Course Specification

(Postgraduate Programs)

Course Title: Physics and Technology of Semiconductors	
Course Code: PHYS 624	
Program: Master of Science in Physics	
Department: Physics	
College: College of Science	
Institution: Majmaah University	
Version: 1	
Last Revision Date: 30/12/2024	

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track-2	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (2nd/1)					
4. Course General Description:					
The course introduces the vital physics underlying semiconductor materials and devices. Discusses methods for studying the phenomena and behavior of semiconductors and presents the key, technologically essential mechanisms that contribute to device optimization.					
5. Pre-requirements for this course (if any):					
Advanced Quantum Mechanics PHYS 612 Electrodynamics PHYS 613					
6. Co-requisites for this course (if any):					
none					
7. Course Main Objective(s):					
1. Provide the student with a detailed understanding of the principles and operation of semiconductor devices. 2. Enable the student to understand the methods by which semiconductors may be produced and characterized. 3. Illustrate how groundbreaking physics has led to advanced technologies					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	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**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
Total		**45**

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

Code	Course Learning Outcomes	Code of PLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Background and development of fundamental knowledge in Physics	**K1**	Lectures	Quiz & Homework
1.2	Fundamental knowledge and mathematical approach in Physics	**K1**	Discussion sessions	Midterm Exams & Final Exams
1.3	To understand the Physics concepts at an advanced level for solving complex problems.	**K4**	Teamwork - Discussion sessions	Quiz & Homework - Mid Term Exams & Final Exams
1.4	Identifying the key factors and applying appropriate principles and assumptions in the formulation of Physics problems	**K4**	- Problem solving	- Midterms
2.0	**Skills**			
2.1	Perform data analysis and draw results and conclusions	**S1**	- Problem solving -Class discussion	Class participation
2.2	Apply the Physics theories and draw relations with research on related topics.	**S1**	Class discussion	Graded homework
2.3	Ability to use analytical and/or computational methods to solve physics problems;	**S3**	- Problem solving -Class discussion	Midterms

2.4	Explain to a general audience and experts in the field, with concepts and results	**S3**	- Problem solving -Class discussion	- Evaluation of group reports and individual contributions within the group
3.0	**Values, autonomy, and responsibility**			
3.1	Applying appropriate scientific programming skills;	**V1**	-Discussion with students	- Evaluation of group reports and individual contributions within the group
3.2	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources.	**V1**	-Discussion with students - Group presentation - Group assignments	- Evaluation of group reports and individual contribution within the group - Peer or self-assessment
3.3	Work effectively in a group	**V3**	Group presentation	Evaluation of group reports and individual contributions within the group

C. Course Content

No	List of Topics	Contact Hours
1.	INTRODUCTION TO SEMICONDUCTOR: Classification of Semiconductor	3
2.	SEMICONDUCTOR BONDING: Empirical Evidence of Semiconductor Bonding, Hybridization of Group IV Elements	3
3.	ENERGY BANDS: One Electron Model, Bloch Theorem, Reduced zone Scheme for representing energy bands,	3
4.	Empty Lattice Band Structure, Effect of Filling the Empty Lattice,	3
5.	Qualitative Band Shapes of the Diamond Lattice, Zinc–Blende,	3
6.	Spin-Dependent Effects, Energy Band Calculations, Temperature Dependence of Bands,	3
7.	Effective Mass & Crystal Momentum, Constant Energy Surfaces.	3

8.	DENSITY OF STATES: MANY–VALLEY MODEL: Semiconductor Statistics, Intrinsic Semiconductors, Electron-Hole Statistics, Intrinsic Case, Boltzmann Approximation (Non-degeneration Semiconductor),	3
9.	Law of Mass Action, Extrinsic Semiconductors, Picture of an Impurity, EMT or Hydrogenic Model.	3
10.	TRANSPORT PROPERTIES: Charge-Carrier Transport, Electrical Conductivity:, One–valley Model, Effect of Electric Field: on a single electron – Zener Oscillations in an otherwise empty band.	3
11.	BOLTZMANN TRANSPORT EQUATION: Relaxation Time Approximation, Charge Transport, Spherical Energy Surfaces – one Valley Model,	3
12.	Transform the Current Integral to Energy Space, Non-degenerate Semiconductors with one–valley: Degenerate Semiconductors, Complete Expression for Conductivity in the one-valley Model: Many–Valley Semiconductors.	6
13.	IMPURITY SCATTERING: Ionized Impurity Scattering, Neutral Impurity Scattering, Lattice Scattering.	6
Total		**45**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Homework-1 (Assignment, Problem solving),	2	3%
2.	Quiz -1	3	5%
3.	Homework- 2 (Assignment, Problem solving)	4	4%
4.	Mid-term-1 Examination	6	10%
5.	Homework -3 (Assignment, Problem solving)	10	3%
6.	Electronic Quiz	10	10%
7.	Mid-term-2 Examination	12	10%
8.	Quiz -2	13	5%
9.	Presentation	13	10%
10.	Final Examination	15	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	The Physics of Semiconductors: an introduction including nanophysics and applications. 2nd ed., Grundmann, M., Berlin ; New York: Springer-Verlag., (2010)
Supportive References	•Semiconductors Ferry, D. K., Macmillan Publishing Company, (1991) •Semiconductors and semimetals, H.J. Novell, Academic Press,

	New York, (1975) •Physics of semiconductor devices, S.M. Sze, Wiley, (1981) •Conductors, Semiconductors, Superconductors An Introduction to Solid-State Physics, Huebener, R. P., Springer, (2020)
Electronic Materials	•Wikipedia https://www.wikipedia.org/ •Saudi Digital Library (SDL): https://eservices.mu.edu.sa/sdl •Physics Today (web version) https://www.aps.org/publications/physics-today.cfm •MIT Courseware: https://ocw.mit.edu/index.htm •IOP Science: https://iopscience.iop.org/
Other Learning Materials	•Class presentation •Black Board (web-based application – course material) •Hand out •Whatsapp group •Software manuals/ user guide

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	•Classroom (must be the same for the same subject) •Seminar room with multimedia •Computer lab for (e-Quiz)
Technology equipment (projector, smart board, software)	•Blackboard (BB) software/login • Whiteboard •MS software suite •Origin Graphic software •Smart board that maintains feedback •Laptop, Desktop, and printer with accessories.
Other equipment (depending on the nature of the specialty)	Library, Seminar Room, and Wi-Fi /internet connections

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	students	Indirect
Effectiveness of Students assessment	students	Indirect
Quality of learning resources	students	Indirect
The extent to which CLOs have been achieved	students	Indirect

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Physics Department
REFERENCE NO.	16
DATE	30/12/2024