Course Specification

(Postgraduate Programs)

Course Title:	**Physics of Low-Dimensional Systems**
Course Code:	**PHY 6267**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**3**
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification:

1. Credit hours: 3				
2. Course type				
A.	☐ University	☐ College	☒ Department	☐ Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: Level 3 or 4/Year 2				
4. Course General Description:				
This course provides a rigorous foundation of Physics of low-dimensional systems. This course will include: Technological Applications, Synthesis, Quantum size effect, Electrical and optical properties, Modern heterostructures at low dimensions.				
5. Pre-requirements for this course (if any): None				
6. Pre-requirements for this course (if any): None				
7. Course Main Objective(s):				

At the end of this course, students will be able to:

- **Explain physical properties when the dimensions of the material are small enough to be comparable to the wavelength of the electrons confined inside. The wave nature of the electrons leads to radically altered electronic properties.**
- **Understand the emerging science of working and building at near the molecular level.**
- **Be familiar with new strategic materials promising in the near future for nanotechnology;**
- **Know some important applications in nanotechnology and understand the reason of the researchers interest on this technology;**
- **Understand the fundamental concepts and the principles through a broad range of interesting applications in nanotechnology;**
- **Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain;**
- **Understand the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)……**	**0**
	Total	**60**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the basics of low-dimensional systems: two, one and zero dimensional nanostructures.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Explain the development of nanophysics and nanotechnology.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Interpret the techniques used for the synthesis and the characterization of the low-dimensional systems.**	**K2, K3**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.1	**Explain and summarize the basic knowledge gained from studying the course of physics of semiconductors and devices**	**S1, S2**	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

C. Course Content:

No	List of Topics	Contact Hours
1.	**Generalities**: Introduction into the basics of low-dimensional systems: two, one and zero dimensional nanostructures.	**10**
2.	**Technological Applications**: The importance of such systems for modern physics and present day technology (e.g. micro-electronics, nano-electronics and opto-electronics) will be explained.	**10**

3.	**Synthesis**: Especially lithography of low dimensional systems like two dimensional systems, Quantum wires and quantum dots and Nanocomposites.	**10**
4.	**Quantum Size Effect**: Electronic configuration, Size effect in metal and semiconductor, required size for size effect.	**10**
5.	**Electrical and Optical Properties**: Theory of carrier transport in semiconductors, Boltzmann equation, ballistic transport, Diffusion theory and tunneling effect and mesoscopic physics of light.	**10**
6.	**Modern Heterostructures at Low Dimensions**: The modern heterostructures at low dimensions, including quantum wells, quantum wires, and quantum dots, together with their applications will be discussed. From this course, the students will appreciate how the fundamental courses of Quantum Mechanics and Solid State Physics are applied to the technologically important semiconductor materials, which leads to today's information revolution.	**10**
Total		**60**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2.	**Midterm Exam 1**	**6th week**	**20 %**
3.	**Midterm Exam 2**	**12th week**	**20 %**
4.	**Final Exam**	**16th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	-J.L. Morán-López, Physics of Low Dimensional Systems, Springer, 2001. S.M. Sze, Physics of Semiconductor Devices, John Wiley and Sons, 1969.
Supportive References	**-M.J. Kelly, Low-dimensional semiconductors: Materials, Physics, Technology, Devices, Clarendon Press, Oxford, 1995.** **-Y. Imry, Introduction to Mesoscopic Physics, Oxford University Press, 1997.** **-T. Ando, Mesoscopic Physics and Electronics, Springer-Verlag, Berlin, 1998.**
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms - Research Labs
Technology equipment (Projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students. - Second examiner	Indirect (The student will complete evaluation forms at the end of semester. Final exam is evaluated by the second examiner)
Effectiveness of students' assessment	- Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	- Faculty - Students	Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	Direct (excel sheet)
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 6
DATE	26/09/2024