of Students Protect Purdue Compliance Plan: Ask, Offer, Leave, Report**

- **Office of the Dean of Students Managing Classroom Behavior and Expectations**

Academic Integrity. http://www.purdue.edu/odos/osrr/academic-integrity/index.html

- **Syllabus statement.** "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 that is submitted provides the greatest opportunity for the university to investigate the concern."
- **Purdue Honors Pledge.** "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."
- **Commercial Websites.**
  - In general, notes are "considered to be 'derivative works' of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials." As such, they cannot be sold or bartered without your express written permission. See the policy with regard to commercial note taking in classes that you may wish to include in your syllabus (see part J of the Purdue student misc. conduct regulations).
  - Course materials may NOT BE posted anywhere due to copyright issues.

Diversity & Inclusion

- 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. Purdue's nondiscrimination policy can be found at: http://www.purdue.edu/purdue/ea_eou_statement.html.

- **When interacting with colleagues (on campus or off-campus), please conduct yourself in a professional, respectful manner**
  - Please help to ensure that we have a positive working environment
  - We want to have fun, but not at the expense of others
  - No jokes or comments that are insensitive with regards to gender, race, religion, sexual orientation, etc.
  - No wall art or white board graffiti that may be considered insensitive
  - No social media posting that portrays anyone associated with AAE in a less than positive manner

Mental Health Syllabus Statement

CAPS Information: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours

Students with Disabilities

- **The Disability Resource Center (DRC)** is a resource for students and instructors. Students may present a "Letter of Accommodation" to you at any point in the semester. Should you have questions about accommodations, please contact the DRC at: 494-1247 or drc@purdue.edu. In many cases the DRC can partner with you to develop inclusive teaching strategies that benefit all students in your class.
- **Accessibility and Accommodations Syllabus Statement:** Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: **drc@purdue.edu** or by phone: 765-494-1247." http://www.purdue.edu/drc/faculty/syllabus.html

Emergency Procedures

- Emergency notification is vital! .
    - Keep your cell phone on to receive a Purdue ALERT text message. (in this case our common text system)
    - Log into a Purdue computer connected to the network…will receive any Desktop Popup Alerts.
    - If you have a "no cell phone" in class policy allow one or two students who have signed up for Purdue ALERT to keep their phones on to receive any alerts.

EMERGENCY PREPAREDNESS – A MESSAGE FROM PURDUE

To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages, view www.purdue.edu/ea.

There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. If you feel threatened or need help, push the button and you will be connected immediately.

If we hear a fire alarm during class we will immediately suspend class, evacuate the building, and proceed outdoors. Do not use the elevator.

If we are notified during class of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in [the basement].

If we are notified during class of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting the door and turning off the lights.

Please review the Emergency Preparedness website for additional information.
http://www.purdue.edu/ehps/emergency_preparedness/index.html

Wang Hall Emergency Procedures

A comprehensive listing of all Armstrong Hall emergency procedures and other information is available in the Building Emergency Plan (BEP). Click the link below to access the ARMS BEP.

https://engineering.purdue.edu/AAE/safety/safety/Shelter_In_Place_Instructions