Course Specification

(Postgraduate Programs)

Course Title:	**Physics of Semiconductors and Devices**
Course Code:	**PHY 6263**
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 fundamental concepts of semiconductors physics. This course will include: Energy Bands in Semiconductors, Electronic Effects of Doping Impurities, Lattice Vibrations, Charge Carrier Transport Properties, Optical Properties, p-n Junctions, Bipolar Junction Transistor, Metal-Semiconductor Devices.				
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: • **Become familiar with semiconductor materials.** • **Demonstrate knowledge of fundamental concepts of semiconductors physics.** • **Solve problems in semiconductors physics.** • **Learn about the most important applications of semiconductors in nanotechnology.**				

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	**Interpret the electronic band structures, band gaps for the technologically important semiconductors, also describe drift, diffusion and scattering under various temperature and impurity concentrations.**	**K1,K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the concentrations of electron and holes with a given temperature in terms of Fermi energy.**	**K1,K3**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Discuss the electric transport properties and the optical properties of the bulk materials.**	**K2, K3**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
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**	**S2, S3**	• Problem classes and group tutorial.	▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	physics related the topics covered by the course.		• Homework assignments as well as problems solutions.	
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S3,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.	**Energy Bands in Semiconductors**: Electronic structure, Electrons in periodic structures, Semiconductor band structure, Pseudo-potential and kp method, Doping in semiconductors.	12
2.	**Electronic Effects of Doping Impurities**: Effective mass theory, Donor impurities in Si and Ge, Donor impurities in III-V semiconductors, Acceptor impurities.	12
3.	**Lattice Vibrations**: Equations of motion, Phonon dispersion curves, Models for calculating phonon dispersion curves, Electron-Phonon interactions.	12
4.	**Charge Carrier Transport Properties**: Quasi-classical approach, Carrier mobility for a non degenerate electron gas, Scattering mechanisms, High field transport and hot carrier effects.	12

5.	**Optical Properties**: Kramers-Kronig relations, Dielectric function, Joint density of states and van Hove singularities, Direct and indirect absorption edges, Excitons, Emission spectroscopies, Light scattering spectroscopies.	12
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	S.M. Sze, Physics of Semiconductor Devices, John Wiley and Sons, 1969.
Supportive References	- W.C.J. Magnus, W.J. Schoenmaker, Quantum Transport in Sub-Micron Devices-A theoretical Introduction, Springer, 2002. - J. Davies, The Physics of Low-Dimensional Semiconductors: An Introduction, Cambridge University Press, 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** - **XRD and optical 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