Form: Course Syllabus	**Form Number**	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or Modification	
	Deans Council Approval Decision Number	2/3/24/2023
	The Date of the Deans Council Approval Decision	23/01/2023
	Number of Pages	06

1.	**Course Title**	Solid State Physics-2
2.	**Course Number**	0302974
3.	**Credit Hours (Theory, Practical)**	(3, 0)
	Contact Hours (Theory, Practical)	(3, 0)
4.	**Prerequisites/ Corequisites**	None
5.	**Program Title**	Ph.D. In Physics
6.	**Program Code**	20
7.	**School/ Center**	Science
8.	**Department**	Physics
9.	**Course Level**	Graduate -Ph.D.
10.	**Year of Study and Semester (s)**	Second Semester/2018-2019
11.	**Other Department(s) Involved in Teaching the Course**	None
12.	**Main Learning Language**	English
13.	**Learning Types**	☐Face to face learning ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐Moodle ☐Microsoft Teams
15.	**Issuing Date**	2/5/2011
16.	**Revision Date**	15/1/2025

17. Course Coordinator:

Name: Prof. Sami H. Mahmood

Contact hours: 2:00 – 3:00 Monday, Wednesday; 12:00 – 1:00 Tuesday

Office number: 17 Phone number: 22023

Email: s.mahmood@ju.edu.jo

18. Other Instructors:

None

19. Course Description:

As stated in the approved study plan. Nearly free electron bands; Tight binding approximation; Methods of band structure calculation; Semi-classical model of electron dynamics; Semi-classical theory of conduction in metals; Surface effects, Harmonic crystals

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)**.**

1. **SO1**: to be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.
2. **SO2**: to be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.
3. **SO3**: to be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.
4. **SO4**: to be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.
5. **SO5**: to be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.
6. **SO6**: to be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.

7. **SO7**: to be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.

8. **SO8**: to be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software.

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Construct the energy bands of free and nearly free electrons along different symmetry directions in a crystalline solid.
2. Construct the energy bands of core electron levels in the tight-binding approximation.
3. Identify the effect of choice of the self-consistent potential on the band structure of a solid.
4. Describe the nature of valence and core electron levels, and the limitations of the free electron model.
5. Construct the band structure of electrons in solids by adopting different methods.
6. Apply the semi-classical model of electron dynamics, and identify its limitations.
7. Determine the band and cyclotron effective mass tensors of electrons and holes in a solid.
8. Describe carrier motion and orbits under the influence of electromagnetic fields.
9. Evaluate the Hall coefficient and magnetoresistance arising from multiple-band conduction and open carrier orbits.
10. Determine the non-equilibrium distribution function of electrons under the influence of electromagnetic fields and temperature gradient.
11. Calculate the DC and AC electrical conductivity of a metal in the semi-classical theory.
12. Determine the thermal conductivity of a metal in the semi-classical model, and evaluate the degree of correctness of the free electron results.
13. Determine the thermoelectric coefficients in various thermoelectric effects.
14. Construct the acoustic and optical phonon bands in crystalline solids.

Course ILOs	**The learning levels to be achieved**					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1	✓	✓	✓	✓		
2	✓	✓	✓	✓		
3		✓	✓	✓	✓	
4	✓	✓			✓	
5			✓	✓	✓	✓
6		✓	✓	✓	✓	
7			✓	✓	✓	
8	✓	✓	✓	✓		
9				✓	✓	
10			✓	✓	✓	
11			✓	✓	✓	
12			✓	✓	✓	
13			✓	✓	✓	
14		✓	✓	✓		

22. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program ILOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)	ILO (6)	ILO (7)	ILO (8)
1	✓		✓					✓
2	✓		✓					✓
3	✓		✓					✓
4	✓		✓					
5	✓	✓	✓					✓
6	✓	✓	✓					✓
7	✓	✓	✓					✓
8	✓	✓	✓					✓
9	✓	✓	✓					✓
10	✓	✓	✓					✓
11	✓	✓	✓					✓
12	✓	✓	✓					✓
13	✓	✓	✓					✓
14	✓		✓					✓

23. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types (Face to Face/ Blended/ Fully	Platform Used	Synchronous / Asynchronous Lecturing	Evaluation Methods	Learning Resources
1	1.1	General instructions and review of the free electron bands in solids	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]
1	1.2	General instructions and review of the free electron bands in solids	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]
1	1.3	General instructions and review of the free electron bands in solids	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]
2	2.1	Construction of free and nearly free electron bands and Fermi surfaces	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]
2	2.2	Construction of free and nearly free electron bands and Fermi surfaces	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]
2	2.3	Construction of free and nearly free electron	1	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2, 3]

		bands and Fermi surfaces						
3	3.1	Description of the tight-binding model	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
3	3.2	Description of the tight-binding model	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
3	3.3	Description of the tight-binding model	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
4	4.1	Calculation of tight-binding bands	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
4	4.2	Calculation of tight-binding bands	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
4	4.3	Calculation of tight-binding bands	2	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
5	5.1	Description of self-consistent potentials and nature of electron levels	3, 4	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
5	5.2	Description of self-consistent potentials and nature of electron levels	3, 4	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
5	5.3	Description of self-consistent potentials and nature of electron levels	3, 4	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
6	6.1	Band structure calculation using	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]

		the cellular method						
6	6.2	Band structure calculation using the cellular method	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
6	6.3	Band structure calculation using the cellular method	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
7	7.1	Muffin-tin potential and the Augmented plane wave method	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
7	7.2	Muffin-tin potential and the Augmented plane wave method	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
7	7.3	Muffin-tin potential and the Augmented plane wave method	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
8	8.1	The orthogonalized plane wave and the pseudopotential methods	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
8	8.2	The orthogonalized plane wave and the pseudopotential methods	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
8	8.3	The orthogonalized plane wave and the	5	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]

		pseudopotential methods						
9	9.1	Semi-classical electron motion in a DC electric field, holes, and mass tensor	6,7	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
9	9.2	Midterm Exam	-	Face to Face	Classroom	Synchronous	Exam	
10	10.1	Electron orbits under applied electromagnetic fields	8	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
10	10.2	Electron orbits under applied electromagnetic fields	8	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
10	10.3	Electron orbits under applied electromagnetic fields	8	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
11	11.1	Hall effect and magnetoresistance	9	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
11	11.2	Hall effect and magnetoresistance	9	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
11	11.3	Hall effect and magnetoresistance	9	Face to Face	Classroom	Synchronous	Homework and class exams	[1, 2]
12	12.1	Non-equilibrium distribution function in the relaxation time approximation	10	Face to Face	Classroom	Synchronous	Final exam	[1, 2]

12	12.2	Non-equilibrium distribution function in the relaxation time approximation	10	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
12	12.3	Non-equilibrium distribution function in the relaxation time approximation	10	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
13	13.1	DC and AC electrical conductivity, and thermal conductivity in metals	11, 12	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
13	13.2	DC and AC electrical conductivity, and thermal conductivity in metals	11, 12	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
13	13.3	DC and AC electrical conductivity, and thermal conductivity in metals	11, 12	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
14	14.1	Thermoelectric effects and thermoelectric coefficients	13	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
14	14.2	Thermoelectric effects and thermoelectric coefficients	13	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
14	14.3	Thermoelectric effects and thermoelectric coefficients	13	Face to Face	Classroom	Synchronous	Final exam	[1, 2]

15	15.1	Harmonic Crystals in solids	14	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
15	15.2	Harmonic Crystals in solids	14	Face to Face	Classroom	Synchronous	Final exam	[1, 2]
15	15.3	Harmonic Crystals in solids	14	Face to Face	Classroom	Synchronous	Final exam	[1, 2]

24. Evaluation Methods:

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

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
Assignment 1	10	Energy Bands	1 - 5	Week 3	In-person
Assignment 2	10	Semi-Classical Model	6, 7	Week 5	In-person
Midterm Exam	30	Various Topics	1-7	Week 7	In-person
Assignment 3	10	Experimental Techniques	8-10	Week 9	In-person
Final Exam	40	Comprehensive	1-14	Week 14	In-person

25. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.):

None

26. Course Policies:

A- Attendance policies: Student's should attend every session; they cannot miss more than two sessions even with a proper excuse.

B- Absences from exams and submitting assignments on time: No late assignments are accepted. No absence from the final exam is accepted unless it is justifiable, in which case an alternative evaluation and a makeup exam will be offered.

C- Health and safety procedures: Safety measures should be followed during all lab sessions.

D- Honesty policy regarding cheating, plagiarism, misbehavior: all students are expected to have the highest levels of honesty and no plagiarism is tolerated in any of the students' reports.

E- Grading policy: Every student will be able to see his/her evaluation grade and graded reports are returned as soon as possible.

F- Available university services that support achievement in the course: A fully furnished lab with computer facility for data analysis is available for the students.in the course:

27. References:

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

[1] Ashcroft and Mermin, Solid State Physics, (Sounders College, Philadelphia, 1976)

B- Recommended books, materials, and media:

[2] Lecture notes (Posted on personal web page).
[3] M.S. Rogalski and S.B. Palmer, Solid State Physics, (Gordon and Breach Science Publishers, Australia, 2000)

[4] Charles Kittel, Introduction to Solid State Physics, 7nth ed. (John Wiley & Sons, New York, 1996)

[5] J.R. Christman, Fundamentals of Solid State Physics (John Wiley & Sons, New York, 1988)

28. Additional information:

Name of the Instructor or the Course Coordinator:	Signature:	Date:
………………………………………………	Sami mahmood	……..………..
Name of the Head of Quality Assurance Committee/ Department	Signature:	Date:
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Name of the Head of Department	Signature:	Date:

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Name of the Head of Quality Assurance Committee/ School or Center	Signature:	Date:
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Name of the Dean or the Director	Signature:	Date:
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