SYLLABUS

Materials for the Electronics of the 21st Century (Physics 8101)

Tuesday and Thursday 12:30—1:45 PM, room 137 Physics Bldg.

INSTRUCTORS

Dr. Carsten A. Ullrich
E-mail: ullrichc@missouri.edu
Office Location: 424 Physics Bldg.
Phone: (573) 882-2467

Dr. Suchi Guha
E-mail: guhas@missouri.edu
Office Location: 422 Physics Bldg.
Phone: (573) 884 3687

COURSE DESCRIPTION

The objective of this course is to provide students with a deep understanding of the materials science underlying the operating principles of electronic devices expected to be fabricated in the 21st century. These materials include inorganic and organic semiconductors and those characterized by strongly correlated electrons such as magnetic materials, multiferroics, oxides, superconducting ceramics, carbon-based materials, and topological insulators. Neutron scattering and other experimental techniques will be discussed as tools for characterizing the structure and the elementary excitations of these materials (spin waves, phonons) as well as the transitions between different ordered phases.

COURSE OUTLINE

Module 1: Electronic Structure of Materials

- Review of the basic concepts in condensed-matter physics
- Optoelectronic materials and optical processes
- Semiconductor device physics
- Methods of theoretical and computational materials science

Module 2: Magnetic, superconducting, and strongly correlated materials

- Structure and elementary excitations in magnetic materials
- Superconductivity and strongly correlated materials
- Quantum Hall effect
- Topological insulators and exotic quantum phases of matter

Module 3: Carbon-based materials

- Excitations in organic semiconductors
- Charge/energy transfer phenomena: applications in displays/solar cells
- Molecular magnets and organic spintronics
- Nanotubes, fullerenes, graphene

Module 4: Nanoscale electronics

- Nanoscale optoelectronics
- Landauer theory of nanoscale transport
- Scaling limits for CMOS
- Materials science of quantum computation

PREREQUISITES

Students should have a good working knowledge of quantum mechanics and electromagnetism.

TEXTBOOKS AND COURSE MATERIAL

There is no required textbook. Students will be provided with lecture notes and assigned reading material.

There will be a course web site (Blackboard) on which course material will be posted, and where students will have a forum for discussion.

COURSE POLICIES

Students are expected to attend all lectures and in-class discussions. Writing assignments should be submitted by their due dates. After that, **no late assignments will be accepted**.

To encourage interdisciplinary and diversified discussions, the students will be divided into groups according to their background. After the end of each 50-minute lecture, the students will participate actively in the 20-minute, in-class group discussions. The students of each group are also expected to discuss and share information on the assigned projects for the term reports and the final paper; however, **students should submit their own writing assignments independently**.

ASSIGNMENTS

- There will be a 20-minute **in-class group discussion** after each lecture. Questions for discussion will be provided before each lecture by the instructor. Participation in the group discussions will contribute 5% toward the total course grade.

- There will be **2 term reports**. Each group will discuss the project and cooperate on literature search. Then **every student will write his/her own term report** based on the group discussions. Each term report will account for 25% of the total grade. Term Report Format: please use the journal template that is provided to you (from Physica Status Solidi) for all your writing assignments.

- There will be a **final paper**. The format requirement of the final paper is the same as that of the term report. Students will choose from a selection of topics, which examines an issue in greater depth. The article will be submitted and evaluated in a preliminary and a final draft. There will be a 10-minute in-class presentation on the last day of classes. The final paper and presentation will contribute 45% toward the final grade.

GRADING SCALE

Scale: A>80%, B: 70-80%, C: 60-70%, D: 40-60%, F<40%

STUDENTS WITH DISABILITIES

If you anticipate barriers related to the format or requirements of this course, if you have emergency medical information to share with me, or if you need to make arrangements in case the building must be evacuated, please let me know as soon as possible.

If disability related accommodations are necessary (for example, a note taker, extended time on exams, captioning), please register with the Office of Disability Services (http://disabilityservices.missouri.edu), S5 Memorial Union, 573- 882-4696, and then notify me of your eligibility for reasonable accommodations. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage.

UNIVERSITY POLICY ON ACADEMIC DISHONESTY

Academic honesty is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards academic dishonesty as an extremely serious matter, with serious consequences that range from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, or collaboration, consult the course instructor.

Academic Dishonesty includes but is not necessarily limited to the following:

A. Cheating or knowingly assisting another student in committing an act of cheating or other academic dishonesty.

B. Plagiarism which includes but is not necessarily limited to submitting examinations, themes, reports, drawings, laboratory notes, or other material as one's own work when such work has been prepared by another person or copied from another person.

C. Unauthorized possession of examinations or reserve library materials, or laboratory materials or experiments, or any other similar actions.

D. Unauthorized changing of grades or markings on an examination or in an instructor's grade book or such change of any grade report.

Academic Integrity Pledge:

Students are expected to adhere to this pledge on all graded work whether or not they are explicitly asked in advance to do so: "I strive to uphold the University values of respect, responsibility, discovery, and excellence. On my honor, I pledge that I have neither given nor received unauthorized assistance on this work."

The University has specific academic dishonesty administrative procedures. Although policy states that cases of academic dishonesty must be reported to the Office of the Provost for possible action, the

instructor may assign a failing grade for the assignment or a failing grade for the course, or may adjust the grade as deemed appropriate. The instructor also may require the student to repeat the assignment or to perform additional assignments. In instances where academic integrity is in question, faculty, staff and students should refer to Article VI of the Faculty Handbook. Article VI is also available in the M-Book. Article VI provides further information regarding the process by which violations are handled and sets forth a standard of excellence in our community.

In the event of a suspected incident of misconduct, the instructor plans to use option B (M-book, page 17; see http://conduct.missouri.edu/wp-content/uploads/2011/08/M-Book-2011-2012.pdf).

INTELLECTUAL PLURALISM

The University community welcomes intellectual diversity and respects student rights. Students who have questions or concerns regarding the atmosphere in this class (including respect for diverse opinions) may contact the Departmental Chair or Divisional Director; the Director of the *Office of Students Rights and Responsibilities* (http://osrr.missouri.edu/); or the *MU Equity Office* (http://equity.missouri.edu/), or by email at equity@missouri.edu. All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.

ACADEMIC INQUIRY, COURSE DISCUSSION AND PRIVACY

University of Missouri System Executive Order No. 38 lays out principles regarding the sanctity of classroom discussions at the university. The policy is described fully in Section 200.015 of the Collected Rules and Regulations. In this class, students may not make audio or video recordings of course activity, except students permitted to record as an accommodation under Section 240.040 of the Collected Rules. All other students who record and/or distribute audio or video recordings of class activity are subject to discipline in accordance with provisions of Section 200.020 of the Collected Rules and Regulations of the University of Missouri pertaining to student conduct matters.

Those students who are permitted to record are not permitted to redistribute audio or video recordings of statements or comments from the course to individuals who are not students in the course without the express permission of the faculty member and of any students who are recorded. Students found to have violated this policy are subject to discipline in accordance with provisions of Section 200.020 of the Collected Rules and Regulations of the University of Missouri pertaining to student conduct matters.