Course Syllabus

(NOTE: This is a preliminary draft of the course syllabus. The final version will be provided at the end of the first week of classes)

1. Course Information

AE/ME 7774		Fatigue of Materials and Structures (~ 3hrs/week)	**Fall Term 2025**
Mondays/Tuesdays	:	**To be Confirmed**	
Wednesdays/ Thursdays	:	**To be Confirmed**	

2. Instructor & Grader Information

Instructor & Grader:	Dr. Louis SATYANARAYAN Ph.D.
Email :	Louis.Satyanarayan@georgiatech-metz.fr
Office Room Number:	226
Office Hours (by appointment):	Tuesdays: 11:00AM – 12:00PM
	Thursdays: 11:00 AM – 12:00 PM

3. Syllabus/Topics covered

Objective

To provide a working knowledge of state of the art methods and contemporary issues of fatigue life prediction and associated physical processes, with emphasis on metal fatigue.

Course Overview

No.	Chapter Name	Description
1	Physics of Fatigue Processes	• Crack nucleation • Crack propagation ○ metals, polymers, ceramics

2	Stress & Strain Response of Metals	• Monotonic tensile tests
		• Temperature and rate dependence
		• Cyclic response
		  ○ hardening, softening
		  ○ cyclic stress-strain curve
		  ○ with / without residual stresses.

3	Strain Life Relationships:	• Stress-life and Basquin's Law

	LCF, HCF	• Coffin-Manson Law • Cyclic property estimates • Combined strain-life curve
	Quiz 1	
4	Influence of Mean Stress, Surface Finish, Hardness	• Role of mean stresses on small crack nucleation/growth • Models for mean stress effects • Load sequence effects on mean stress • Effects of surface finish and hardness on fatigue
5	Fatigue at Notches	• Theoretical stress concentration, size effects and Kf • Neuber's rule and notch root stress-strain analysis • Load sequence effects on notch root behavior
6	Variable Loading	• Cycle counting techniques and history reconstruction • Damage summation - linear and nonlinear approaches • Component calibration curves • Applications to loading spectra
	Quiz 2	

7	Scatter in Fatigue	• Probability distributions for scatter of
		  ○ fatigue strength
		  ○ fatigue life (S-N curves)
		• Size effects and weak link theory
		• Scatter in HCF versus LCF

8	LEFM Concepts and growth laws for physically long cracks	• Stress intensity factor and DK • Cyclic crack tip fields • Paris growth law • Threshold and fracture regimes • Crack closure and DKeff
9	Growth of small/short cracks	• Characteristics of microstructurally small crack growth • Mechanics considerations/ Residual strength analyses. • Kitagawa diagram and HCF thresholds • Small cracks growing from notches • Transition to long crack behavior
	Quiz 3	
10	Multiaxial fatigue	• Historical overview of multiaxial HCF and LCF crack initiation • Critical plane observations for small fatigue cracks • Gamma plane representation
	Final Exam	