

UNIVERSITY OF CALIFORNIA, DAVIS  
Department of Materials Science and Engineering

**EMS 272: Advanced Functional Properties of Materials (CRN: 23056)**  
**4 units, WF 10:00-11:50 am**

**Lecture Locations: W: Social Sciences 90; F: Bainer 1062**  
**COURSE OUTLINE – Winter 2023**

**Instructor** Professor Yayoi Takamura  
2015 Kemper Hall  
email: ytakamura @ ucdavis.edu  
Office hours: Tuesdays at 11am AND Fridays at 1:30pm, or by appointment. Unless otherwise announced, we will meet in Kemper 2015. A Zoom option will be available.

**Reader** Hudson Shih  
email: hashih @ ucdavis.edu  
Office hours: Wednesdays at 4pm in Kemper 119. A Zoom option will be available.

**Course Description**

Fundamental physical properties of materials important to solid state devices, specifically electronic, magnetic, dielectric, and optical properties and the implementation of these properties into devices.

**Recommended Textbooks:** This course will not follow a single textbook but will select the best sections of various textbooks for each topic. A copy of these textbooks will be on course reserves and on the Reading List through Canvas.

1. R.E. Hummel, *Electronic Properties of Materials*, 3<sup>rd</sup>/4<sup>th</sup> Edition, Springer, 2001/2011, ISBN: 0-3876-95144/1-4419-8163-9 (4<sup>th</sup> edition available electronically (free) or in paperback form from Springer when using a UC Davis IP address)
  2. L. Solymar, D. Walsh, (and R.R.A. Syms), *Electrical Properties of Materials*, 7<sup>th</sup>/8<sup>th</sup>/9<sup>th</sup>/10<sup>th</sup> Edition, Oxford Press, 2004/2010/2014/2018, ISBN: 978-0199267934/978-0199596935/978-0198702788/978-0198829959
  3. S.O. Kasap, *Principles of Electronic Materials and Devices*, 3<sup>rd</sup>/4<sup>th</sup> Edition, McGraw-Hill, 2006/2018, ISBN: 978-0073104645/978-0078028182
  4. N.A. Spaldin, *Magnetic Materials: Fundamentals and Device Applications*, 2<sup>nd</sup> Edition, Cambridge University Press, 2011, ISBN: 978-0521886697
  5. T. Tsurumi, H. Hirayama, M. Vacha, and T. Taniyama, *Nanoscale Physics for Materials Science*, CRC Press, 2010, ISBN: 978-1439800591
  6. S. Trolrier-McKinstry and R.E. Newnham, *Materials Engineering: Bonding, Structure, and Structure-Property Relationships*, Cambridge University Press, 2018, ISBN: 978-1107103788
- Supplemental readings (i.e., journal articles, small sections from additional textbooks) will be required and available through Canvas.

**Prerequisites** Graduate standing in Engineering, Physics, or Chemistry, or passed EMS 172 with a grade of B or above.

<b>Grading</b>	Homework (~ 5 assignments)	30%
	Group Oral Presentation	15%
	Midterm Exam (around Friday, February 10 <sup>th</sup> , in class)	25%
	Final Exam (Thursday, March 23 <sup>rd</sup> from 8-10 am)	30%

The grades may be curved up (otherwise grades will be assigned according to point values). Regrade requests for homework and exams must be submitted within ONE week of the release of the grades for each assignment.

A request for Student-Assisted Course Recording has been submitted for the Wednesday lectures held in Social Sciences Room 90. A recording of the Friday lectures held in Bainer 1060 will be available. However, if in-person attendance falls dramatically, then this service will be suspended. The availability of the recordings is intended for students who must miss lecture due to personal or family illness, or to review lecture materials.

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**Course Policies**

1. Homework is due by 10am on the specified due date to Canvas. No late homework will be accepted. **Double check your electronic submissions each time to ensure that all pages are submitted correctly without corruption.** Ensure plenty of time before the submission deadline to account for internet or Canvas connectivity issues. Canvas automatically timestamps submissions.
2. Save your homework files with clear names, including your name, the class name, and the assignment name (i.e., EMS272\_HW1\_YOUR NAME). This protocol will avoid submission of the incorrect assignments.
3. For questions involving images that I provided, you can screen capture the image and mark your answers electronically using programs such as Word, PowerPoint, or Paint. (i.e. use the 'Print Screen' button on your keyboard and paste the image into the other program)
4. Exams will be closed book, closed notes, but you will be allowed one 8 ½ “ x 11” cheat sheet (double sided) for the midterm exam and two 8 ½ “ x 11” cheat sheets (double sided) for the final exam. You should ensure you have a calculator (NO smartphones will be allowed). A ruler is recommended.
5. Unless you are instructed otherwise, you may discuss homework problems with other students in the class, but submitted work must be your own. The UC Davis Code of Academic Conduct will be strictly enforced. (see <https://ossja.ucdavis.edu/code-academic-conduct>)
6. It is expected that students will abide by the UC Davis Principles of Community (see <https://diversity.ucdavis.edu/principles-community>). These policies include not sharing course materials on other websites (i.e., CourseHero, Chegg).

**Use of Plotting Software**

Homework may require the use of plotting software to calculate equations and plot data. No specifications of any particular software will be made, but options include Excel, Matlab, Python, Origin, Google Sheets etc... Note that Office 365 is available for all UC Davis students <https://iet.ucdavis.edu/content/free-microsoft-office-365-now-available-all-uc-davis-students>

**Student Resources**

Prof. Susan Ebeler has compiled an extensive list of valuable student resources at:  
<https://ebeler.faculty.ucdavis.edu/resources/faq-student-resources/>

**Plagiarism Statement**

According to Dictionary.com, plagiarism is defined as: “*I: an act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author’s work as one’s own, as by not crediting the original author*”.

**UC Davis Copyright Statement**

My lectures and course materials, including PowerPoint presentations, tests, outlines, and similar materials, are protected by U.S. copyright law and by University policy. I am the exclusive owner of the copyright in those materials I create. You may take notes and make copies of course materials for your own use. You may also share those materials with another student who is enrolled in or auditing this course. You may not reproduce, distribute or display (post/upload) lecture notes or recordings or course materials in any other way — whether or not a fee is charged — without my express prior written consent. You also may not allow others to do so. If you do so, you may be subject to student conduct proceedings under the UC Davis Code of Academic Conduct. Similarly, you own the copyright in your original papers and exam essays. If I am interested in posting your answers or papers on the course web site, I will ask for your written permission.

**UC Davis Student Disability Center (SDC) Statement**

UC Davis is committed to educational equity in the academic setting, and in serving a diverse student body. I encourage all students who are interested in learning more about the Student Disability Center to contact them directly at [sdc.ucdavis.edu](https://sdc.ucdavis.edu), [sdc@ucdavis.edu](mailto:sdc@ucdavis.edu) or 530-752-3184. If you are a student who currently receives academic accommodation(s), please submit your SDC Letter of Accommodation to me as soon as possible, ideally within the first two weeks of this course.

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**Tentative Reading List - Winter 2023**

Topic	Reading
Electronic Structure	(Review <i>Hummel</i> Ch. 1-5), <i>Hummel</i> Ch. 6, <i>Tsurumi</i> , Ch. 2 Extracurricular reading on STM
Conductors	<i>Hummel</i> Ch. 7
Semiconductors	<i>Solymar &amp; Walsh</i> Ch. 8; <i>Kasap</i> Ch. 5
Electronic Devices	<i>Muller &amp; Kamins</i> ; <i>Pierret</i> ; <i>Rockett</i> (supplemental)
Optical Properties	<i>Hummel</i> Ch. 10-12
Dielectric/Ferroelectric Properties	<i>Kasap</i> Ch. 7; <i>Trolier-McKinstry &amp; Newnham</i> Ch. 28
Magnetic Properties/Devices	<i>Hummel</i> Ch. 14-17; <i>Spaldin</i> ; Supplemental reading

Additional supplemental readings (required) and extracurricular readings (optional) will be available on the course Canvas site.