Tamkang University Academic Year 107, 2nd Semester Course Syllabus

Course Title	SPECIAL TOPICS IN MANY-BODY PHYSICS	Instructor	HSUEH, HUNG-CHUNG
Course Class	TSPXD1A DOCTORAL PROGRAM, DEPARTMENT OF PHYSICS, 1A	Details	◆ Selective ◆ One Semester ◆ 3 Credits

Departmental Aim of Education

Ⅰ. Conveying professional knowledge: Teach the students to learn the core knowledge of physics, to obtain the basic skills needed for physics research, and to apply the professional knowledge to physics related technologies.

Ⅱ. Analyzing and solving problems: Guide the students to analyze problems, and to acquire the mathematical ability to quantify conceptual models and also the capability needed to think and to innovate in solving various scientific and engineering problems.

Ⅲ. Training for experimental techniques: Teach the students on how to carry out and to verify various experiments, and at the same time to have the mentality of working cautiously and the awareness in operating safely.

Ⅳ. Expressing personal characteristics: Help the students to use their personal characteristics, like resolution, sincerity, and concentration, plus their professional skills to gain recognition among the executives and their peers.

Ⅴ. Cultivating team spirit: Train the students to have the organizational ability and the communicational skills to let them have the adaptability to integrate into a professional team, and to obtain the ability to bring out and to put to use the strength of the team to solve professional problems.

Ⅵ. Building international views: Comply to the trends of globalization to build an international learning environment and opportunities in order to educate the students to continue in their self-advancements, to absorb new worldwide knowledge, and to become a professional with international views in their future perspective careers.

Departmental core competences

A. To acquire the core knowledge in the field of physics.

B. To understand the overall features of specific fields of physics.

C. To learn the advanced knowledge of specific fields of physics.

D. To obtain the mathematical ability to quantify concepts, models, and practical problems.

E. To cultivate the basic ability to discover, to analyze, and to solve problems.

F. To practice the actual handling of physics problems.

G. To comprehend the trend of technological development and to acquire the knowledge and skills of other fields needed in their professional career.

H. To have good oral and written skills.

Course Introduction	Based on the fundamental quantum many-body theory, this lecture will cover the mean-field theory, collective electronic excitations, and many-body perturbation theory of electronics in condensed matter systems.

The Relevance among Teaching Objectives, Objective Levels and Departmental core competences

I.Objective Levels (select applicable ones) :

(i) Cognitive Domain : C1-Remembering, C2-Understanding, C3-Applying, C4-Analyzing, C5-Evaluating, C6-Creating

(ii) Psychomotor Domain : P1-Imitation, P2-Mechanism, P3-Independent Operation, P4-Linked Operation, P5-Automation, P6-Origination

(iii) Affective Domain : A1-Receiving, A2-Responding, A3-Valuing, A4-Organizing, A5-Charaterizing, A6-Implementing

II.The Relevance among Teaching Objectives, Objective Levels and Departmental core competences :

(i) Determine the objective level(s) in any one of the three learning domains (cognitive, psychomotor, and affective) corresponding to the teaching objective. Each objective should correspond to the objective level(s) of ONLY ONE of the three domains.

(ii) If more than one objective levels are applicable for each learning domain, select the highest one only. (For example, if the objective levels for Cognitive Domain include C3,C5,and C6, select C6 only and fill it in the boxes below. The same rule applies to Psychomotor Domain and Affective Domain.)

(iii) Determine the Departmental core competences that correspond to each teaching objective. Each objective may correspond to one or more Departmental core competences at a time. (For example, if one objective corresponds to three Departmental core competences: A,AD, and BEF, list all of the three in the box.)

No.	Teaching Objectives	Relevance	
		Objective Levels	Departmental core competences
1	Students will learn the application of quantum many-body theory in condensed matter systems	C2	C

Teaching Objectives, Teaching Methods and Assessment

No.	Teaching Objectives	Teaching Methods	Assessment
1	Students will learn the application of quantum many-body theory in condensed matter systems	Lecture, Discussion	Report, exercises

This course has been designed to cultivate the following essential qualities in TKU students	
Essential Qualities of TKU Students	Description
◇ A global perspective	Helping students develop a broader perspective from which to understand international affairs and global development.
◇ Information literacy	Becoming adept at using information technology and learning the proper way to process information.
◇ A vision for the future	Understanding self-growth, social change, and technological development so as to gain the skills necessary to bring about one's future vision.
◇ Moral integrity	Learning how to interact with others, practicing empathy and caring for others, and constructing moral principles with which to solve ethical problems.
◆ Independent thinking	Encouraging students to keenly observe and seek out the source of their problems, and to think logically and critically.
◇ A cheerful attitude and healthy lifestyle	Raising an awareness of the fine balance between one's body and soul and the environment; helping students live a meaningful life.
◇ A spirit of teamwork and dedication	Improving one's ability to communicate and cooperate so as to integrate resources, collaborate with others, and solve problems.
◇ A sense of aesthetic appreciation	Equipping students with the ability to sense and appreciate aesthetic beauty, to express themselves clearly, and to enjoy the creative process.

Course Schedule

Week	Date	Subject/Topics	Note
1	108/02/18 ~ 108/02/24	Review of 2nd quantization and many-body models	
2	108/02/25 ~ 108/03/03	Review of 2nd quantization and many-body models	
3	108/03/04 ~ 108/03/10	Electron in solids : Mean-field methods(Hartree approx.)	
4	108/03/11 ~ 108/03/17	Electron in solids : Mean-field methods(Hartree-Fock approx.)	
5	108/03/18 ~ 108/03/24	Electronic correlations	
6	108/03/25 ~ 108/03/31	Collective electronic excitations (plasmons, magnons, etc.)	
7	108/04/01 ~ 108/04/07	Collective electronic excitations (plasmons, magnons, etc.)	
8	108/04/08 ~ 108/04/14	Diagrammatic methods	
9	108/04/15 ~ 108/04/21	Diagrammatic methods	
10	108/04/22 ~ 108/04/28	Midterm Exam Week	
11	108/04/29 ~ 108/05/05	Many-body perturbation theory at T=0 (Green’ s functions)	

12	108/05/06～ 108/05/12	Many-body perturbation theory at T=0 (Wick’ s theorem)	
13	108/05/13～ 108/05/19	Many-body perturbation theory at T=0 (Hedin’ s equations)	
14	108/05/20～ 108/05/26	Many-body perturbation theory at T=0 (GW method)	
15	108/05/27～ 108/06/02	Many-body perturbation theory at T=0 (Quasiparticles)	
16	108/06/03～ 108/06/09	Many-body perturbation theory at finite temperatures	
17	108/06/10～ 108/06/16	Many-body perturbation theory at finite temperatures	
18	108/06/17～ 108/06/23	Final Exam Week	

Requirement	
Teaching Facility	Computer, Projector
Textbook(s)	Fundamentals of Many-body Physics Principles and Methods/ Wolfgang Nolting, Springer-Verlag (2009)
Reference(s)	A Guide to Feynman Diagram inn the Many-Body Problem / Richard D. Mattuck, 2nd ed., Dover (1992) Quantum Many-Particle Systems / John W. Negele and Henri Orlando, Addison-Wesley (1988) Many-Particle Physics / Gerald D. Mahan, 3rd ed., KA/PP (2000) Interacting Electrons / Richard M. Martin, Lucia Reining, and David M. Ceperley, Cambridge (2016)
Number of Assignment(s)	**5** (Filled in by assignment instructor only)
Grading Policy	◆ Attendance： % ◆ Mark of Usual：40.0 % ◆ Midterm Exam： % ◆ Final Exam： % ◆ Other〈exercises and report〉：60.0 %
Note	This syllabus may be uploaded at the website of Course Syllabus Management System at http://info.ais.tku.edu.tw/csp or through the link of Course Syllabus Upload posted on the home page of TKU Office of Academic Affairs at http://www.acad.tku.edu.tw/CS/main.php . **※ Unauthorized photocopying is illegal. Using original textbooks is advised. It is a crime to improperly photocopy others' publications.**