



AALBORG UNIVERSITET

# KANDIDATUDDANNELSEN I NANOBIOTEKNOLOGI 2020

CIVILINGENIØR  
AALBORG

MODULER SOM INDGÅR I STUDIEORDNINGEN

## INDHOLDSFORTEGNELSE

Nanobioengineering 2023/2024 .....	3
Advanced Gene Technology 2023/2024 .....	5
Reaction Engineering and Molecular Electronics 2023/2024 .....	7
Molecular Simulations 2023/2024 .....	9
Characterisation of Nanobiostructures 2023/2024 .....	11
Self-Assembling Systems 2023/2024 .....	13
Overfladefysik og -kemi (B) 2023/2024 .....	15
NMR og MS 2023/2024 .....	17
Advanced Nanobiotechnology 2023/2024 .....	19
Materials Chemistry 2023/2024 .....	21
Materials Characterization 2023/2024 .....	23
Advanced Nanobiotechnology 2023/2024 .....	25
Advanced Nanobiotechnology 2023/2024 .....	27
Project-oriented Study in an External Organisation 2023/2024 .....	29
Master's Thesis 2023/2024 .....	31
Master's Thesis 2023/2024 .....	33
Master's Thesis 2023/2024 .....	35

# NANOBIOENGINEERING

## 2023/2024

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The project is designed to cover a broad range of topics. It can be a theoretical or an experimental project dealing with all aspects relevant for manufacturing and engineering of biological/organic nanostructures.

#### LEARNING OBJECTIVES

##### KNOWLEDGE

- Must have knowledge about how to design, model and manufacture different biological/organic nanostructures.
- Must be able to understand the fundamental concepts of engineering and design of nanostructures based on organic/biological systems.

##### SKILLS

- Must be able to apply the design, engineering and manufacturing concepts in order to predict and fabricate the desired organic or bio-nanostructures
- must be able to evaluate the different methods used for production, design, and engineering of nanobiostructures
- Compose a project report according to the norms of the scientific field, include relevant original literature, use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

##### COMPETENCES

- Must have obtained the skills to design, model, fabricate and characterize nano-scale (bio)structures.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

#### TYPE OF INSTRUCTION

Supervised project work done in groups.

#### EXTENT AND EXPECTED WORKLOAD

This is a 15 ECTS project module and the work load is expected to be 450 hours for the student.

### EXAM

#### EXAMS

Name of exam	Nanobioengineering
Type of exam	Oral exam based on a project
ECTS	15
Permitted aids	All written and all electronic aids
Assessment	7-point grading scale

Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Nanobioengineering
Module code	M-NB-K1-1
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Evamaria Petersen</a>

## ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# ADVANCED GENE TECHNOLOGY

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained by the module Gene Technology on 5th semester of the Bachelor in Nanotechnology as well as knowledge in Organic Chemistry and Biochemistry.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Must have knowledge about advanced gene expression systems.
- Must have knowledge about high throughput screening methods.
- Must have knowledge about advanced applications of gene technology in the areas of biotechnology, medicine, and nanotechnology.

#### SKILLS

- Must be able to apply the knowledge to solve real world problems.
- Must be able to understand the principles.
- Must be able to engineer (theoretically) new DNA based nano-devices.

#### COMPETENCES

- Must have a deeper understanding of the principles and tools.
- Must know how to engineer nano-devices for applications in the area of medicine and biotechnology.

### TYPE OF INSTRUCTION

The teaching is organized in accordance with the general form of teaching. Please see the programme curriculum §17.

### EXTENT AND EXPECTED WORKLOAD

This is a 5 ECTS course module and the work load is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Gene Technology
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Avanceret genteknologi
Module code	M-NB-K1-2
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Evamaria Petersen</a>

## ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# REACTION ENGINEERING AND MOLECULAR ELECTRONICS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge in the area of Physical Chemistry, Inorganic and Organic Chemistry, Lab-on-a-Chip, Basic Quantum Mechanics, and Microbiology.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Must acquire knowledge about basic design principles and modeling of chemical, biochemical, and biotechnological reactors.
- Must acquire knowledge about micro-reactors and their application in biotechnology.
  
- Must acquire knowledge on the underlying principles and the current state of molecular electronics.

#### SKILLS

- Must be able to apply the acquired knowledge to the design and performance evaluation of batch and continuous flow reactors.
- Must be able to model chemical and biochemical reactors using COMSOL and other mathematical modeling software.

#### COMPETENCES

- Must have working knowledge and basic skills for designing, modeling and evaluating of chemical, biochemical, and biotechnological reactors.
- Must acquire an overview of the current progress in the area of molecular electronics.

### TYPE OF INSTRUCTION

Lectures and exercises.

### EXTENT AND EXPECTED WORKLOAD

This is a 5 ECTS course module and the work load is expected to be 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Reaction Engineering and Molecular Electronics
Type of exam	Oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination

Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures
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## FACTS ABOUT THE MODULE

Danish title	Engineering af reaktioner og molekylær elektronik
Module code	M-NB-K1-3
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Leonid Gurevich</a> , <a href="#">Evamaria Petersen</a>

## ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science



# MOLECULAR SIMULATIONS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained in the area of Organic Chemistry, Protein Physics, Basic Quantum Mechanics, and Physical Chemistry.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

Students who complete the module: will have gained skills in the up to date computer modeling techniques of molecular dynamics and analysis of in silico modeled protein, peptide and membrane structures and function.

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Must have knowledge about modern force fields.
- Must have knowledge about protein folding and function.
  
- Must have knowledge about the general building blocks of proteins and their chemistry.
  
- Must be able to evaluate protein structures.
  
- Must be able to apply the principals of protein structures and functions to real problems.

#### SKILLS

- Must be able to apply principals of Molecular dynamics simulations to real problems.
- Must be able to evaluate modeled protein structures and function.
  
- Must be able to apply the properties and chemistry of the aminoacids to real world problems.
  
- Must be able to evaluate results from molecular dynamics simulations.

#### COMPETENCES

- Must have a basic understanding of molecular modelling.
- Must have a general understanding of the physics of protein dynamics and force field based modeling strategies.
  
- Must have a general knowledge molecular simulations.

#### TYPE OF INSTRUCTION

Lectures with accompanying problem solving session.

#### EXTENT AND EXPECTED WORKLOAD

This is a 5 ECTS course module and the work load is expected to be 150 hours for the student.

**EXAM****EXAMS**

Name of exam	Molecular Simulations
Type of exam	Active participation/continuous evaluation The re-exam will be written or oral.
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

**FACTS ABOUT THE MODULE**

Danish title	Molekylær simulering
Module code	M-NB-K1-4
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

**ORGANISATION**

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# CHARACTERISATION OF NANOBIOSTRUCTURES

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained by the project on NB1 (1st semester).

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The project is designed to cover a broad range of topics. It can be a rather more theoretical or experimental project dealing with all aspects relevant for manufacturing and characterization of biological/organic nanostructures.

## LEARNING OBJECTIVES

### KNOWLEDGE

- Must have knowledge about methods and tools used for production and characterization of biological/organic nanostructures.
- Must be able to understand the fundamental concepts behind the methods and tools used for production and characterization of biological/organic nanostructures.

### SKILLS

- Must be able to produce biological/organic nanostructures and must be able to investigate their properties by using different methods and tools.
- Must be able to evaluate the different methods used for production and characterization of nano(bio)structures.
- Compose a project report according to the norms of the scientific field, include relevant original literature, use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

### COMPETENCES

- Must have obtained the skills to produce and characterize biological/organic nanostructures by using different tools.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

### TYPE OF INSTRUCTION

Supervised project work done in groups.

### EXTENT AND EXPECTED WORKLOAD

This is a 15 ECTS project module and the work load is expected to be 450 hours for the student.

## EXAM

### PREREQUISITE FOR ENROLLMENT FOR THE EXAM

- An approved PBL competency profile is a prerequisite for participation in the project exam.

## EXAMS

Name of exam	Characterisation of Nanobiostructures
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Karakterisering af nanobiostrukturer
Module code	M-NB-K2-1A
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Evamaria Petersen</a>

## ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# SELF-ASSEMBLING SYSTEMS

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained in the area of Physical Chemistry, Inorganic and Organic Chemistry, and Biochemistry.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Must acquire knowledge about basic principles of self-assembling behavior in nature, forces involved in the process, ways to model and design a self-assembling system
- Must acquire knowledge about application of self-assembly for drug-delivery, thin films and nano-arrays

#### SKILLS

- Must be able to use Langmuir-Blodgett technique as well as other methods to fabricate monolayers, micelles and vesicles
- Must be able to apply the acquired knowledge to critically read and understand research papers on the subject of self-assembly

#### COMPETENCES

- Must acquire an overview of the current progress in the areas of self-assembly and drug delivery

### TYPE OF INSTRUCTION

Lectures and exercises.

## EXAM

### EXAMS

Name of exam	Self-Assembling Systems
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Selvorganiserende biostrukturer
Module code	F-NB-K2-2
Module type	Course

Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Leonid Gurevich</a> , <a href="#">Fojan</a>

## ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# OVERFLADEFYSIK OG -KEMI (B)

**2023/2024**

## ANBEFALEDE FAGLIGE FORUDSÆTNINGER FOR AT DELTAGE I MODULET

Modulet bygger på viden opnået i faststoffysik, grund- og fysiskkemi.

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

Kursets mål er, at give viden om specielle aspekter samt fysiske og kemiske fænomener på overflader og grænseflader.

### LÆRINGSMÅL

#### VIDEN

- struktur af krystalliske overflader samt metoder og teknologier indenfor fremstilling og karakterisering
- grundlæggende termodynamik og kinetik af overfladeprocesser herunder fænomener om overfladespænding og adsorption/desorption
- de vigtigste interaktioner nær grænsefladerne herunder van der Waals og dobbelt-lags kræfter
- fysi- og kemisorption på overflader og katalyse
- struktur af grænseflader, befugtning teori, hydrofobicitet, membraner og vækst af tynde film
- elektronisk struktur af overflader, elektriske og magnetiske fænomener på overflader og grænseflader;

#### FÆRDIGHEDER

Den studerende vil blive uddannet i at løse problemer inden for de emner, der er anført ovenfor, og vil være i stand til at anvende teorier og metoder fra overfladefysik og -kemi.

#### KOMPETENCER

Kompetencerne som opnås, skal udvikle og styrke kendskab til, forståelse af og anvendelse af teorier og metoder i overfladefysik. Den studerende skal ud fra givne forudsætninger kunne ræsonnere og argumentere med begreber fra overfladefysik.

#### UNDERVISNINGSFORM

Forelæsninger med tilhørende opgaveregning.

#### OMFANG OG FORVENTET ARBEJDSINDSAT

Kursusmodulets omfang er 5 ECTS svarende til 150 timers studieindsats.

## EKSAMEN

### FORUDSÆTNING FOR INDSTILLING TIL PRØVEN

- Aflevering/oplæg og godkendelse af opgaver er en forudsætning for deltagelse i eksamen.

### PRØVER

Prøvens navn	Overfladefysik og -kemi
Prøveform	Skriftlig eller mundtlig

ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	Physics and Chemistry of Surfaces
Modulkode	F-FYS-K2-5A
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Engelsk
Tomplads	Ja
Undervisningssted	Campus Aalborg
Modulansvarlig	<a href="#">Leonid Gurevich</a> , <a href="#">Vladimir Popok</a>

## ORGANISATION

Studienævn	Studienævn for Mekanik og Fysik
Institut	Institut for Materialer og Produktion
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet



# NMR OG MS

2023/2024

## MODULETS INDHOLD, FORLØB OG PÆDAGOGIK

I løbet af kurset bliver følgende temaer gennemgået:

NMR: Den fysiske baggrund for NMR:

- kerne spin, spin i et magnetisk felt, CW-NMR, FT-NMR, radiofrekvens pulser
- Spektrale Parametere: kemisk skift, skalar og dipolær kopling
- Spectroskopisk Teknik: 1D eksperimenter med én eller flere pulser
- Praktiske Aspekter: konstruktion af NMR spektrometere, praktisk eksperimentel NMR, signalbehandling, Kerne Magnetisk Relaxation: spin-gitter og spin-spin relaxation og disses afhængighed af molekylær mobilitet, Overhauser effekten
- 2D-NMR: begrebet 'chemical shift labelling', magnetiserings overførsel mellem spin, hvorledes opnås den anden dimension, homonuclear 2D (COSY, TOCSY, NOESY), heteronuclear 2D (HSQC, HMQC)
- Dynamisk NMR Spektroskopi: kemisk udveksling, linieform analyse, 'coalescence', tidsskala for NMR
- Anvendelse af feltgradienter i NMR, Diffusion-Ordered Spectroscopy, Fortolkning af NMR Spektre: tilordning af signaler, bestemmelse af struktur af små molekyler
- Udvalgte emner af moderne, anvendt NMR, fx: NMR af makromolekyler, 'magnetic resonance imaging', kvantemekanisk beskrivelse af NMR, metabolic profiling vha NMR
- Opgaver: fortolkning af spektre, identifikation af forbindelser fra spektre, optagelse af spektre på eget spektrometer, teoretiske beregninger.

MS:

- Historie for MS udvikling og anvendelses muligheder inden for Life Sciences, Bioteknologi og Kemi.
- De fysiske principper bag MS ionisering (matrix-assisted laser desorption ionization/elektro-spray)
- Masse analysatorer (time-of flight, quadropol, ion-fælde, Orbitrap)
- MS/MS sekventering, iondetektering, reflektrom.
- Anvendelse af on-line kromatografi (HPLC, GC, CE).
- Den konkrete anvendelse af forskellige MS vil blive gennemgået, f. eks. MALDI-TOF-MS og nano-spray fulgt af MS/MS til proteinanalyser.
- Tolkning af spektre af organiske molekyler, proteiner, peptider og DNA sekvenser, kulhydrater) og regneopgaver til at støtte den teoretiske gennemgang.
- Anvendelse af MS i targeted og untargeted metabolomics og proteomics. Introduktion til massespektrometri baseret bioinformatik.

## LÆRINGSMÅL

### VIDEN

Studerende, der gennemfører modulet

- Skal kunne redegøre for de teoretiske grundlag for NMR og MS, herunder også hvordan de observerede signaler opstår
- Skal kunne redegøre for den eksperimentelle fremgangsmåde ved måling af NMR og MS data

### FÆRDIGHEDER

- Skal kunne fortolke 1D og 2D NMR spektre, herunder være i stand til at forudsige spektre fra en given struktur, finde en ukendt struktur fra et givent spektrum eller være i stand til at tilordne NMR signaler til atomer i strukturen
- Skal kunne vurdere anvendeligheden af NMR og MS på givne kemiske/bioteknologiske/nanoteknologiske problemstillinger
- Skal kunne fortolke MALDI MS og ESI MS spektre
- Skal kunne benytte korrekte begreber, notationer og symboler fra NMR og MS litteraturen

## UNDERVISNINGSFORM

Uddannelsen bygger på en kombination af faglige, problemorienterede og tværfaglige tilgange og tilrettelægges ud fra følgende arbejds- og evalueringsformer, der kombinerer færdigheder og faglig refleksion:

- Forelæsninger
- Klasseundervisning
- Projektarbejde
- Workshops
- Opgaveløsning (individuelt og i grupper)
- Lærerfeedback

## OMFANG OG FORVENTET ARBEJDSINDSAT

150 timer

## EKSAMEN

### PRØVER

Prøvens navn	NMR og MS
Prøveform	Skriftlig eller mundtlig
ECTS	5
Bedømmelsesform	7-trins-skala
Censur	Intern prøve
Vurderingskriterier	Vurderingskriterierne er angivet i Universitetets eksamensordning

## FAKTA OM MODULET

Engelsk titel	NMR and MS
Modulkode	K-BT-B6-14
Modultype	Kursus
Varighed	1 semester
Semester	Forår
ECTS	5
Undervisningssprog	Dansk
Tomplads	Ja
Undervisningssted	Campus Aalborg
Modulansvarlig	<a href="#">Wimmer</a>

## ORGANISATION

Studienævn	Studienævn for Kemi og Biovidenskab
Institut	Institut for Kemi og Biovidenskab
Fakultet	Det Ingeniør- og Naturvidenskabelige Fakultet

# ADVANCED NANBIOTECHNOLOGY

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained by the project on NB2 (2nd semester).

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

This project focuses on all kinds of advanced biostructures and their static and dynamic properties.

Different advanced nanobiostructures will be manufactured and/or modeled and their static and dynamic properties will be characterized using state-of-the-art scientific tools, techniques and theories.

## LEARNING OBJECTIVES

### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject.

### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art methods and principles used in the project.
- Ability to define the limits of the project.
- Ability to reflect over the obtained results.
- Compose a project report according to the norms of the scientific field, include relevant original literature, use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

### COMPETENCES

- Should be able to identify, formulate, and analyze independently a problem.
- Should have the necessary skills to identify and apply the relevant scientific theories and methods to the formulated problem.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

### TYPE OF INSTRUCTION

Project work.

### EXTENT AND EXPECTED WORKLOAD

This is a 20 ECTS project module and the work load is expected to be 600 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Nanobiotechnology
Type of exam	Oral exam based on a project
ECTS	20
Permitted aids	All written and all electronic aids
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Avanceret Nanobioteknologi
Module code	M-NB-K3-2
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	20
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# MATERIALS CHEMISTRY

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module adds to the knowledge obtained in Inorganic Chemistry and Physical Chemistry

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

The purposes of the course are to introduce both fundamental chemical principles of materials and nano-materials, and main methods for developing, optimizing, post-treating and characterizing materials regarding different physical and chemical performances.

The focus will be placed on the relation between chemical composition, structure and properties. The course will introduce the current status of materials and nano-materials technologies.

Materials chemistry focuses on the fundamental principles and applications of both conventional and advanced inorganic materials. The course is divided into the following two parts.

1. General inorganic materials chemistry and characterization of inorganic materials (e.g., glass chemistry, ceramic chemistry, metal chemistry, cement industry)
2. Chemistry of organic and inorganic nano-materials (e.g., thin films, nano-crystals and –particles, nanotubes, mesoporous materials, nano wires, etc.).

## LEARNING OBJECTIVES

### KNOWLEDGE

Students who have passed the module should be able to

- explain the fundamental principles of materials chemistry and how it relates to practical use
- explain different application areas of materials and ways to optimize the production process of materials

### SKILLS

- prepare, synthesize and modify materials to reach target properties using theoretical and practical knowledge in materials chemistry
- design, synthesize, and produce nanostructured materials with given properties.
- characterize conventional materials and nano-materials

## TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises (individually and in groups)

## EXTENT AND EXPECTED WORKLOAD

150 hours

**EXAM****EXAMS**

Name of exam	Materials Chemistry
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

**FACTS ABOUT THE MODULE**

Danish title	Materialekemi
Module code	K-KEM-K1-20
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Yue</a>

**ORGANISATION**

Study Board	Study Board of Chemistry and Bioscience
Department	Department of Chemistry and Bioscience
Faculty	The Faculty of Engineering and Science

# MATERIALS CHARACTERIZATION

## 2023/2024

### CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

#### LEARNING OBJECTIVES

##### KNOWLEDGE

- Attain knowledge about the theory behind different materials characterization techniques
- Attain knowledge about the application areas of different materials characterization techniques

##### SKILLS

- Be able to use different experimental techniques within the areas of ellipsometry, photoluminescence, vibrational spectroscopy, diffraction methods, thermal analysis and atomic force microscopy

##### COMPETENCES

- Be able to analyse the results of different materials characterization techniques
- Be able to combine characterization techniques for an overall determination of materials structure and behaviour

#### TYPE OF INSTRUCTION

The form(s) of teaching will be determined and described in the connection with the planning of the semester. The description will account for the form(s) of teaching and may be accompanied by an elaboration of the roles of the participants.

The teaching is organized in accordance with the general form of teaching. Please see the programme curriculum § 17.

#### EXTENT AND EXPECTED WORKLOAD

Since it is a 5 ECTS course module the expected workload is 150 hours for the student.

## EXAM

### EXAMS

Name of exam	Materials Characterization
Type of exam	Written or oral exam
ECTS	5
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

## FACTS ABOUT THE MODULE

Danish title	Karakterisering af Materialers Egenskaber
Module code	M-MN-K1-2A

Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Jensen</a>

## ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Materials and Nanotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science



# ADVANCED NANBIOTECHNOLOGY

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained by the project on NB2 (2nd semester).

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

This project focuses on all kinds of advanced biostructures and their static and dynamic properties.

Different advanced nanobiostructures will be manufactured and/or modeled and their static and dynamic properties will be characterized using state-of-the-art scientific tools, techniques and theories.

## LEARNING OBJECTIVES

### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject.

### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art methods and principles used in the project.
- Ability to define the limits of the project.
- Ability to reflect over the obtained results.
- Compose a project report according to the norms of the scientific field, include relevant original literature, use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

### COMPETENCES

- Should be able to identify, formulate, and analyze independently a problem.
- Should have the necessary skills to identify and apply the relevant scientific theories and methods to the formulated problem.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

### TYPE OF INSTRUCTION

Project work.

### EXTENT AND EXPECTED WORKLOAD

This is a 25 ECTS project module and the work load is expected to be 750 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Nanobiotechnology
Type of exam	Oral exam based on a project
ECTS	25
Permitted aids	All written and all electronic aids
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Avanceret Nanobioteknologi
Module code	M-NB-K3-3
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	25
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# ADVANCED NANBIOTECHNOLOGY

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

The module builds on knowledge obtained by the project on NB2 (2nd semester).

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

This project focuses on all kinds of advanced biostructures and their static and dynamic properties.

Different advanced nanobiostructures will be manufactured and/or modeled and their static and dynamic properties will be characterized using state-of-the-art scientific tools, techniques and theories.

## LEARNING OBJECTIVES

### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject.

### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art methods and principles used in the project.
- Ability to define the limits of the project.
- Ability to reflect over the obtained results.
- Compose a project report according to the norms of the scientific field, include relevant original literature, use correct academic language and communicate the project's research-based basis and problem and results in a coherent written and oral manner, including the connection between the problem formulation, the project's execution and the main conclusions.
- Evaluate and select relevant original literature and current scientific methods, models and other tools used in the project work, as well as assess the project's problem in relevant technical scientific context.

### COMPETENCES

- Should be able to identify, formulate, and analyze independently a problem.
- Should have the necessary skills to identify and apply the relevant scientific theories and methods to the formulated problem.
- Plan, implement and manage complex and unpredictable research and / or development tasks and assume a professional responsibility for conducting professional and interdisciplinary collaborations.
- Take responsibility for own academic development and specialization.

### TYPE OF INSTRUCTION

Project work.

### EXTENT AND EXPECTED WORKLOAD

This is a 30 ECTS project module and the work load is expected to be 900 hours for the student.

## EXAM

### EXAMS

Name of exam	Advanced Nanobiotechnology
Type of exam	Oral exam based on a project
ECTS	30
Permitted aids	All written and all electronic aids
Assessment	Passed/Not Passed
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Avanceret Nanobioteknologi
Module code	M-NB-K3-4
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# PROJECT-ORIENTED STUDY IN AN EXTERNAL ORGANISATION

**2023/2024**

## RECOMMENDED PREREQUISITE FOR PARTICIPATION IN THE MODULE

This module is based on knowledge obtained on the 1st and 2nd semester of the master programme.

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Discuss the subject matter of the project specified within the area of the study programme.

#### SKILLS

- Solve complex problems using theory and concepts within physics.
- Evaluate and choose among potentially relevant theories, concepts and methodologies applied to solve problem within physics.
- Evaluate the relevance and limitations of the theories, concepts, methods and tools actually applied in the project.
- Account for any choices made during the problem analysis and solution development.
- Develop solution alternatives and evaluate the consequences of solution alternatives and make a well-informed choice based on that.
- Plan, execute and report an extensive individual research project within an agreed time frame.
- Write a well-structured project report, which meets all the usual requirements of an academic work, including:
  - Empirical background
  - Research problem/project objective
  - Relevant theory
  - Research design
  - Presentation of data
  - Presentation and discussion of findings
  - Evaluation of the project; i.e., findings, methods and, if relevant, considerations regarding the limitations and generalizability of the study.

#### COMPETENCES

- Analyze and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental, and/or numerical methods and models.
- Work together with an organization and identify problems and finally develop solutions.
- Operationalize theoretical contributions in a practical setting
- Compare and critically evaluate the results of the project in relation to existing knowledge and accepted theories within the subject area.
- Communicate a balanced view of the results and conclusions of the project in well-organized written and oral presentation.

#### TYPE OF INSTRUCTION

The student is included in the company's daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship.

#### EXTENT AND EXPECTED WORKLOAD

This is a 30 ECTS project module and the work load is expected to be 900 hours for the student.

**EXAM****EXAMS**

Name of exam	Project-oriented Study in an External Organisation
Type of exam	Oral exam based on a project
ECTS	30
Permitted aids	All written and all electronic aids
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

**FACTS ABOUT THE MODULE**

Danish title	Projektorienteret forløb i en virksomhed
Module code	M-NB-K3-5
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Thomas Møller Søndergaard</a>

**ORGANISATION**

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# MASTER'S THESIS

**2023/2024**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures described in the thesis.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject of the thesis.
- Explain the scientific basis and scientific issues within the specialization
- Explain the highest international research in the field of specialization.

#### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art within the area of the thesis subject.
- Ability to define the limits of the project.
- Ability to demonstrate scientific and professional project work.
- Master the scientific methods and general skills related to the field of specialization
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

#### COMPETENCES

- Applying the knowledge and skills obtained during the master program to solve the subject specific problem of the thesis with the support of the supervisor.
- Evaluate the approach, methods, and materials used for the project to fulfill the goal of the project.
- Be able to relate the problem to the relevant field/area and the obtained results.
- Be able to make and justify decisions on the relevant theories and methods.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

#### TYPE OF INSTRUCTION

Project work.

#### EXTENT AND EXPECTED WORKLOAD

This is a 50 ECTS project module and the work load is expected to be 1500 hours for the student.

The master thesis can be conducted as a long master thesis. If choosing to do a long master thesis, it has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS.

## EXAM

### EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	50
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-NB-K4-3
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	50
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science



# MASTER'S THESIS

**2023/2024**

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures described in the thesis.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject of the thesis.
- Explain the scientific basis and scientific issues within the specialization
- Explain the highest international research in the field of specialization.

#### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art within the area of the thesis subject.
- Ability to define the limits of the project.
- Ability to demonstrate scientific and professional project work.
- Master the scientific methods and general skills related to the field of specialization
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

#### COMPETENCES

- Applying the knowledge and skills obtained during the master program to solve the subject specific problem of the thesis with the support of the supervisor.
- Evaluate the approach, methods, and materials used for the project to fulfill the goal of the project.
- Be able to relate the problem to the relevant field/area and the obtained results.
- Be able to make and justify decisions on the relevant theories and methods.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

#### TYPE OF INSTRUCTION

Project work.

#### EXTENT AND EXPECTED WORKLOAD

This is a 60 ECTS project module and the work load is expected to be 1800 hours for the student.

The master thesis can be conducted as a long master thesis. If choosing to do a long master thesis, it has to include experimental work and has to be approved by the study board. The amount of experimental work must reflect the allotted ECTS.

## EXAM

### EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	60
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-NB-K4-4
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	60
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science

# MASTER'S THESIS

2023/2024

## CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

### LEARNING OBJECTIVES

#### KNOWLEDGE

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures described in the thesis.
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject of the thesis.
- Explain the scientific basis and scientific issues within the specialization
- Explain the highest international research in the field of specialization.

#### SKILLS

- Ability to approach, describe, and solve a specific problem using the tools available.
- Ability to explore and achieve sufficient understanding of the state-of-the-art within the area of the thesis subject.
- Ability to define the limits of the project.
- Ability to demonstrate scientific and professional project work.
- Master the scientific methods and general skills related to the field of specialization
- Compose a project report according to the field's norms, use correct professional language, document extensive inclusion of relevant original literature, communicate and discuss the project's research-based basis and problem and results in a written, graphic and oral manner in a coherent way.
- Critically evaluate the project's results in relation to relevant original literature and current scientific methods, models and evaluate and discuss the project's problem in a relevant technical scientific context.
- Assess and put the project's potential into perspective for further development.

#### COMPETENCES

- Applying the knowledge and skills obtained during the master program to solve the subject specific problem of the thesis with the support of the supervisor.
- Evaluate the approach, methods, and materials used for the project to fulfill the goal of the project.
- Be able to relate the problem to the relevant field/area and the obtained results.
- Be able to make and justify decisions on the relevant theories and methods.
- Participate in and independently carry out technological development and research, as well as solve complex tasks using scientific methods.
- Perform planning, implementation and management of complex and unpredictable research and / or development tasks and assume a professional responsibility for completing independent academic tasks as well as interdisciplinary collaborations.
- Independently take responsibility for own professional development and specialization.

#### TYPE OF INSTRUCTION

Project work.

#### EXTENT AND EXPECTED WORKLOAD

This is a 30 ECTS project module and the work load is expected to be 900 hours for the student.

## EXAM

### EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

### FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	M-NB-K4-1
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	English
Location of the lecture	Campus Aalborg
Responsible for the module	<a href="#">Fojan</a>

### ORGANISATION

Education owner	Master of Science (MSc) in Engineering (Nanobiotechnology)
Study Board	Study Board of Mechanical Engineering and Physics
Department	Department of Materials and Production
Faculty	The Faculty of Engineering and Science