# Course Specification

(Postgraduate Programs )

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|---|
| **Course Title**: Characterization of Advanced Materials |
| **Course Code**: PHYS 625 |
| **Program**: Master of Science in Physics |
| **Department**: Physics |
| **College**: College of Sciences |
| **Institution**: Majmaah University |
| **Version**: 1 |
| **Last Revision Date**: 30/12/2024 |

## Table of Contents

**A. General information about the course:** ..... 3

**B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods** ..... 4

**C. Course Content** ..... 5

**D. Students Assessment Activities** ..... 6

**E. Learning Resources and Facilities** ..... 6

**F. Assessment of Course Quality** ..... 7

**G. Specification Approval** ..... 7

## A. General information about the course:

### 1. Course Identification

| | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours: (3)** | | | | | |
| **(2,2,0)** | | | | | |
| **2. Course type** | | | | | |
| A. | ☐University | ☐College | ☒ Department | ☐Track-2 | ☐Others |
| B. | ☒ Required | | ☐Elective | | |
| **3. Level/year at which this course is offered: (Level 2nd/1)** | | | | | |
| **4. Course General Description:** | | | | | |
| This course introduces graduate students to the fundamental experimental methods used in advanced materials research. It covers the complete workflow, from material synthesis and processing to characterization and data analysis. Students will explore common synthesis routes for advanced and nanostructured materials and learn how processing parameters influence material properties.<br>A wide range of characterization techniques—structural, chemical, thermal, mechanical, and morphological—will be presented to illustrate how materials are evaluated from both fundamental and applied perspectives. Special emphasis is placed on modern methods used for the analysis of nanoparticles and other emerging material systems.<br>The course also provides training in data acquisition, uncertainty estimation, and error analysis, enabling students to interpret experimental results reliably and communicate them effectively. | | | | | |
| **5. Pre-requirements for this course (if any):** | | | | | |
| Advanced Quantum Mechanics, PHYS 612<br>Electrodynamics, PHYS 613 | | | | | |
| **6. Co-requisites for this course (if any):** | | | | | |
| none | | | | | |
| **7. Course Main Objective(s):** | | | | | |
| The purpose of the course is to prepare students for research in experimental physics.<br>In this course, students can apply their knowledge across various fields of interest, including nanotechnology, plasma physics, experimental laser physics, and electronics. | | | | | |

Awareness about thin film Physics and its preparation methods.
Awareness about structural, electronic, optical, and thermal characterization techniques.

### 2. Teaching mode (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1 | Traditional classroom | 45 | 100% |
| 2 | E-learning | | |
| 3 | Hybrid<br>• Traditional classroom<br>• E-learning | | |
| 4 | Distance learning | | |

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

| No | Activity | Contact Hours |
|---|---|---|
| 1. | **Lectures** | 30 |
| 2. | **Laboratory/Studio** | 30 |
| 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 | **Explain** the main synthesis and processing routes for advanced materials and nanomaterials. | **K2** | Lectures<br>Presentations | Quiz<br>Mid-term Exam |
| 1.2 | **Describe** the principles and applications of key characterization techniques. | **K2** | | |
| 1.3 | **Identify** sources of measurement error and the basics of data acquisition and uncertainty analysis. | **K3** | | |
| **2.0** | **Skills** | | | |

| | | | | |
|---|---|---|---|---|
| 2.1 | **Select and apply** suitable synthesis and characterization methods for a given material system. | **S2** | Lecture problem solving Case studies | Mid-term Exam Presentation Lab Exam |
| 2.2 | **Operate** common experimental instruments and **collect** reliable data. | **S3** | | |
| 2.3 | **Analyze and interpret** experimental results using proper data-processing and error-analysis tools. | **S3** | | |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| 3.1 | **Demonstrate** responsible laboratory practices, safety awareness, and ethical handling of data. | **V2** | Group Presentations | Presentations |
| | **Work effectively** in teams and contribute to collaborative experimental tasks. | **V2** | | |
| | **Show accountability** in the proper use and maintenance of laboratory instruments and shared resources. | **V3** | | |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | Overview of Characterization of Advanced Materials: Experimental methods and problems, Experimental skills and design, Design of Experiment, Experimental parameters, Reproducibility of Data, Data and error analysis: Uncertainties and measurements | 6 |
| 2. | Principles and objectives of Etching methods, Characterizations in Physics: Physical Characterization of Materials (Bulk characterizations, Surface characterizations), Requirements of Characterizations (Kinetic theory concept of elements) | 6 |
| 3. | Diffraction techniques: Experimental methods for X-ray structure determination, Properties of X-rays, Experimental methods and crystal determination techniques. Optical Microscopy: Principles and objectives of optical microscopy | 9 |
| 4. | Electron Microscopy: Principles and objectives of SEM, EDX, Thermal Analysis: Principles and objectives of Differential Scanning Calorimetry (DSC) | 12 |

| | | |
|---|---|---|
| 5. | Optical properties: Principle and objectives of Photoluminescence spectroscopy, Principle and objectives of FTIR spectroscopy, Principle and objectives of UV-Visible. | 12 |
| **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 | 3 | 5% |
| 3. | Homework- 2 (Assignment, Problem solving) | 4 | 3% |
| 4. | Mid-term-1 Examination | 6 | 15% |
| 5. | Homework -3 (Assignment, Problem solving) | 10 | 4% |
| 6. | Electronic Quiz | 10 | 5% |
| 7. | Mid-term-2 Examination | 12 | 15% |
| 8. | Presentation | 13 | 10% |
| 9. | 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** | Encyclopedia of Materials Characterization, C. R. Brundle, C. A. Evans, Jr. S. Wilson, Manning Publications Co., 1992 |
| **Supportive References** | Data Reduction and Error Analysis, D. Bevington, McGraw-Hill Publishers, 2003. |
| **Electronic Materials** | Saudi Digital Library (SDL) |
| **Other Learning Materials** | none |

### 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| **facilities** (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | Classrooms |
| **Technology equipment** (projector, smart board, software) | Smart Board |
| **Other equipment** (depending on the nature of the specialty) | None |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | Students | Indirect |

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

Assessment Methods (Direct, Indirect)

## G. Specification Approval

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