

**Course Registration Numbers:** 13522 (on campus) and 13523 (EPE)

**Schedule:** Tuesdays and Thursdays at 9:00 - 10:15 am in 2599 Wang Hall

**Instructor:** Michael D. Sangid; Email: msangid@purdue.edu  
Office: 3329 ARMS; Telephone: 494-0146  
Office Hours: Wednesdays 3:00 – 4:00 pm  
Additionally, I will be briefly available immediately after class or by appointment. Appointments will be scheduled within a week of the request. **For assistance with HW, contact the TA (not the instructor).**

**TA:** Veerappan Prithivirajan Email: vprithiv@purdue.edu  
Office Hours: Prithivi will hold regular office hours for HW assistance.  
***Mondays 3:00 – 5:00 pm in room 3118 ARMS.***

**Prerequisites:** Prior course in mechanics of materials (AAE 204)

**Highly Recommended Text:** *Metal Fatigue in Engineering*, Ali Fatemi, Wiley, 9780471510598

**Supplemental Texts (for reference only):**

*Mechanical Behavior of Materials*, Norman E. Dowling, Prentice Hall  
*Fatigue of Materials*, Subra Suresh, Cambridge  
*Fundamentals of Structural Integrity*, A.F. Grandt, Jr., Wiley  
Additional relevant journal papers will be posted to Blackboard

**Course Website:**

We will be using Blackboard. The current schedule as well as supplementary information will be kept on Blackboard. The HW and presentations displayed in class will be found on Blackboard.

**Learning Objective:**

To develop methods for characterizing fatigue resistance of materials and predicting cyclic lives of structural components; discuss approaches for preventing fatigue failures through materials selection, fatigue resistant design, and "fleet management" concepts. Both crack initiation (stress and strain based) and crack propagation (fracture mechanics) approaches are developed and compared. While general class concepts compare to a variety of structures, emphasis throughout is on aerospace applications.

**Description:**

Development and application of methods for predicting the fatigue life of structural components. Characterization and response of materials to cyclic loading. Fatigue resistant design of structures. Both fatigue crack initiation and crack propagation concepts are discussed.

**Approach:***Lectures:*

All students are expected to keep up with the materials and homework assignments and to live up to the highest standards of honesty and integrity. Lectures will include presentation of concepts and methods and working of examples. A typical class period will include a lecture highlighting the important concepts and integrating examples. On campus students are expected to be present and prompt for class and encouraged to ask questions during class. To facilitate, the typical lecture will last for approximately one hour, which leaves sufficient time for questions and answers at the end. The class will be a mixture of Powerpoint slides and written notes on the DocumentCamera (DocCam). A pdf of the slides will be provided on Blackboard. Any notes written on the DocCam or annotations made on the slide presentations will not be provided, as it is expected that the students will take notes during lecture, including relevant points discussed by the instructor, as a means of active learning. EPE students will receive course credentials to view the lectures remotely. For on campus students, lectures can be viewed, please contact the instructor. At any point during the semester, if attendance in the class falls below a quorum, the instructor reserves the rights to change the on campus login credentials, thus disabling access to the pre-recorded videos. There will be 1 or 2 guest lecturers during the semester, thus offering subject matter experts. To show respect to these professionals who travel to Purdue to lecture, attendance will be mandatory during these lectures (which will be announced in advance).

*Office Hours:*

The instructor will hold office hours on Wednesdays at 3 to 4 pm in ARMS 3329. During this time, the instructor will be connected to WebEx to enable off campus students to have regular discussions.

Access to WebEx during this time:

URL: <https://purdue.webex.com/>

Instructions: On the toolbar, click on Meeting Center

Meeting number: 646 671 253

Meeting password: rZPiRw2g

*Policy on Emails:*

Emails will be checked once per day (but not continuously). Please allow approximately 24 hours for a reply during the week and email responses will not occur over the weekend. Most responses to emails will be written during office hours.

Instructor will not respond to emails regarding the HW. Please email the TA.

The TA will provide short responses to your emails and will not provide detailed HW solutions (nor a step by step guide to do the HW).

*Announcements:*

Announcements will occur at the beginning of each lecture and will be posted on Blackboard, including HW due dates, exams, guest lecturers, review sessions, and pre-recorded lectures.

*Discussion Board:*

The discussion board feature on Blackboard is enabled and will be regularly monitored by the TA. Students are encouraged to discuss the HW, but if HW solutions are directly provided or any other unethical behavior is exhibited, the instructors reserves the right to disable this feature.

### *Homework:*

Assigned weekly on the previous Tuesday (given on Blackboard) and due on the following Tuesday. On campus students should turn in their assignment during class. Distance students should upload their HW assignment to the designated folder on blackboard by 5 pm est on Tuesday. Late HW will not be accepted. There will be approximately 10 HW assignments throughout this course.

The HW is for your own benefit and is necessary to properly learn the material. It is expect that each student put forward an honest effort in solving each problem. Although discussion of assignments between students is permitted, the solution should represent your own efforts and understanding of the problem. Blatant copies of the solutions will not be accepted, and repeated evidence of copying will lead to failure of the course.

Lastly, the purpose of homework assignments is for students to gain further understanding of classroom principles through application to practical problems. A critical aspect is problem solving and thinking about strategies to solve each question. This training is important to your overall understanding of the material and the ability to do well on the exams. HW will be graded based on approach, demonstration of work, and effort (not necessarily on the answer). Full credit will be given if the student has demonstrated that thought and effort has been put into the solution and the student is on the right track. If the question is not attempted, minimal effort is given, the student gives a flippant response, or the trajectory towards the solution is completely off path, then no credit will be given for this question. The grades will be posted on blackboard. The individual HW will not be marked up to identify where the student deviated from the path and give partial credit, as we would rather dedicate this time to put into spending time with students a priori and towards teaching. Instead, a detailed HW solution will be given to the students after the HW is submitted. This HW solution can be used as a study guide towards the exam.

### *Exams:*

There will be two midterm exams and one final exam. Exams will be accumulative. Midterms will be held at night, to allow students more time and space. A non-communicating calculator and 8.5"x11" *crib* sheet are allowed. The *crib* sheet must be hand-written and cannot be duplicated and used by another student. The material on the exam will be closely related to the lectures and types of questions asked on the HW. Prior to the exam, the TA will host an in-class review. The TA will have no prior knowledge of the questions on the exam. Yet, the TA has a strong academic track record and can give guidance on studying and answer questions about the material. Note – the instructor does not necessarily endorse any views by the TA.

- Midterm 1 – Thursday, September 28, 6:30 to 7:30 pm in ARMS 1010
- Midterm 2 – Wednesday, November 1 6:30 to 7:30 pm in ARMS 1010
- Final Exam – (comprehensive, date TBD by university)

The exam solutions will not be distributed to the students, but will be reviewed in class. Exam grades will not be openly discussed. If the students have grade appeals, they must submit a written appeal along with the original copy of their graded exams within one week of the exams being returned. The exam will be re-graded, which may reduce the overall grade, as any grading that was too generous may be corrected.

**Grading:** 3 Credit Hours – HW (20%), Midterm 1 (25%), Midterm 2 (25%), and Final (30%). In general, we will have a 90%|80%|70%|60% grade scale with +/- grades. Depending on how the class performs on its assignments and tests, the instructor reserves the right to curve the scale in the favor of the class, if necessary, based on his discretion. Grades will never be curved downward.

**Definition of Academic Dishonesty:** Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty" ([University Regulations](#), Part 5, Section III, B, 2, a). Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest" (University Senate Document 72-18, December 15, 1972).

**Academic Integrity:** "Purdue University values intellectual integrity and the highest standards of academic conduct. To be prepared to meet societal needs as leaders and role models, students must be educated in an ethical learning environment that promotes a high standard of honor in scholastic work. Academic dishonesty undermines institutional integrity and threatens the academic fabric of Purdue University. Dishonesty is not an acceptable avenue to success. It diminishes the quality of a Purdue education which is valued because of Purdue's high academic standards" (S. Akers, *Academic Integrity, A Guide for Students*, 1995, revised 1999). Also, see PURDUE UNIVERSITY CODE OF HONOR

**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."*

**Students with Disabilities:** Students with disabilities requiring additional assistance should make themselves known to the instructor.

**Campus Emergency:** 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.

**Additional Information:** This class will uphold Purdue University's policies on 'Attendance and Grief Absence', 'Adverse Weather', 'Campus Emergency', etc. Please consult [purdue.edu](http://purdue.edu) for more information.

**Schedule:**

A detailed schedule will be posted on Blackboard and updated regularly. The topics covered during each lecture will be summarized during the announcements. Below is an outline of topics with reading in parentheses, which correspond to sections in the *Metal Fatigue in Engineering* required text.

1. Introduction, History, Motivation for Fatigue, Syllabus (1) – 1 lecture
2. Design for Fatigue (2) – 2 lectures
3. Stress - Life Approach – 6 lectures
  - Overview of stress-life (4.1-4.2)
  - Mean Stress Effect (4.3)
  - Notch Effect (7.1-7.2)
  - Factors Influencing stress-life (4.4)
  - Residual Stresses (8)
  - Surfaces Effects (4.4) and Shot Peening (8)
  - Variability in Fatigue / Scatter (13)
4. Strain - Life Approach – 5 lectures
  - Bauschinger Effect and Hysteresis Loops (5.1-5.3)
  - Overview of Strain-Life (5.4-5.5)
  - Mean Stress Effect (5.6)
  - Shakedown / Ratcheting
  - Energy Methods
  - Notches and Neuber's Rule (7.3)
5. Physics of Fatigue – 2 lectures
  - Slip Bands – Crack Initiation (3, supplementary reading)
  - Microstructure Effect (supplementary reading)
6. Multiaxial Fatigue – 2 lectures
  - Multiaxial Stress States (10.1-10.3)
  - Critical Plane Approach (10.4)
7. Fatigue Crack Growth – 6 lectures
  - Intro to Fracture (6.1)
  - Crack Tip Plasticity (6.1-6.2)
  - Fracture Toughness (6.3)
  - Fatigue Crack Growth (6.4)
  - Mean Stress and Crack Closure (6.5-6.7)
  - Small Cracks (6.8-6.9)
8. Environmental Effects – 2 lectures
  - Corrosion and Local Chemistry (11.1)
  - Thermo-mechanical fatigue (11.4)
  - Dwell Loading Effects
9. Variable Amplitude – 2 lectures
  - Linear/ Non-linear Approaches (9.1-9.4)
  - Cycle Counting - Rainflow Method (9.5)
10. Based on time (optional) – 1 lecture
  - Fatigue of Eng Material, composites, ceramics, etc (supplementary reading)



## EMERGENCY PREPAREDNESS SYLLABUS ATTACHMENT

**EMERGENCY NOTIFICATION PROCEDURES** are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately evacuate the building.
- Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.
- **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (Shelter in Place) in a safe location within the closest building.
  - “Shelter in place” means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency\*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

*\*In both cases, you should seek additional clarifying information by all means possible...Purdue Emergency Status page, text message, Twitter, Desktop Alert, Albertus Beacon, digital signs, email alert, TV, radio, etc...review the Purdue Emergency Warning Notification System multi-communication layers at [http://www.purdue.edu/ehps/emergency\\_preparedness/warning-system.html](http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html)*

### **EMERGENCY RESPONSE PROCEDURES:**

- Review the **Emergency Procedures Guidelines**  
[https://www.purdue.edu/emergency\\_preparedness/flipchart/index.html](https://www.purdue.edu/emergency_preparedness/flipchart/index.html)
- Review the **Building Emergency Plan** (available on the Emergency Preparedness website or from the building deputy) for:
  - evacuation routes, exit points, and emergency assembly area
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.

### **EMERGENCY PREPAREDNESS AWARENESS VIDEOS**

- "Shots Fired on Campus: When Lightning Strikes," is a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See:  
<http://www.purdue.edu/securePurdue/news/2010/emergency-preparedness-shots-fired-on-campus-video.cfm>  
(Link is also located on the EP website)

### **MORE INFORMATION**

Reference the Emergency Preparedness web site for additional information:  
[https://www.purdue.edu/ehps/emergency\\_preparedness/](https://www.purdue.edu/ehps/emergency_preparedness/)