Curriculum Committee - Course Proposal Form

|  |  |
| --- | --- |
| **Term** | 2021-2022 Spring |
| **Course Code** | ENS 4803/5803 (double-coded) |
| **Level of course (undergraduate/graduate)** | UG/GR |
| **Course title in Turkish** | MDBF’de Özel Konular: Nanobiyoteknoloji |
| **Course title in English** | Special Topics in FENS: Nanobiotechnology |
| **SU/ ECTS Credits\*** | 3 SU Credits/ 10 ECTS Credits  (Please see **Table 1** for details) |
| **Engineering/ Science Credits (ECTS)**  **(Please Explain)** | ECTS Total: 7 (For UG students)  *(Term project and presentation are excluded)*  ECTC Basic Science: 3  ECTS Engineering: 4 |
| **Learning Outcomes** | * Defining models of key biological molecules, emphasizing the commonalities and differences with structural models of soft and hard matter * Developing models of these molecules toward enabling biotechnology * Defining structural models of nanomaterials that offer features attractive for nanobiotechnology * Developing these models to enable nanobiotechnology * Demonstrate how modifications made to these models offer prototypical examples of nanobiotechnology * Define and demonstrate the main tools for practical processing, characterization, and application of nanobiotechnology ; * Quantification of biomolecules, secondary structure determination of ssDNA/RNA molecules by mfold * Surface modification of up-conversion/down conversion/gold NPs with synthetic DNA molecules * Characterization of the DNA-modified up-conversion/down conversion/gold NPs with Gel Electrophoresis, UV-Visible Spectrophotometry, Dynamic Light Scaterring, Cicular Dichroism, and Surface Plasmon Resonance techniques. |
| **Course Summary / Content in Turkish** | Nano ölçekte geliştirilmiş; karbon temelli, floresan temelli ve plazmon temelli malzemelerin genel özelliklerini ve biyoteknolojideki temel kullanım alanlarını tanıtmak, nanomalzeme yüzey biyomodifikasyon ve karakterizasyon tekniklerini öğretmek, bu malzemelerin “hedef madde tayini, hedef bölge görüntüleme ve hedeflendirilmiş ilaç gönderimi ” gibi uygulama alanlarını güncel örneklerle tartışmak ve öğrencilere laboratuvar uygulamaları ile desteklenmiş, disiplinlerarası bir bakış açısı kazandırmaktır. |
| **Course Summary / Content in English** | The aim of this course is to introduce general concepts of biotechnology, nanotechnology, nanomaterials (carbon-based, fluorescence-based and plasmon-based nanomaterials), surface bio-modification techniques and characterization of bio-modified nanomaterials. |
| **Prerequisites / Corequisites** | - |
| **Registration constraints** | * - |
| **Program Requirements (Core, Area, Free elective etc.)** | * - |
| **Reason for proposing the course** | The proposed course content is multidisciplinary in nature covering the basic aspects of biotechnology and nanotechnology, and the most recent applications of the bio-modified nanomaterials in technology. Description of the most utilized nanomaterials in biotechnology (Table 2), modification of nanomaterials with DNA, protein and enzymes, confirmation of the modification with fundamental laboratory techniques and finally the most recent applications of the bio-modified nanoparticles will be explained during the implementation of the course. With the described content, students are expected to learn “nano-bio-probe” preparation and characterization techniques for potential applications in biosensing, bioimaging, targeted delivery. Additionally, students are expected to gain an enhanced vision for collaborative science during the implementation of this course. |
| **Relationships – differences in comparison to other courses already present in the catalogue (if any)** | The content of this course is different than the ones already available in BIO/MAT course catalog. |
| **Other Notes** | Details of the suggested course content are presented in **Table 2,** at the end of this document. The content can be readily improved according to the student/department needs. |

\****ECTS Credit System***

* 17 weeks per term X 45 working hours a week = 765 hours  
  765 Hours / 30 ECTS = 25,5 hours  
  **1 ECTS = 25,5 hours (25-30 hours are acceptable)**
* ECTS Credits of courses should be an estimation of student work load and should be crosschecked with student work load surveys. It shouldn’t be calculated with a formula.
* It should be possible for any student to take 30 credits per term and graduate in time. Overload and under loading in a term is up to the student, but number of credits that should be collected to be entitled for a degree is set.
* Non-credit courses now should be credit ones. BUT they can still be pass-fail courses and wouldn’t be taken into account in GPA calculation.

**Table 1 An Example for Nanobiotechnology Course**

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity** | **Duration (Hours per week)** | **Total number of weeks** | **Total hours in term** |
| **Courses (Face-to-face teaching)** | 3 | 14 | 42 |
| **Own studies outside class** | 5 | 13 | 65 |
| **Practice, Recitation** | 1 | 4 | 4 |
| **Laboratory** | 1.5 | 6 | 9 |
| **Homework** | 1 | 3 | 3 |
| **Term project** | 1 | 7 | 7 |
| **Term project presentation** | 3 | 1 | 3 |
| **Quiz** | 1 | 3 | 3 |
| **Own study for mid-term exam** | 5 | 6 | 30 |
| **Mid-term** | 2 | 1 | 2 |
| **Personal studies for final exam** | 5 | 13 | 65 |
| **Final exam** | 2 | 1 | 2 |
|  |  | **Total workload** | **235** |
|  |  | **Total ECTS credits** | **10** |

**Table 2. ENS4803-ENS5803 Course content**

|  |  |
| --- | --- |
| **Week 1** | **Title: The molecules of life**   * Molecular structure and functions of DNA * Molecular structure and functions of RNA * Molecular structure and functions of protein * A summary of replication (DNA), transcription (RNA) and translation (protein) processes |
| **Week 2** | **Title: The universe at the nanoscale**   * General perspectives of nanotechnology * General perspectives of biotechnology * Intersection of biotechnology and nanotechnology: Nanobiotechnology |
| **Week 3** | **Title: Carbon based nanomaterials and their applications in biotechnology**   * Giant carbon materials (allotropes of carbon) * Fullerene * Graphene * Carbon nanotubes * How to engineer carbon-based nanomaterials in biotechnology? * **Quiz /Homework/Assignment (5% of the final grade)** |
| **Week 4** | **Title: Metallic nanomaterials and their applications in biotechnology**   * Plasmonic nanoparticles * Magnetic nanoparticles * How to design magnetic particles for bio-separation? * **Quiz /Homework/Assignment (5% of the final grade)** |
| **Week 5** | **Title: Fluorescent nanomaterials and their applications in biotechnology**   * The concept of fluorescence * Down-converting nanoparticles (Quantum Dots-QDs) * Up-converting nanoparticles (UCNPs) * How to use fluorescent nanomaterials in biosensing? * **Quiz /Homework/Assignment (5% of the final grade)** |
| **Week 6** | **Title: Engineering affinity probes for surface modification of nanoparticles**   * Antibodies (protein-based affinity probes) * Aptamers (DNA/RNA based synthetic affinity probes) * Quantification of biomolecules, secondary structure determination of ss-DNA/RNA molecules by m-fold * **Term project assignment (10% of the final grade)** |
| **Week 7**  **14.04.2022**  **PHYSICAL in CLASSROM** | * **Midterm exam (25% of the final grade)** |
| **Week 8** | **Title: Surface bio-modification (labelling) techniques**   * Carbodiimide chemistry (NHS-EDC reaction) * Streptavidin-biotin interaction * Gold-thiol interaction * Ni/Co His-tag interaction * Modification of up- /down-converting NPs/gold NPs with synthetic DNA |
| **Week 9** | **Title: Characterization of surface bio-modification-1**   * Gel electrophoresis (GE) technique * UV-Vis spectrophotometry * Practice/Recitation * Characterization of DNA modified up-conversion/down conversion/gold NPs with GE and UV-Vis |
| **Week 10** | **Title: Characterization of surface bio-modification-2**   * Dynamic light scattering (DLS) * Circular dichroism (CD) * Practice/Recitation * Characterization of DNA modified up-conversion/down conversion/gold NPs with DLS/CD |
| **Week 11** | **Title: Other Techniques-1**   * Surface plasmon resonance * Nano-sight * Practice/Recitation * Surface modification of gold chip surfaces with DNA/protein/enzyme |
| **Week 12** | **Title: Other Techniques-2**   * Fluorescence spectroscopy (FS) * Practice/Recitation * Characterization of fluorescent-labelled magnetic bead particles with FC |
| **Week 13** | **Title: Presentations**   * Student presentations for specified topics in nanobiotechnology * **Presentation (10% of the final grade)** |
| **Week 14** | **Title: Visit to SUNUM laboratories**   * Clean room facility; information on lithography techniques * Material characterization tools * Microscopy facilities * Nanobiotechnology laboratory |
| **Week 15**  **09.06.2022**  **PHYSICAL in CLASSROM** | * **Final exam (40% of the final grade)** |
| **Textbooks and materials** | * Nanobiotechnology: Concepts, Applications, and Perspectives. Christof M. Niemeyer (Editor) and Chad A. Mirkin (Editor),2004, ISBN: 978-3-527-30658-9 * The Nanobiotechnology Handbook, Yubing Xie, 2012, ISBN 9781439838693 * Nanobiosensors, Volume 8, 1st Edition, Editors: Alexandru Grumezescu Hardcover, 2016, ISBN: 9780128043011 |
| **Recommended readings** | * Feynman, R. P. Engineering and Science 22–36 (February 1960). * Feynman, R. P., Leighton, R. B. & Sands, M. Feynman Lectures on Physics (Vols 1–3) (Addison Wesley, 1963). * Feynman, R. P. Surely You're Joking, Mr. Feynman!' Adventures of a Curious Character (W. W. Norton, 1985). * Toumey, C. Engineering and Science 16–23 (June 2005). * <https://www.nature.com/subjects/nanobiotechnology> |