جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Contemporary Topics in Materials Science - MSE 394

Division	Physical Science and Engineering Division
Course Number	MSE 394
Course Title	Contemporary Topics in Materials Science
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Sun Tue

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Aurelien Christophe Francois Manchon	aurelien.manchon@kaust.edu.sa	+966128084410	3232, 3, Ibn Sina (bldg. 3)	

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course introduces seminal concepts in many-body quantum physics in condensed matter. Fundamental theoretical tools such as second quantization, Green's function formalism, as well as Feynmann diagrams will be introduced. These tools will be used to treat particles interactions such as electron-electron, electron-phonon and electron-impurities. The concept of quasiparticle, imaginary time Green's function, kinetic equation will be explained. Methodology to investigate transport properties such as Kubo formula and quantum Boltzmann equation will be presented. Applications of these techniques in selected topics such as weak localization, Kondo and Hubbard models, Luttinger-Tomonaga liquid, heavy fermions and superconductivity will be discussed
Course Description from Program Guide	Lecture-based class
Goals and Objectives	- Objective 1: Understand the Kubo formula and apply it to calculate various response functions - Objective 2: Exploit Keldysh formalism to derive diffusion equations - Objective 3: Use Feynmann diagrams to compute interactions in many-body systems - Objective 4: Acquire a firm knowledge of the physics of strongly correlated materials
Required Knowledge	Good control of quantum mechanics
Reference Texts	Many-Body Quantum theory in condensed matter physics, Bruus and Flensberg, Oxford Graduate Texts, 2004 ISBN-13: 978-0-19-856633-5
Method of evaluation	**40.00**% - Oral presentation **60.00**% - Homework /Assignments
Nature of the assignments	The homeworks are problems to be solved and handed over by the student. In addition, the student will be requested to present two lectures on the application of the many-body techniques seen in class.
Course Policies	**Class policy:** Attendance to the class is mandatory; not handing back the homework in time will result in a “0” grade.

Additional Information	Heavy math ahead!

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 01/27/2019	Second quantization
1	Tue 01/29/2019	Second quantization
2	Sun 02/03/2019	Time dependence in quantum theory
2	Tue 02/05/2019	Time dependence in quantum theory
3	Sun 02/10/2019	Linear response theory
3	Tue 02/12/2019	Linear response theory
4	Sun 02/17/2019	Green's functions
4	Tue 02/19/2019	Green's functions
5	Sun 02/24/2019	Interacting mesoscopic systems
5	Tue 02/26/2019	Interacting mesoscopic systems
6	Sun 03/03/2019	Imaginary-time Green's functions
6	Tue 03/05/2019	Imaginary-time Green's functions
7	Sun 03/10/2019	Feynmann diagrams and external potentials
7	Tue 03/12/2019	Feynmann diagrams and external potentials
8	Sun 03/17/2019	Feynmann diagrams and pair interactions
8	Tue 03/19/2019	Feynmann diagrams and pair interactions
9	Sun 03/24/2019	Spring Break
9	Tue 03/26/2019	Spring Break
10	Sun 03/31/2019	The interacting electron gas
10	Tue 04/02/2019	The interacting electron gas
11	Sun 04/07/2019	Fermi liquid theory
11	Tue 04/09/2019	Fermi liquid theory
12	Sun 04/14/2019	Impurity scattering and conductivity
12	Tue 04/16/2019	Impurity scattering and conductivity
13	Sun 04/21/2019	Keldysh formalism
13	Tue 04/23/2019	Keldysh formalism
14	Sun 04/28/2019	Superconductivity
14	Tue 04/30/2019	Superconductivity
15	Sun 05/05/2019	Luttinger-Tomonaga Liquids
15	Tue 05/07/2019	Luttinger-Tomonaga Liquids
16	Sun 05/12/2019	Heavy fermions and slave bosons
16	Tue 05/14/2019	Heavy fermions and slave bosons
17	Sun 05/19/2019	Final Exam Week
17	Tue 05/21/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.