Course Syllabus

1	**Course title**	Solid State Physics	
2	**Course number**	0302471	
3	**Credit hours**	3	
	Contact hours (theory, practical)	3	
4	**Prerequisites/corequisites**	Quantum Mechanics (0332361)	
5	**Program title**	Physica	
6	**Program code**	2	
7	**Awarding institution**	The University of Jordan	
8	**School**	Science	
9	**Department**	Physics	
10	**Course level**	Senior (fourth year)	
11	**Year of study and semester(s)**	First semester, 2022-2023	
12	**Other department(s) involved in teaching the course**	None	
13	**Main teaching language**	English	
14	**Delivery method**	☒Face to face learning ☐Blended ☐Fully online	
15	**Online platforms(s)**	☐Moodle ☒Microsoft Teams ☐Skype ☐Zoom ☐Others…………	
16	**Issuing/Revision Date**	9/10/2022	

17 Course Coordinator:

Name: Sami H. Mahmood	Contact hours: 11:30 – 13:00 Mon, Wed.
Office number: 17	Phone number: 0796709673
Email: s.mahmood@ju.edu.jo	

18 Other instructors:

None

19 Course Description:

Crystal lattice and structure; reciprocal lattice; crystal binding; lattice vibrations; elastic scattering of waves; thermal properties of solids; free-electron gas, energy bands in solids.

20 Course aims and outcomes:

A- Aims: **The course contents are designed to:**

1. **Provide the students with essential knowledge on the structure of crystalline solids having different structural symmetries.**
2. **Establish an understanding of the relevance of reciprocal space to the structure of solids.**
3. **Establish an understanding of the different types of binding in solids, and provide the students with the knowledge and tools that are necessary to determine the binding energy in solids and molecules.**
4. **Establish an understanding of the lattice vibrational modes and properties of elastic waves in three-dimensional solid**
5. **Derive the density of states for elastic waves, and determine the contribution of lattice vibrations to the thermal properties of solids**
6. **Establish an understanding of the electronic distribution in a metal, and derive the electronic density of states based on the free, independent-electron model.**
7. **Establish an understanding of the role of electron dynamics and scattering processes on the thermal and electrical properties of a metal.**
8. **Explain the occurrence of energy bands in solids, within the free and nearly free electron model, and allow students to construct the energy bands for simple crystal structures.**

B- Students Learning Outcomes (SLOs):

Upon successful completion of this course, students will be able to:

Program SLOs / Course SLOs	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Define the lattice, basis, translation vectors, unit cell, crystal structure, and calculate atomic packing in 1-, 2-, and 3-dimensional solids	✓	✓					✓		
2. Identify symmetry operations, and determine the crystal structure, crystal planes and directions, and Miller indices.	✓	✓					✓	✓	
3. Construct the reciprocal lattice and know its relation to diffraction of waves by crystals.	✓	✓			✓	✓	✓	✓	✓
4. Explain Laue Equations, Brillouin zone, and calculate the structure factor for different crystal systems	✓	✓				✓	✓	✓	
5. Define bonds in crystals, inert gas crystals, Van der Waals-London interaction, repulsive interaction, and calculate the	✓	✓			✓	✓	✓		

cohesive energy of inert gas crystals.									
6. Define the ionic crystal, Madelung energy, Madelung constant, and calculate the lattice energy of ionic crystals.	✓	✓			✓	✓	✓		
7. Define the covalent, metallic, and hydrogen bonds	✓	✓			✓		✓		
8. Explain the vibrational modes in crystals, and derive the dispersion relations of elastic waves for monatomic and diatomic linear chain.	✓	✓					✓	✓	
9. Explain the acoustic and optical vibrational modes	✓	✓					✓		
10. Define the thermal properties of phonons, heat capacity, density of states, and calculate the heat capacity of a solid using Debye and Einstein models.	✓	✓				✓	✓	✓	
11. Discuss the thermal properties of solids in light of anharmonicity, crystal imperfections and phonon scattering mechanisms	✓	✓			✓		✓	✓	
12. Explain Fermi electron gas and Fermi-Dirac distribution as a function of temperature.	✓	✓			✓		✓		
13. Determine the Fermi energy and density of states for a free-electron system in various dimensions, and calculate the electronic contribution to specific heat of solids.	✓	✓					✓	✓	
14. Define the energy band structure in the nearly free electron approximation, the Bloch theory, and Kronig-Penney model.	✓	✓			✓		✓	✓	

21. Topic Outline and Schedule:

Week	Lecture	Topic	Intended Learning Outcome	Learning Methods (Face to Face/Blended/ Fully Online)	Platform	Synchronous / Asynchronous Lecturing	Evaluation Methods	Resources
1 9/10	1.1	Crystal structure	SLO(1),	Face to face			Test	For all units of this course, the students may refer to the following resources: *Text book and suggested references *Power Point Presentations & illustrations to be provided on e-learning and Microsoft Teams
	1.2	Crystal structure	SLO(1),	Face to face			Test	
2 16/10	2.1	Crystal structure	SLO(2),	Face to face			Test	
	2.2	Crystal Structure	SLO(2),	Face to face			Test	
3 23/10	3.1	Crystal Structure	SLO(2),	Face to face			Test	
	3.2	Reciprocal Lattice	SLO(3),	Face to face			Test	
4 30/10	4.1	Reciprocal lattice	SLO(3),	Face to face			Test	
	4.2	Reciprocal lattice	SLO(3),	Face to face			Test	
5 6/11	5.1	Reciprocal Lattice	SLO(4),	Face to face			Test	
	5.2	Reciprocal lattice	SLO(4),	Face to face			Test	
6 13/11	6.1	Crystal binding	SLO(5),	Face to face			Test	
	6.2	Crystal binding	SLO(5),	Face to face			Test	
7 20/11	7.1	Crystal binding	SLO(6),	Face to face			Test	
	7.2	Crystal binding	SLO(7),	Face to face			Test	

8 27/11	8.1	28/11/2022, First Exam						
	8.2	Phonon modes	SLO(8),	Face to face			Test	
9 4/12	9.1	Phonon modes	SLO(8),	Face to face			Test	
	9.2	Phonon modes	SLO(9),	Face to face			Test	
10 11/12	10.1	Thermal properties	SLO(10),	Face to face			Test	
	10.2	Thermal properties	SLO(10),	Face to face			Test	
11 18/12	11.1	Thermal properties	SLO(10),	Face to face			Test	
	11.2	Thermal properties	SLO(11),	Face to face			Test	
12 25/12	12.1	26/12/2022, Second Exam						
	12.2	Free electron gas	SLO(12),	Face to face			Test	
13 1/1	13.1	Free electron gas	SLO(13),	Face to face			Test	
	13.2	Free electron gas	SLO(13),	Face to face			Test	
14 8/1	14.1	Free electron gas	SLO(13),	Face to face			Test	
	14.2	Energy bands	SLO(14),	Face to face			Test	
15 15/1	15.1	Energy bands	SLO(14),	Face to face			Test	
	Tuesday, 17/01/2023 is the last day of teaching. 19/01/2023 – 30/01/2023 is the period of final exams							

22 Evaluation Methods:

Opportunities to demonstrate achievement of the SLOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	SLOs	Period (Week)	Platform
First Exam	25	Crystal structure & Reciprocal lattice	SLO(1) – SLO(4)	Week 8 (28/11/2022)	
Second Exam	25	Crystal binding & Phonon modes	SLO(5) – SLO(9)	Week 12 (26/12/2022)	
Final Exam	50	All course content	SLO(1) – SLO(14)		

23 Course Requirements

Each student should have access to a computer & internet connection

24 Course Policies:

A- Attendance policies:

Attendance is mandatory. Students who record absences more than the legally acceptable limit **may lose their chance to sit for the final exam of the course**.

B- Absences from exams and submitting assignments on time:

False medical reports and other devious ways to avoid taking exams on time are not acceptable. The students are encouraged to handle their responsibility and develop **positive learning attitudes**.

C- Health and safety procedures:

Follow the instructions regarding health and safety procedures in the university.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

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The course is designed to provide students with learning opportunities. Group work and discussions accompanied with individual input and hard work are encouraged to fulfill the objectives of the course, whereas **cheating and misbehavior are completely unacceptable**.

E- Grading policy:

Do not waste time arguing about grades and grading policies. Instead, invest your time in fruitful learning.

F- Available university services that support achievement in the course:

- ✓ E-learning resources
- ✓ Microsoft Teams
- ✓ Smart Class rooms
- ✓ Computer facilities

25 References:

A- Required book(s), assigned reading and audio-visuals:

*Textbook: Charles Kittel; Introduction to Solid State Physics, 8th Ed., (John Wiley & Sons, Hoboken, NJ, 2005)
Power point presentations and illustrations designed to explain the contents of the course.

B- Recommended books, materials, and media:

[1] J.S. Blakemore, Solid State Physics, 2nd Ed., (Cambridge University Press, Cambridge, 1985)
[2] M.S. Rogalski and S.B. Palmer, Solid State Physics, (Gordon and Breach Science Publishers, Australia, 2000)
[3] J. Richard Christman, Fundamentals of Solid State Physics, John Wiley & Sons, New York, 1988)

26 Additional information:

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Name of Course Coordinator: Sami H. Mahmood Signature		Date: 9/10/2022
Head of Curriculum Committee/Department: ---		Signature: -------------------
Head of Department: -- Signature: -----------------------------		
Head of Curriculum Committee/Faculty: --------------------------------------- Signature: --------------------------		
Dean: -- Signature: --		