# Advanced Mechanics of Materials

**Fall 2017**

**Instructor:** Ashfaq Adnan

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**Office Hours:** by appointment

**Section Information:** AE 5304-001/002; ME 5304-001/002

**Time and Place of Class Meetings:** Room WH 402: Woolf Hall

Tuesday-Thursday 9:30 am – 10:50 am

**Description of Course Content:** This graduate level course will cover the calculation of stresses and strains in a body that experiences elastic, plastic and/or viscoelastic deformation. This course will also highlight hyperelasticity to show large deformation behavior of materials and piezoelectricity to demonstrate the voltage-displacement relations of piezoelectric materials.

**Prerequisite:** MAE 2312 (Solid Mechanics) or equivalent.

**Textbooks:** None. All necessary materials will be supplied by the instructor.

**Suggested Reading:**

1. Theory of Elasticity (3rd Edition) by S.P. Timoshenko and J. N Goodier
2. Theory of Viscoelasticity (2nd Edition) by Richard M. Christenson
3. Theory of Plasticity (3rd Edition) by J. Chakrabarty
4. Classical and Computational Solid Mechanics by Y. C. Fung and Pin Tong
5. Special Topics in the Theory of Piezoelectricity by Jiashi Yang (Editor)

# Nano Mechanics and Materials: Theory, Multiscale Methods and Applications by Wing Kam Liu, Eduard G. Karpov and Harold S. Park

**Student Learning Outcomes:**

After the completion of this course, students should be able to:

* describe the elastic, plastic and viscoelastic behavior of materials from their stress-strain curves;
* understand the physical interpretation of material constants in mathematical formulation of constitutive relations;
* solve analytically the simple boundary value/initial value problems with elastic, elasto-plastic, viscoelastic, thermoelastic or thermoviscoelastic properties;
* recognize the roles of surface elasticity and surface stress on the elastic deformation of nanomaterials.
* understand the constitutive relation between a mechanical stress and an electrical voltage in piezoelectric solids.

**Course Content**: The topics listed below will be covered during this course.

1. Stress and Strain
2. Constitutive Relations
   1. Elasticity
   2. Hyper-elasticity
   3. Viscoelasticity
   4. Plasticity
3. Benchmark Problems (Boundary value/Initial Value)
   1. Elasticity
   2. Viscoelasticity
   3. Plasticity
4. Special Topic:
   1. Piezoelectricity

**Descriptions of major assignments and examinations:**

* There will be homework assignments, project, one midterm exam and one final exam.
* Details about the project will be discussed in class.
  + **Homework:** Assigned during the Tuesday classes and due dates are defined in the assignment.
  + **Midterm:** Tentative schedule - October 26, 2017
  + **Final Project Due:** December 5, 2017
  + **Final Exam:** December 14, 2017, 8.00 am to 10.30 am.
  + Homework turned in late (after 5.00 pm of the due date) will receive a 20% penalty per class until solution is posted. No late home work will be accepted after the solution is posted. UTA regulations permitting, missed midterms and/or final exams can only be rescheduled when missed due to major health problems or circumstances beyond the student’s control. With instructions discretion, students will be required to reschedule the missed exams at the earliest time possible.
  + **Grading Policy**: Final numerical grade for each student will be determined based on his/her total earned points on a scale from 0 to 100. The total earned points for each student will be computed by adding points obtained by the student from midterm exam, homework assignments and final exam.
  + **Point Distributions:**

Homework + Project 30

Midterm 35

Final Exam 35

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Total points 100

The final letter grade for each student will be determined from his/her final numerical grade according to the following ranges:

**Tentative Grading Scale Letter Grade**

90 – 100 A

80 – 89 B

70 – 79 C

60 – 69 D

00 – 59 F

**Attendance:** At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods of evaluating students’ academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I will take attendance sporadically. Students are strongly recommended to attend each class. While UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients “begin attendance in a course.” UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Blackboard. This date is reported to the Department of Education for federal financial aid recipients.

**Drop Policy:** Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://wweb.uta.edu/aao/fao/>).

**Americans with Disabilities Act:** The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the *Americans with Disabilities Act (ADA)*. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at [www.uta.edu/disability](http://www.uta.edu/disability) or by calling the Office for Students with Disabilities at (817) 272-3364.

**Academic Integrity:** Students enrolled in this course are expected to adhere to the UT Arlington Honor Code:

*I pledge, on my honor, to uphold UT Arlington’s tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*

*I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents’ Rule* 50101, §2.2, suspected violations of university’s standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student’s suspension or expulsion from the University.

**Student Support Services**:UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to [resources@uta.edu](mailto:resources@uta.edu), or view the information at [www.uta.edu/resources](http://www.uta.edu/resources).

**Drop Policy:** Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://wweb.uta.edu/aao/fao/>).

**Disability Accommodations:** UTArlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including *The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA),* and *Section 504 of the Rehabilitation Act.* All instructors at UT Arlington are required by law to provide “reasonable accommodations” to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of **a letter certified** by the Office for Students with Disabilities (OSD).Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting: **The Office for Students with Disabilities, (OSD)** [www.uta.edu/disability](http://www.uta.edu/disability) or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at [www.uta.edu/disability](http://www.uta.edu/disability).

Counseling and Psychological Services (CAPS) [www.uta.edu/caps/](http://www.uta.edu/caps/) or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

**Non-Discrimination Policy:** *The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit*[*uta.edu/eos*](http://www.uta.edu/hr/eos/index.php)*.*

**Title IX Policy:** The University of Texas at Arlington (“University”) is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated.*For information regarding Title IX, visit* [www.uta.edu/titleIX](http://www.uta.edu/titleIX) or contact Ms. Jean Hood, Vice President and Title IX Coordinator at (817) 272-7091 or [jmhood@uta.edu](../../../hannabas/AppData/Local/Microsoft/Windows/Temporary%20Internet%20Files/Content.Outlook/697W32M3/jmhood@uta.edu).

**Academic Integrity:** Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

*I pledge, on my honor, to uphold UT Arlington’s tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*

*I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents’ Rule* 50101, §2.2, suspected violations of university’s standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student’s suspension or expulsion from the University. Additional information is available at <https://www.uta.edu/conduct/>.

**Electronic Communication:** UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

**Campus Carry:** Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit <http://www.uta.edu/news/info/campus-carry/>

**Student Feedback Survey:** At the end of each term, students enrolled in classes categorized as “lecture,” “seminar,” or “laboratory” shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student’s feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington’s effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit <http://www.uta.edu/sfs>.

**Final Review Week:** for semester-long courses**,** a period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

**Emergency Exit Procedures:** Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist handicapped individuals.

**Woolf Hall 406 Computer Teaching Lab Policies:**

1. WH 406 must be officially reserved for all events including classroom instructions due to the limited classroom space equipped with computers and scheduling logistics. Please see Lanie or Janet for reservation.

2. WH 406 is a computer teaching lab. Faculty and Instructors must be present while students occupy this room.  When an instructor leaves the room, students are to leave WH 406 as well.  Instructors should encourage students to use WH 320 if needed after class is over. The computer lab in WH 320 is available for MAE student access 24/7.

3. WH 406 doors are not to be propped open.  Propped doors are considered a security breach by the UTA Police Department and a hazard violation by the Fire Inspector.

4. Food, drink, and tobacco products are prohibited in WH 406.

**Emergency Phone Numbers**: In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911. Non-emergency number 817-272-3381

**Course Schedule**

| **Lecture** | **Mechanics** | **Topic** |
| --- | --- | --- |
| 1 | Statics and Solid Mechanics | Review of Mechanics of Material - I |
| 2 | Review of Mechanics of Material - II |
| 3 | Elasticity | Foundation of Elasticity |
| 4 | 2D problems in Rectangular Coordinates – I |
| 5 | 2D problems in Rectangular Coordinates - II |
| 6 | 2D problems in Polar Coordinates – I |
| 7 | 2D problems in Polar Coordinates – II |
| 8 | Hyper-Elasticity  And Thermo-Elasticty | Hyperplastic Materials |
| 9 | Thermal Stress Analysis |
| 10 | Reserve | |
| 11 | Viscoelasticity | Foundation of Viscoelasticity |
| 12 | Differential Constitutive Equations |
| 13 | Hereditary Integral Representations of Stress and Strain |
| 14 | Elementary Viscoelastic Stress Analysis for Bars and Beams |
| 15 | Viscoelastic Stress Analysis in Two and Three Dimensions -I |
| 16 | Viscoelastic Stress Analysis in Two and Three Dimensions -II |
| 17 | Midterm Exam (tentative) | |
| 18 | Plasticity | Foundation of Plasticity |
| 19 | Elastoplastic Bending/Torsion |
| 20 | Elastoplastic Boundary Value Problems - I |
| 21 | Elastoplastic Boundary Value Problems - II |
| 22 | Plane Problems in Plastic Flow and Collapse -I |
| 23 | Plane Problems in Plastic Flow and Collapse -II |
| 24 | Reserve | |
| 25 | Piezoelectricity | Theory and Mathematical Foundation |
| 26 | 2D Piezoelectric Boundary Value Problem - I |
| 27 | 2D Piezoelectric Boundary Value Problem -II |
| 28 | Nanoelasticity  &  Nanomechanics | Foundation of Surface Stress and Surface Elasticity |
| 29 | Size Effect and Mechanics of Nanostructures |
| 30 | Reserve | |

*As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. –Ashfaq Adnan*