ماجستير العلوم فى علوم المواد و تكنولوجيا النانو
Master of Science in Materials Science and Nanotechnology

من خلال هذا البرنامج سوف تنمى القدرة لفهم ركيزة المفاهيم العلمية الاساسية لعلوم النانو و خصائص المواد و المواد الحيوية في مستوى الذرة/الجزيء و قانون القياس الذي يقيس هذة الخصائص و فهم تطورات الحدود الحالية في علوم المواد وتكنولوجيا النانو وادراك واستحداث وابتكار الافكار بأستخدام الطرق المعملية و علي وجه التحديد ادوات التشخيص و التصنيع المستخدمة في علوم المواد وتكنولوجيا النانو مثل الميكروسكوبات المتنوعة و تحورات السطح و طرق بناء مستوي الجزيء.

الأهداف ومخرجات التعلم المقصودة:

الهدف الرئيسى من هذا البرنامج هو تسهيل مهارات التواصل بين التخصصات ذات الصله بالعلوم والتكنولوجيا إلى دراسة تكنولوجيا النانو . الطلاب سوف تنمى لديهم القدرة لـ :-

1. فهم ركيزة المفاهيم الأساسية لعلوم النانو بشكل تفصيلي .
2. فهم الخصائص الأساسية للمواد الحيوية فى المستوى الذرى / الجزيئى.
3. فهم الحدود الحالية للتطورات فى علوم المواد وتكنولوجيا النانو المحلية والدولية .
4. إدراك وتطوير الأفكار الجديدة والمبتكرة.
5. دراسة واستيعاب ادوات التشخيص والتصنيع المستخدمة فى علوم المواد وتكنولوجيا النانو مثل الميكروسكوبات المتنوعة وطرق بناء المستوى الجزيئى وتحورات السطح .
6. تبنى الجوانب المتعددة لتخصصات تكنولوجيا النانو التى تقع فى صميم فهمها والإندماج بإيجابية مع الباحثين والافكار فى العديد من التحصصات .
7. الاتصال القائم على حل المشاكل ومهارات التفكير النقدى التى سوف تعزز التعليم مدى الحياة.

تكون الدراسة علي مرحلتين

المرحله الاولي: دراسة نظرية لمده عام أكاديمي Pre-master courses

المرحله الثانية: تسجيل النقطة البحثية و إجراء الأبحاث المعملية و نشر بحث دولي واحد علي الأقل و كتابة الرسالة العلمية. و تمنح الدرجة بعد تحكيم الرسالة.

Pre-master Courses

1. Compulsory Courses:

First Semester							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
NT601	Materials Science 1	علوم المواد 1	2	2	0	2	100
NT602	Elements of crystallography	اساسيات اللبلورات	1	1	0	1	50
NT603	Nano-biotechnology	التكنولوجيا الحيوية النانومترية	2	2	0	2	100
NT604	Instrumental Analysis	أجهزة التحليل	2	2	0	2	100
NT605	Modeling and simulation	النمذجة و المحاكاة	1	1	0	1	50
NT606	Fundamentals of Nanoscience	أساسيات العلوم النانومترية	2	2	0	2	100
GC601	Scientific Thinking and Writing	التفكير والكتابه العلميه	1	1	0	1	50
Second Semester							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
NT608	Materials Science 2	2علوم المواد	2	2	0	2	100
NT609	Nanotubes: Production to Application	الأنانبيب النانومترية : من الإنتاج إلي التطبيقات	2	2	0	2	100
NT610	Nanomaterials for catalysis	المواد النانومترية الحفازة	2	2	0	2	100
NT611	Health and Environmental Impact of Nanotechnology	الأثر الصحي و البيئي للمواد النانومترية	2	2	0	2	100
NT612	Biomedical Applications of Nanomaterials	التطبيقات الطبية - الحيوية للمواد النانومترية	2	2	0	2	100
NT613	Materials & Nanotechnology Project	مشروع تكنولوجيا المواد والتكنولوجيا النانومترية	1	1	0	1	50

2. Elective courses:

Elective Courses							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
NT614	Nanotechnology of Engineering and Construction Materials	التكنولوجيا النانومترية وهندسة مواد التشييد و البناء	1	1	0	1	50
NT615	Good Laboratory Practices and safety	الممارسات والأمان المعملي	1	1	0	1	50
NT616	Semiconductor Nanostructures	المواد النانومترية الشبه موصلة	2	2	0	2	100
NT617	Nanoparticle and thin film technology	تكنولوجيا الطبقات الرقيقة والجزيئات النانومترية	2	2	0	2	100
NT618	Fabrication Techniques for Micro and Nano Devices	طرق تصنيع الأجهزة الميكرومترية والنانومترية	1	1	0	1	50
NT619	The Physics of Nanostructures	فيزياء المواد النانومترية	1	1	0	1	50
NT620	Microelectronics, Photonics and optoelectronics	الإلكترونيات الميكرومترية , الضوئيات والإلكترونيات الضوئية	1	1	0	1	50
NT621	Solar energy - Photovoltaics	الألواح الشمسية	2	2	0	2	100
NT622	Energy conversion and storage	تحويل و تخزين الطاقة	2	2	0	2	100

To complete the pre-requisite courses (pre-master courses) you should finish total credit hours = 26

[Compulsory Courses (22 credit hours) + Elective Courses (4 credit hours)]

3. Complementary Courses:

Complementary Courses (set by the department)							
Course code	Course title		Total Credit Hours	Lecture Credit Hours	Lab Credit Hours	Exam Duration (hour)	Final grades out of
	English	Arabic					
CN 101	Physical Chemistry	الكيمياء الفيزيائيه	2	2	0	2	100
CN 102	Analytical Chemistry	الكيمياء التحليليه	2	2	0	2	100
CN 103	Waves and Optics	الضوئيات والموجات	2	2	0	2	100
CN 104	Thermodynamics	الديناميكا الحراريه	2	2	0	2	100
CN 105	Surface Chemistry	كيمياء السطوح	2	2	0	2	100
CN 106	Properties of Matter	خواص الماده	2	2	0	2	100
CN 107	Selected Topics in Chemistry	مواضيع مختارة في الكيمياء	2	2	0	2	100
CN 108	Selected Topics in Physics	مواضيع مختارة في الفيزياء	2	2	0	2	100

Course Specifications

NT601 Materials Science 1

Crystal structure and symmetry-lattice imperfection in solids – Mechanical properties of solids – Creep and Fatigue of solids – Electrical and magnetic properties of solids - Classifications of magnetic materials —- Types of Defects in Crystalline materials – The Production of Defects in Solids – Effect of Lattice Defects on the Physical and Mechanical Properties of Solids- Interaction of Dislocations with Point Defects.

NT602 Elements of crystallography

Elements of XRD - Neutron Diffraction - Electron diffraction - Bravais lattice - Brillouin zone - Calculations of unit cell parameters - Atomic packing parameter - Introduction to group theory – space group

NT603 Nano-biotechnology

The aim of this course is to convey a well-founded, wide-ranging basis of knowledge for developing, implementing and evaluating nanobiotechnological applications. In this way, the course graduates should find themselves in a position, where they are able to assess the manifold interrelationships and effects of these new technologies. On this basis, they will have the ability to elaborate useful applications for their own institutions on surfaces; transduction and control of materials and information through biological interfaces; bilayers; bioelectronics; biosensors.

This module covers: interactions of biological molecules with surfaces; manipulation of bio-molecules.

NT604 Instrumental Analysis

Automated methods of analysis, overview of automatic instruments, Instrumentation, flow injection analysis, discrete automatic systems, Analysis based upon multilayer films - Thermogravimetric

methods (TG), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC). FTIR/FTRAMAN, Atomic Absorption, XRD, HPLC, mass spectrometry. TEM and SEM, BET, Zeta sizer.

NT605 Modeling and simulation

Introduction to Modeling and Simulation (IM/S) provides an introduction into modeling and simulation approaches, covering continuum methods (e.g. finite element analysis), atomistic simulation (e.g. molecular dynamics) as well as quantum mechanics. Atomistic and molecular simulation methods are new tools that allow one to predict functional material properties such as Young's modulus, strength, thermal properties, color, and others directly from the chemical makeup of the material by solving Schrodinger's equation (quantum mechanics). This approach is an exciting new paradigm that allows to design materials and structures from the bottom up - to make materials greener, lighter, stronger, more energy efficient, less expensive; and to produce them from abundant building blocks. These tools play an increasingly important role in modern engineering! In this subject they will get hands-on training in both the fundamentals and applications of these exciting new methods to key engineering problems.

NT606 Fundamentals of Nanoscience

Introduction to nanoscience – definition of nanomaterials and nanoscale. Preparation methods of nanostructures including up-down and bottom-up techniques. Selected industrial applications of nanomaterials.

GC601 Scientific Thinking and Writing

Scientific Planning – How to use a research engine - How to write a proposal – How to write a paper – Research ethics – Publication – social media.

NT608 Materials Science 2

The different modern theories of superconducting materials - Absorption of direct and indirect Semiconductor transitions - Optical Constants Relations - Photo and electr1oluminescence - Photoconductivity - Semiconductor Nanotechnology - Methods of preparations of thin films -

Mechanism of film formation - Electrical Properties of thin films - Electrical and magnetic properties of superconductors- The basis of magnetism: classical and quantum mechanical points of view. Different kinds of magnetic materials. Magnetic phenomena including anisotropy, magnetostriction, domains, and magnetization dynamics. Current frontiers of nano-magnetics research including thin films and particles. Optical, data storage, and biomedical engineering applications of soft and hard magnetic materials.

NT609 Nanotubes: Production to Application

Production of nanotubes with different composition- characterization of the nanotubes using Field Emission SEM and High Resolution TEM- industrial application of the nanotubes
Selected topics in the scope of the most recent applications of nanotubes.

NT610 Nanomaterials for catalysis

Catalysis- types of catalysis (homogenous catalysis, heterogeneous catalysis, auto-catalysis)- theories of catalysis – nanomaterials for catalysis (Practical examples from industry).

NT611 Health and Environmental Impact of Nanotechnology

This course covers the environmental and health aspects of nanotechnology. It presents an overview of nanotechnology along with characterization and properties of nanomaterials. The course material covers the biotoxicity and ecotoxicity of nanomaterials. A sizable part of the course is devoted to discussions about the application of nanotechnology for environmental remediation along with discussions about fate and transport of nanomaterials. Special emphasis is given to risk assessment and risk management of nanomaterials, ethical and legal aspects of nanotechnology, and nano-industry and nano-entrepreneurship. Nanomaterials and pollution control. Waste water treatment, Water desalination, membranes, nanomembranes and nanofilters.

NT612 Biomedical Applications of Nanomaterials

Medical applications of nanomaterials in: drug delivery – pharmaceuticals formulation – Targeting – Detecting- Imaging and cancer treatment.

NT613 Materials & Nanotechnology Project

Selecting a topic deals with nanoscience and nanotechnology and writing an essay on the topic with standard level of English language and science (may include an experimental part).

NT614 Nanotechnology of Engineering and Construction Materials

This course would cover the nanotechnology of the most widely used building materials such as concrete, asphalt, and wood. Structural design properties, including strength and durability, will be related to nanoscale considerations. Laboratory exercises will relate gross properties, such as strength and permeability, to nanoscale measurements and imaging.

NT615 Good Laboratory Practices and safety

Hazardous Chemical /Substance Spills – Fires - Weather Alerts - First Aid - Identification of Chemical Hazards - Chemical Inventories and Labeling - Personal Safety - Standard Laboratory Safety Equipment - Fire Prevention - Chemical and Hazardous Waste Identification and Disposal.

NT616 Semiconductor nanostructures

This module covers the physics and technology of semiconductor nanostructures, considering both the present status and possible future trends. It includes ultra-small and low dimensional devices (quantum wire and quantum dot lasers, single electron devices); self-assembly of semiconductor nanostructures; physical processes in semiconductor nanostructures; electronic and optical characterization techniques for semiconductor nanostructures.

NT617 Nanoparticle and thin film technology

This module will provide an understanding of methods for producing and characterizing nanoparticles and thin films of inorganic materials, hands-on training in synthesizing nanoparticles and films, and an appreciation of their potential applications in electronic, biomedical and structural engineering.

NT618 Fabrication Techniques for Micro and Nano Devices

Deals with aspects of the technology of processing procedures involved in the fabrication of microelectronic devices and microelectromechanical systems (MEMS). Students will become familiar with various fabrication techniques used for discrete devices as well as large-scale integrated thin-film circuits. Students will also learn that MEMS are sensors and actuators that are designed using different areas of engineering disciplines and they are constructed using a microlithographically-based manufacturing process in conjunction with both semiconductor and micromachining microfabrication technologies.

NT619 The Physics of Nanostructures

Progress in the technology of nanostructure growth; space and time scales; quantum confined systems; quantum wells, coupled wells, and superlattices; quantum wires and quantum dots; electronic states; magnetic field effects; electron-phonon interaction; and quantum transport in nanostructures: Kubo formalism and Butikker-Landau formalism; spectroscopy of quantum dots; Coulomb blockade, coupled dots, and artificial molecules; weal localization; universal conductance fluctuations; phase-breaking time; theory of open quantum systems: fluctuation-dissipation theorem; and applications to quantum transport in nanostructures.

NT620 Microelectronics, Photonics and optoelectronics

An overview of microelectronics and photonics science and technology. It provides the student who wishes to specialize in their application, physics or fabrication with the necessary knowledge of how the different aspects are interrelated. It is taught in three modules: design and applications, operation of electronic and photonic devices, fabrication and reliability. This course covers the theory, design, fabrication and applications of photonic materials and devices. After a survey of optical materials design for semiconductors, dielectrics and polymers, the course examines ray optics, electromagnetic optics and guided wave optics; physics of light-matter interactions; and device design principles of LEDs, lasers, photodetectors, modulators, fiber and waveguide interconnects, optical filters, and photonic crystals. Device processing topics include crystal growth, substrate engineering, thin film

deposition, etching and process integration for dielectric, silicon and compound semiconductor materials. The course also covers microphotonic integrated circuits and applications in telecom/datacom systems.

NT521 Solar energy- Photovoltaics

Solar energy is like wind energy an important source of sustainable and renewable energy. Therefore, learning more about technology that converts solar energy into electricity, heat and solar fuels might be a good investment. Photovoltaic (PV) devices are presented in this course as advanced semiconductor devices that deliver electricity directly from sunlight. The emphasis is on understanding the working principle of a solar cell, fabrication of solar cells, PV module construction and the design of a PV system. The student will understand the principles of the photovoltaic conversion (the conversion of light into electricity). The student will learn about the advantages, limitations and challenges of different solar cell technologies, such as crystalline silicon solar cell technology, thin film solar cell technologies and the latest novel solar cell concepts as studied on lab-scale. Fundamentals of Photovoltaics. Photovoltaics and the Renewable Electricity Grid. Crystalline Silicon Photovoltaics. Material and Solar Cell Characterization and Modelling.

NT622 Energy conversion and storage

This course will focus on the engineering fundamentals of thermodynamics, flow and transport processes, as applied particularly in the current topics of interest such as fuel cells and other direct conversion systems, but encompassing also future forms of traditional systems. The course incorporates fundamentals, process and system's analysis tools in the broad energy area, intended to educate future leaders in the field of energy technology, and is not constrained by disciplinary boundaries or limited to a monolithic view of energy conversion and utilization. The course will cover the underlying common principles of energy systems, and the analytical, experimental and computational tools used in their analysis, design and optimization. The course covers energy conversion, utilization and storage by introducing the common concepts and tools used in this field within a generic framework that allows students to analyze several alternative systems and determine according to fundamental principles which approach is compatible with the intended performance. The course covers indirect and direct energy conversion, energy conversion involving renewable sources (geothermal, electromagnetic and kinetic), the optimal integration of heterogeneous energy systems for hybrid operation, the production of energy carriers, like hydrogen, and synthesized fuels, the utilization of knowledge to maximize flexibility and extend the performance envelope, etc. It covers fundamental physical chemistry of energy conversion, both at the macroscopic and microscopic levels, and how these systems are engineered and integrated into functional modalities. The course will cover macroscopic and microscopic analysis of direct and indirect energy conversion in thermochemical, electrochemical, thermomechanical and other processes. Material includes chemical thermodynamics and kinetics in homogeneous and heterogeneous environment; kinetic theory and transport phenomena in energy systems, critical flow

processes and how they impact performance. Applications to systems utilizing fossil fuels, hydrogen, and renewable resources, including electrochemical cells, catalysis, photovoltaics, supercritical and combined cycles. Examples form very large-scale power plants to microscale energy and propulsion devices will be used to demonstrate the approach and the future trends. The course provides advanced training on energy issues covering techniques for energy storage and chemical generation, including advanced battery design; fuel cells; hydrogen generation and storage systems; heat recovery and storage in the process industries.

CN101 Physical chemistry

The properties of gases- chemical equilibrium- phase diagrams- molecular structure- Molecular spectroscopy.

CN102 Analytical chemistry

Stoichiometric calculations- general concepts of chemical equilibrium- precipitation reactions and titrations- chromatography

CN103 Waves and optics

Mechanical vibrations and waves – electromagnetic waves – mechanics and electromagnetism - reflection, refraction, and diffraction.

CN104 Thermodynamics

The internal energy and the entropy – enthalpy – 1^{st} and 2^{nd} law of thermodynamics – Carnot cycle.

CN105 Surface chemistry

Surfaces and interfaces – adsorption – structure of surfaces – thermodynamics and dynamics of surfaces – catalysis by surfaces.

CN106 Properties of matter

Crystal lattices and crystal structure – properties of solids.

CN107 Selected topics in Chemistry

To be determined according to the department.

CN108 Selected topics in Physics

To be determined according to the department.