



Course Specification

(Postgraduate Programs)

Course Title: **Non-Crystalline Materials**

Course Code: **PHYS 637**

Program: **Master of Science in Physics**

Department: **Physics**

College: **College of Sciences**

Institution: **Majmaah University**

Version: **1**

Last Revision Date: **30/12/2024**



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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-2 Others
B. Required Elective

3. Level/year at which this course is offered: (3rd Semester)

4. Course General Description:

This course comprehensively covers non-crystalline (amorphous) materials, focusing on their unique structural, electronic, optical, and mechanical properties. Students will explore glasses, amorphous semiconductors, amorphous metals, and polymers. The course emphasizes structure-property relationships, synthetic methods, characterization techniques, and technological applications in electronics, optics, and energy-conversion devices.

5. Pre-requirements for this course (if any):

Characterization of Advanced Materials, PHYS 625

6. Co-requisites for this course (if any):

none

7. Course Main Objective(s):

- **Understand the fundamental differences between crystalline and non-crystalline materials**
- Analyze structural models and characterization methods for amorphous materials
- Evaluate electronic and optical properties of non-crystalline semiconductors
- Design and optimize amorphous materials for specific applications
- Assess mechanical properties and relaxation phenomena in glasses and polymers

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> • 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 the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Demonstrate comprehensive knowledge of amorphous material structures and bonding.	K1	Lectures, interactive discussions, video demonstrations, and problem-solving sessions	Exams, Assignments
1.2	Apply theoretical models to predict properties of non-crystalline materials.	K3	Lectures, examples, computational exercises, and problem-solving workshops.	Problem set, Midterms
...				
2.0	Skills			
2.1	Analyze experimental data from structural and spectroscopic characterization.	S1	Laboratory demonstrations, data analysis workshops, case studies, and hands-on exercises	Data analysis assignments
2.2	Design amorphous materials with tailored properties for device applications.	S2	Design projects, simulation software training, group work, and literature review	Design project, Presentation
2.3	Use computational tools and simulations to model and improve the structure-property relationships in amorphous materials.	S4	Computational workshops, simulation software training (e.g., molecular dynamics or DFT tools), guided modeling exercises, and case studies on amorphous systems	Simulation assignments, Computational project report, Midterm/Final exam questions on modeling results



Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.0	Values, autonomy, and responsibility			
3.1	Communicate research findings effectively in written and oral formats	V3	Presentation practice sessions, report writing guidance, peer review, and feedback sessions.	Presentation, Report
3.2	Evaluate current research trends in amorphous materials science	V3	Literature review assignments, journal club discussions, research seminars, and critical analysis exercises	Literature review, Presentation
...				

C. Course Content

Week	Topics	Hours
1	Introduction: Definition and classification of non-crystalline materials. Comparison with crystalline solids. Historical overview and technological importance	3
2	Structural Models: Random network theory, continuous random network model. Radial distribution function. Short-range and medium-range order	3
3	Glasses and Glass Formation: Glass transition, thermodynamics of glass formation. Kinetics and relaxation phenomena. Glass-forming ability criteria	3
4	Characterization Approach for Amorphous Materials - Overview of structural characterization strategies specific to non-crystalline materials. Interpretation of radial distribution functions and pair correlation functions.	3
5	Electronic Properties I: Density of states in amorphous materials. Localized states and mobility edges. Anderson localization and percolation theory	3
6	MIDTERM EXAMINATION 1	3
7	Electronic Properties II - Transport mechanisms specific to amorphous materials: hopping and variable-range hopping. Thermoelectric power in disordered systems.	3
8	Optical Properties: Optical absorption and band tails. Urbach edge. Photoluminescence. Optical band gap determination methods	3
9	Amorphous Semiconductors: Hydrogenated amorphous silicon (a-Si:H). Defects and dangling bonds. Doping mechanisms. Applications in thin-film transistors and solar cells	3
10	Chalcogenide Glasses: Structure and bonding in chalcogenides. Phase-change materials. Memory applications. Photoinduced effects and optical storage	3





11	Metallic Glasses: Formation and structure of amorphous metals. Mechanical properties and deformation mechanisms. Applications in structural materials and coatings	3
12	MIDTERM EXAMINATION 2	3
13	Mechanical Properties: Viscosity and rheology of glasses. Stress relaxation and creep. Mechanical strength and fracture. Hardness and wear resistance	3
14	Polymer Science: Structure and properties of amorphous polymers. Glass transition in polymers. Conducting polymers. Applications for flexible electronics	3
15	STUDENT PRESENTATIONS: Current research in non-crystalline materials	3
Total		45

D. Students' Assessment Activities

Assessment Activity	Assessment timing (in week no)	Percentage of Total Assessment Score
Homework Assignments (3)	2, 4, 8	5%
Quizzes (2)	3, 10	5%
Midterm Examination 1	6	15%
Midterm Examination 2	12	15%
Research Presentation	15	15%
Class Participation	1-14	5%
Final Examination	Final 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	K. Rao: Structural Chemistry of Glasses, Science direct press, 2002 N.F. Mott & E.A. Davis, Electronic Processes in Non-Crystalline Materials, Clarendon Press (Oxford University Press), 2012 (ISBN: 978-0-19-102328-6)
Supportive References	Richard Zallen, The Physics of Amorphous Solids, Wiley-VCH, 1998 (ISBN: 978-0-471-29941-7)
Electronic Materials	<ul style="list-style-type: none"> · Saudi Digital Library (SDL) · Web of Science and Scopus databases · https://www.wikipedia.org/
Other Learning Materials	none



2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	· Lecture room with at least 25 seats. Auditorium with a capacity of not less than 100 seats for large lecture format classes.
Technology equipment (projector, smart board, software)	· A smart board to write on and a computer.
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	Internal Reviewer Committee	Direct
Effectiveness of Students assessment	students	Indirect
The extent to which CLOs have been achieved	peer review	Direct

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

