**BMEN 4325 Biomedical Nanotechnology**

**Course Syllabus**

Instructor: Dr. Neda Habibi

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Office Hours: By appointment

Section Information: BMEN

Time and Place of Class Meetings: Monday-Wednesday 1-2:20 pm

**Description of course content:**

This course provides an overview of nanotechnology, fabrication, characterization and functions of nanoscale structures, and serves as an introduction to major areas in biomedical sectors influenced by developments in nanotechnology. This course will introduce students to different nanomaterials such as carbon nanotubes, gold, and magnetic nanoparticles, synthesis methods, and their application in biomedical engineering. A comprehensive review of the microfabrication techniques for microelectromechanical systems (MEMS), bioMEMS, and nanomaterials will be covered. Recent advances in using nanotechnology in tissue engineering, biosensors, therapeutic devices, cell engineering, and cancer treatment will also be discussed.

Biomedical Nanotechnology Course Schedule

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|  | Monday | Wednesday |
| Week # 1  August 18 | Understanding Nanotechnology,  Nanotechnology impact on biomedicine | Nanoscale and its effect on materials properties |
| Week # 2  August 25 | Synthesis of nanostructures  Physical Vapor Deposition (PVD)  Chemical Vapor Deposition (CVD) | Quiz #1(nano synthesis, PDV, CVD)  Synthesis of nanostructures  (Sol-gel, Inert Gas) |
| Week # 3  September 1 | Labor day | Gold and Silver Nanoparticles and its biomedical applications,  Nanomaterials for Drug delivery |
| Week # 4  September 8 | Magnetic nanoparticles, properties and synthesis | Biomedical application of magnetic nanoparticles,  Imaging and Diagnostics |
| Week # 5  September 15 | Quiz # 2 (Gold, magnetic Nps)  Carbon nanostructures, and Graphene, Synthesis and properties | Biomedical application of carbon nanostructures,  Biosensors with nanoparticles |
| Week # 6  September 22 | Self-assembly in nanotechnology | Self-assembling molecules, peptides, amphiphile molecules, |
| Week # 7  September 29 | Mechanical Properties | Mechanical Properties, common metal oxides and implants  Review for mid-term |
| Week # 8  October 6 | *Mid-term Exam # 1* | Nanomedicine  Choosing your group and topic’s project, how to write the reports? |
| Week # 9  October 13 | Nanolithography  Characterization techniques:  *Fourier Transform Infrared Spectroscopy (FTIR)* | Characterization techniques: UV spectroscopy, Dynamic Light scattering  and X-Ray Diffraction |
| Week # 10  October 20 | Characterization techniques:  *Scanning Force Microscopy, Atomic Force Microscopy* | Characterization techniques:  *Atomic Force Microscopy and applications* |
| Week # 11  October 27 | Characterization techniques:  Scanning electron Microscopy | Characterization techniques:  *Transmission Electron* |
| Week # 12  November 3 | *Electrospinning,* Tissue Engineering and nanomaterials Drug delivery | *Therapeutic Devices:* Biosensors and devices |
| Week # 13  November 10 | Mid-term Exam # 2 | Biosensors and devices |
| Week #14  November 17 | Current trends in biomedical nanotechnology- | Group Presentation (Group 1-4) |
| Week # 15  November 24 | **Thanksgiving Break** | **Thanksgiving Break** |
| Week # 16  December 1 | Groups Presentation  (Group 5-8) | (Group 9)  Review for Final  (Due date to send the group project paper) |

**Course Schedule**

08/18                            First day of class

10/06                            Midterm Exam 1

11/10                            Midterm Exam 2

12/04 Due date to send the group project paper.

TBD                             Final Exam

**Course Objective**

By the end of this course, students will be able to:  
1. Understand novel function resulted from the nanoscale structures using scientific and technological principles.

1. Gain knowledge of various nanoscale fabrication and characterization techniques
2. Appraise the unique elements of nanostructured materials for biomedical applications
3. Assess the present and ever-developing state-of-art biomedical nanotechnology in the areas of tissue engineering, and stem cell research by considering the elements unique to nano- structured materials, nanostructures, nanofabrication techniques, and cell behavior

**Topics covered in the course:**

Introduction to Nanotechnology, Biomedical Nanotechnology, Nanoscale effect and Function

Nanomaterials I Gold/Silver, Magnetic Nanoparticles

Nanomaterials II: Carbon Nanotubes, Graphene and Biosensors

Biomedical Application of Nanoparticles, Sol-Gel Process, Ti and Zinc oxide Nanoparticles in implants

Nanolithography and BioMEMS, Etching and Deposition

Quartz Crystal Microbalance and Biosensors

Self-assembly, Synthetic Self- assembled Materials, Microspheres and Drug Delivery

Natural Self-assembling Biomaterials, Peptide inorganic hybrids

Nanoscale Characterization: SEM, TEM

Nanoscale Characterization: AFM, STM,

Nanoscale Characterization: Dynamic Light Scattering, UV/Vis

X-RD, FTIR, Electrospinning

Therapeutic Nano-devices, Electrochemical Sensors

Nanotechnology and Tissue Engineering

Nanotechnology and Cell Engineering, Cancer Research

**Textbooks and other materials:**

Required Textbooks and Other Course Materials

No required textbooks. Lecture notes will be uploaded to Canvas (course files). The covered content is adapted from the following biomedical books, current literatures in drug delivery systems, nanomedicine, biomedical nanotechnology and biomaterials, etc.

* G. Mani, M. Appleford, O. Joo, M. C. Agrawal, “Introduction to Biomaterials: Basic Theory with Engineering Applications” (Cambridge University Press, 2013).
* H. Wang, “In Vivo self-assembly of Nanotechnology for Biomedical Application” (2018, Springer Nature Singapore Pte Ltd.)
* N. H. Malsch, “Biomedical Nanotechnology” (2005, Taylor & Francis Group)

**Descriptions of Major Assignments and Exams**

Homework assignments and quizzes 20 %

Oral presentation and Paper review 20 %

Two midterm exams 30 %

Final exam 30 %

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Total 100 %

**Letter Grading:**

A 90 – 100 %

B 80 – 89.9 %

C 70 – 79.9 %

D 60 – 69.9 %

F <60%

* Attendance is mandatory. We will have a sign-in sheet for each class. Up to 3 point extra credits will be added to the final exam for students who attend all class sessions, and/or actively participate in class discussions.
* Homework assignments will be uploaded in canvas. Quizzes will be taken during class and students will be informed ahead.
* Homework assignments are to be uploaded in canvas by the due date. Late submission (homework and project) will be graded with less points.
* Students are expected to read materials assigned thoroughly and search related literatures using PubMed and Google Scholar.
* Students are encouraged to discuss class material and homework in order to better understand concepts. However, all the homework you submit must be of your own. Direct copying of a solution (from a friend or a book) will be considered as plagiarism and a violation of the University Honor Code.
* All students are responsible for announcements made in lecture on the student access website or via the class email list.
* Each midterm exam will cover contents from the previous lectures till current lecture.
* Final exam will be comprehensive, covering contents from the entire course lectures.
* Exam questions will be in the combined form of multiple choices, true/false, short answers, fill in the blanks, matching, etc.
* No make-up exams will be given if absent on exam days without university-approved permission.

**Registration, Drop and Withdrawal Policy**

Drop: It is the student’s responsibility, and not the instructor’s, to drop the course. You may find important details about how dropping a class can affect your GPA and your Financial Aid here: <http://registrar.unt.edu/registration/dropping-class>

Withdrawal: It is the student’s responsibility to withdraw from the course by either going to their academic advisor’s office (which should be the first stop when considering a withdraw), the Registrar’s office, or the Department. If you can’t complete the course, you must withdraw for a “W” (after this date, you’d receive either a “WP” or a “WF”). Withdrawing from a course is a formal procedure which YOU must initiate. I can’t do it for you. If you simply stop attending and do not withdraw, you will receive a performance grade, usually an “F.” All deadlines can be found at: <http://registrar.unt.edu/registration/fall-registration-guide>

University Policy on Academic Misconduct

Academic Misconduct (Sec. 3.4 from the Student Handbook):

Any act that violates the academic integrity of the institution is considered academic misconduct. The procedures used to resolve suspected acts of academic misconduct are available in the offices of Academic Deans and the Office of Campus Life. Specific examples include, but are not limited to:

Cheating: Copying from another student’s test paper, written assignment, other report, or computer files and listings; Using, during any academic exercise, material and/or devices not authorized by the person in charge of the test; Collaborating with or seeking aid from another student during a test or laboratory without permission; Knowingly using, buying, selling, stealing, transporting, or soliciting in its entirety or in part, the contents of a test or other assignment unauthorized for release; Substituting for another student or permitting another student to substitute for oneself.

Plagiarism: The appropriation, theft, purchase or obtaining by any means another’s work, and the unacknowledged submission or incorporation of that work as one’s own offered for credit. Appropriation includes the quoting or paraphrasing of another’s work without giving credit (especially online resources). Turnitin will be utilized to ensure online resources are not misappropriated.

Any work not meeting this standard will be evaluated and subject to either a re-write, if the Instructor concludes that the assignment was unintentionally plagiarized or a zero for the assignment. Egregious forms of academic conduct are subject to a formal hearing. For more information on paper writing, including how to avoid plagiarism, and how to use citations, see http://anthropology.unt.edu/resources-writingpaper.php. For information on the University’s policies regarding academic integrity and dishonesty, see the UNT Center for Student Rights and Responsibilities, <http://www.unt.edu/csrr/>.

Collusion: The unauthorized collaboration with another in preparing work offered for credit.

Sexual Discrimination, Harassment and Assault

UNT is committed to providing an environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic violence, dating violence, and stalking. If you (or someone you know) has experienced or experiences any of these acts of aggression, please know that you are not alone. The federal Title IX law makes it clear that violence and harassment based on sex and gender are Civil Rights offenses. UNT has staff members trained to support you in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more.

DEI Statement:

It is my intention to ensure that students from diverse backgrounds and perspectives will be well served by this course. Diversity of students in this class will be an asset to learning and understanding the material. This course welcomes students of all ages, backgrounds, beliefs, ethnicities, gender identities, national origins, religious affiliations and sexual orientations. All students in this class are expected to contribute to a respectful, welcoming and inclusive environment for all other members of this class. If you feel that your contribution is not being valued, please feel free to speak with me during office hours.

Personal Distress

Excerpts from <http://studentaffairs.unt.edu/care> “The University of North Texas cares about our students' success, not only academically, but emotionally and physically…. Because of our commitment, we provide literally hundreds of departments and services across campus that respond to our students' unique needs…. UNT believes it is important to foster an environment that encourages students to maintain a standard of responsibility for self-care which includes the ability to respond adequately to one's emotional, physical, and educational needs. If you are experiencing physical or emotional distress which adversely affects your ability to succeed in class, please see me as soon as possible. Together, we will point you towards the appropriate resources.