# Course Specification
## (Bachelor)

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|---|
| **Course Title: Nanomaterials** |
| **Course Code: PHYS 0486** |
| **Program: BSc in Physics** |
| **Department: Physics** |
| **College: Science** |
| **Institution: Majmaah University** |
| **Version: 2024** |
| **Last Revision Date: 30/12/2024** |

## Table of Contents

## A. General information about the course:

### 1. Course Identification

| 1. Credit hours: 3(3, 0, 0) | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| **2. Course type** | | | | | |
| **A.** | ☐ University | ☐College | ☒ Department | ☐Track | ☐Others |
| **B.** | ☐ Required | | ☒ Elective | | |
| **3. Level/year at which this course is offered:** | | | | | |
| **4. Course General Description:** | | | | | |
| **This course provides a comprehensive introduction to nanomaterials, exploring their unique properties, synthesis techniques, characterization methods, and applications. Students will gain a deep understanding of the fundamental principles governing the behavior of matter at the nanoscale, and how these principles can be exploited to develop innovative materials and devices in several fields such as optoelectronics, solar cells, sensors, medical applications, etc** | | | | | |
| **5. Pre-requirements for this course** (if any)**:** | | | | | |
| **Solid State Physics 1 PHYS 0381** | | | | | |
| **6. Co-requisites for this course** (if any)**:** | | | | | |
| **None** | | | | | |
| **7. Course Main Objective(s):** | | | | | |

- **Understand the fundamental concepts of nanoscience and nanotechnology.**
- **Learn various techniques for synthesizing and characterizing nanomaterials.**
- **Analyze the unique properties of nanomaterials and their applications.**
- **Develop critical thinking and problem-solving skills in the context of nanotechnology.**
- **Appreciate the potential and challenges of nanotechnology for society.**

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

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

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| | • 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** | |
| 5. | **Others (specify)** | |
| **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** | | | |
| 1.2 | **Identify different techniques of characterization of nanomaterials** | **K2** | **Lectures** | **Exams, homework, classwork, and quizzes.** |
| **2.0** | **Skills** | | | |
| 2.1 | **Ability to Compare between nanomaterial and other material** | **S1** | **Problem solving. Homework** | **Exams, homework, classwork, and quizzes. Assignment** |
| 2.4 | **Able to know some available make presentation that can effectively be admired by an audience** | **S4** | **Problem solving. Homework** | **Exams, homework, classwork, quizzes. Assignment** |
| **3.0** | **Values, autonomy, and responsibility** | | | |
| 3.2 | **Present a short report in a written form and orally** | | **Presentation, reports** | **Oral exams, Assignments** |

| Code | Course Learning Outcomes | Code of PLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | **using appropriate scientific language** | **V2** | | |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | **Definition of Nanotechnology**: Understanding the nanoscale and its significance and history. | **3** |
| 2. | **Size Effects:** Exploring the unique properties of materials at the nanoscale, such as quantum confinement, playing a key role in quantum wells, quantum wires, and quantum dots. | **6** |
| 3. | **Synthesis Techniques:**<br>○ Top-down approaches (e.g., lithography, milling)<br>○ Bottom-up approaches (e.g., chemical vapor deposition, sol-gel synthesis, molecular beam epitaxy)<br>○ Self-assembly and template-based synthesis | **9** |
| 4. | **Characterization Techniques:**<br>○ Microscopy techniques (TEM, SEM, AFM)<br>○ Spectroscopic techniques (UV-Vis, PL, PLE, Raman)<br>○ X-Ray diffraction and scattering techniques | **9** |
| 5. | **Properties of Nanomaterials:**<br>○ Optical properties (plasmonics, quantum dots)<br>○ Electronic properties (nanowires, nanotubes)<br>○ Magnetic properties (magnetic nanoparticles)<br>○ Mechanical properties (nanocomposites) | **9** |
| 6. | **Applications of Nanomaterials:**<br>○ Electronics and optoelectronics (nanodevices, solar cells)<br>○ Medicine (drug delivery, biosensors)<br>○ Energy storage (batteries, fuel cells) | **6** |
| 7. | **Initiation to writing scientific paper about Nanomaterials including Nanotechnology, Nanoscience … etc** | **3** |
| | **Total** | **45** |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| **1.** | Midterm Exam 1 | 7th | 15 % |
| **2.** | Midterm Exam 2 | 12th | 15 % |
| **3.** | E-exam | 13th | 10 % |
| **4.** | Homework | -- | 5 % |
| **5.** | Quizzes | 4th, 8th, and 12th | 5 % |
| **6.** | Library assignment and/or Presentation | 13th | 10% |
| **7.** | Final Exam | 16th | 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** | **Nanostructures And Nanomaterials: Synthesis, Properties, And Applications**, Guozhong Cao, Ying (Jane) Wang , World Scientific Publishing Company. 2011, 2nd edition. |
| **Supportive References** | 1-**Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience**, Edward L. Wolf, Wiley-VCH,2005, 2nd edition.<br>2- **Nanomaterials, the Original Product of Nanotechnology**, Maria Ben Elmekki |
| **Electronic Materials** | • Saudi Digital Library<br>• ResearchGate<br>• National Nanotechnology Initiative (NNI) |
| **Other Learning Materials** | • Origin<br>• MATLAB<br>• MS Office (particularly MS Excel) |

### 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| **facilities**<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | • Furnished Lecture Room equipped with smart board and computer<br>• Lab for nanotechnology Fabrication and Characterization (for Future improvement)<br>• Library,<br>• Seminar Room |
| **Technology equipment**<br>(projector, smart board, software) | • The classroom is equipped with a smart board, its running software 'Blackboard or active inspire', and internet connection.<br>• Wi-Fi Internet Connections |
| **Other equipment**<br>(depending on the nature of the specialty) | • Atomic force Microscope (AFM),<br>• Scanning probe tunnelling microscope,<br>• Nanoprobing station |

## F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | Students, Program Leaders, Peer Reviewer | Indirect (The feedback of the students is studied carefully) |
| Effectiveness of Students' assessment | Peer Reviewer | Direct |
| Quality of learning resources | Program Leaders | Indirect (final decisions of the committee will be studied in the department's council) |
| The extent to which CLOs have been achieved | Faculty | Indirect |
| Other | | |

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

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

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