Texas State Technical College Waco
Course Syllabus

Course Rubric & Number: NANO 1305 (1-3-7)

CIP Code: 15.0304

Course Title: Overview of Nanotechnology

Course Description: This course is designed to introduce the student to nano sciences and the terminology of this highly, emerging technology. Topics covered will include what nano science can/cannot do with relevance to today's world and the possible future as well as why and how nanoscales will impact the areas of biology, solid-state manufacturing, material science, and chemistry.

Prerequisites:

Instructor: John Pedrotti

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Building & Office Room Number: Electrical/Electronic Offices, Laser Offices

Department Chair: Tommy Harper *Date:* _____

Approved by CIP Committee: *Date:* _____

WECM Learning Outcomes:

1. Define nanotechnology and summarize the current state of the art in this field.
2. Identify some nanoscale devices and summarize the potential applications for the technologies emerging from this subject area.
3. Distinguish the relationships between top-down and bottom-up nanotechnology.
4. Describe the relationship between micro and nanotechnology.
5. Explain and identify some applications with nanotechnology, especially with carbon nanotubes (synthesis, applications, & future applications) and self-assembled wet films.
6. Summarize and explain some biological applications, such as self-assembly, deoxyribonucleic acid (DNA) self-assembly, and thin-film sensors.
7. Sketch and label the schematic diagram and physical view of a thin-film sensor.
8. Distinguish and differentiate between top-down and bottom-up nano-fabrication techniques.
9. Recognize where quantum effects become important in materials and devices.
10. Describe the futures of nanotechnology with examples of the latest initiatives being researched.
11. Demonstrate and perform fabrication safety skills.
12. Discuss the operation of silicon fabrication.
13. Explain, in detail, the operation of a thin films lab.
14. Summarize the operation of a laser.
15. Discuss, in detail, the operation of an interferometer.
16. Align an optical metrology instrument interferometer.
17. Demonstrate and practice laser safety skills, both written and practical, while performing work in the laboratory environment.
18. Verify that matter is quantized (atoms and molecules) and how that effects the way matter behaves at the nanoscale (quantum effects) and the advantages that this brings to bottom up nanofabrication.
19. Distinguish the relationships of ‘wet’ and ‘dry’ nanotechnology.

Resources:

Textbook

- *Nanotechnology for Dummies*, Booker & Boysen, Wiley Publishing Inc. (ISBN-13: 978-0-7645-8368-1)

Tools & Materials Students Purchase

Quantity	Item Description
1	64MB Jump Drive
1 pair	Clear safety glasses (Shatter-proof lens, side shields, direct ventilation. Must meet ANSIZ87.1 compliance standards.
1 box	Latex gloves, vinyl or nitral. 200 gloves per box.
2 each	Pen, black ballpoint, fine
2 each	Pencil # 2
1	Spiral Notebook (8.5” X 11”) 70 sheets: No Perforated Edges
1	12 inch Ruler (Metal)

TSTC Grading Policy:

(Grades for all Major courses must be C or better)

Grade	Percent	Description	Grade Points
A	90-100	Excellent/Superior Performance Level	4
B	80-89	Above Required Performance Level	3
C	70-79	Minimum Required Performance Level	2
D	60-69	Below Required Performance Level	1
F	Below 60	Failure to meet Performance Requirements	0
IP	--	In Progress	
W	--	Withdrawal	0
CR	--	Credit	0
AUD	--	Audit of Course	0
See College Catalog for complete descriptions.			

Department's Participation Policy:

A student absent for more than 15% of the lecture periods or 15% of the lab periods, regardless of grades earned on assignments, will have to repeat the course.

Instructor's Participation Policy:

You are expected to be in class every day. You are expected to be on time. Roll will be taken everyday in the form of a quiz or homework assignment. On the rare occasion that no quiz or homework was assigned roll will be called and a daily grade will be given as follows: **On time = 100, Tardy = 50 and Absent = 0.** It is your responsibility to make sure that you get the appropriate daily grade.

You are allowed to miss 15% of the total class time. That equals 5 days per semester. If you miss more than 5 days (excused or unexcused) you will be dropped from the course.

Course Schedule:

Student Objectives	Assignments/Assessments
Learning Activity 1 – Industry Overview	
1. Identify the major areas of the nanotechnology industry. 2. Identify the major fields of science required to support the growth of the nanotechnology industry. 3. Identify the major industries that may benefit from nanotechnology. 4. Define Top-Down and Bottom Processes and site examples of each.	Read: Richard Feynman's speech "There is Room at the Bottom". Read: Chapter 1 (textbook) Assignment: Web Articles – Nanotechnology Applications Assignment: Bottom-up Processing and Top-Down Processing. Assignment: Nanotechnology companies Assignment: Research Labs
Learning Activity 2 – Understanding Roadblocks to overcome in Bringing Nanotechnology to Market	
5. Discuss problems associated with bringing an idea to testing to mass production in nanotechnology.	Read: Chapter 2 (textbook) Assignment: Articles – Production of Nanotechnology

6. Identify some of the problems nanotechnology may face in bringing products to market. 7. Identify possible hazards to human life when dealing with nanoparticles.	products.
Learning Activity 3 – Identifying Industry Specific Technologies	
8. Identify expected emerging applications from the following industries: a. Materials Sciences b. Medical Applications c. Detection Devices d. Semiconductor Applications e. Energy Resources Applications	Assignment: Web Articles – Nanotechnology Applications Assignment: Summary of Web Article Assignment: Industry Examples Read: Chapters 6-11
Learning Activity 4 – Identify Basic Concepts of Sciences Required for Nanotechnology	
9. Identify the following concepts of Quantum Physics and state the importance of these concepts to Nanotechnology: a. Heisenberg Uncertainty Principle b. Schrödinger's Cat c. Wave and Particle concept of light d. Classical Physics Flaws e. Quantum Physics Definition 10. Identify the basic atomic concepts including the basic structure of an atom, protons, neutrons and electrons and their basic functions. 11. Identify the role of photonics in nanotechnology.	Web-based Articles
Learning Activity 5 – Defining Self Assembly	
12. Define self-assembly based on nature's idea of the DNA model. 13. Identify the makeup a DNA chain. 14. Explain a hydrogen bond and how it enables DNA self-Assembly. 15. Identify the 4 nucleic acids and identify which acids bond and describe why. 16. Describe why DNA self-assembly is a model for nanotechnology self-assembly. 17. Identify which process (bottom-up or top down) "self-assembly" is categorized under.	
Learning Activity 6 – Identifying Nanotechnology Evaluation Equipment and Techniques.	
18. Explain the basic theory of the following Microscopy Techniques: a. Scanning Electron Microscopes	

b. Scanning Tunneling Microscopes c. Atomic Force Microscopes d. Transmission Electron Microscopes. e. Laser Microscope f. Fourier Transform Infrared Spectroscope g. Atomic Probe Microscope 19. Correctly focus from 5X to 150X on an optical microscope without damaging the optics or the sample.	
Learning Activity 7 – Cleaning Optical Components and Silicon Wafers	
20. Manually clean and rinse a silicon wafer. 21. Identify specific cleaning solutions/methods for organic and inorganic contaminants. 22. Clean a glass slide and flat glass circle.	
Learning Activity 8 – Basic Laser Alignment Techniques	
23. Describe the basic techniques used to create a beam line and align an optical cavity. 24. Observe Newton's Rings and center the rings on an aperture of a laser.	
Learning Activity 9 – Introduction to the Fab and Activities in the Fab	
25. Identify the correct procedure to gown and enter a class 100 clean room. 26. Identify all the equipment in the fab and describe its function. 27. Describe the operation of the Thermco Furnace controllers and the Filmetrics Filmeasure F20.	
Learning Activity 10 – Thin Films Lab	
28. Identify all of the thin film deposition systems in the lab. 29. Clean and prep a slide for DC sputtering. 30. Operate DC sputtering system. 31. Change parameters to achieve different thickness. 32. Measure base line transmission and reflection from slide with a HeNe Laser and Diode pumped ND: YAG laser. 33. Measure the coating thickness with Filmetrics Filmeasure F20 System.	
Learning Activity 11 – Introduction to Lasers and Basic Laser Safety	
34. Identify basic safety rules to follow when working with lasers. 35. Identify components of HeNe and Diode Pumped ND: YAG lasers. 36. Identify the operation procedures of the	

lasers used in this course.	
Learning Activity 12 – Introduction to Semiconductor Fab Processes, Equipment and Safety	
37. Describe the function of the different equipment used in a semiconductor manufacturing lab. 38. Identify the safety procedures to employ when using equipment in the semiconductor manufacturing lab. 39. Discuss the safety procedures and concerned with the chemicals in the fab lab.	
Learning Activity 13 - Laser Alignment Techniques 1	
40. Establish a beam line to a triangular rail and through a capillary tube. These techniques are necessary to align optical components and the alignment of laser systems.	
Learning Activity 14 - Laser Alignment Techniques 2	
41. Use turning mirrors to establish a beam line to a triangular rail and through a capillary tube. These techniques will enable a student to use mirrors in an optical set-up. They can also be applied to alignment of various laser systems.	
Learning Activity 15 - Laser Alignment Techniques 3	
42. Establish a beam line through a large bore glass tube and various solid rods. These techniques can be applied to optical lab set-ups for experiments and measurements with various lasers. They can also be applied to alignment of various laser systems.	
Learning Activity 16 - Alignment of an Optical Interferometer	
43. Use the techniques taught in the previous alignment labs, align an interferometer.	
Learning Activity 17 - Basic Microscopy Methods, Filmetrics Filmeasure F20 Introduction	
44. Explain the operation of the following microscopy devices: a. scanning electron microscope b. atomic force microscope c. scanning tunneling microscope d. transmission electron microscope e. laser microscope and atomic probe microscope. 45. Explain the operation of fourier transform infrared spectroscope. 46. Operate the Filmetrics Filmeasure F20	

system. Measurements of known thickness oxide layers on silicon will be taken with the F20 system to verify competent operation of the device.	
Learning Activity 18 – Surface Preparation	
47. Practice methods of preparing and cleaning of optical components and semiconductor wafers. 48. Use basic detergent cleans and rinses for silicon wafers and procedures documented. 49. Clean glass slides and glass circles with methanol and acetone cleans using the swipe and drag methods. 50. Use a sonicator to cleaning surfaces.	
Learning Activity 19 - Furnace Controller Operation and Profiling of a Thermco Controlled Mini-Brutes Furnace	
51. Explain the operation of Thermco furnace controllers and temperature settings 52. Turn on and operate the furnace. A temperature profile at 1 inch distances will be recorded for the above mentioned furnace.	
Learning Activity 20 - Introduction to a Thin Films Lab	
53. Explain the operation of several thin film deposition systems. 54. Using the real-time lab notebook, draw each system present in the lab and record the uses of each system beneath the drawings.	
Learning Activity 21 - DC Sputter Deposition	
55. Deposit thin films on glass slides using the DC Sputtering systems in the lab. Copper and Aluminum will be deposited on clean and dirty slides. Current, pressure and time of deposition will be varied to determine the different levels of deposition caused by the change in each parameter.	
Learning Activity 22 – DC Sputter Film Characterization	
56. Characterize the thin films deposited in the DC Deposition Lab. Characterization will be based on permanence of deposited film, reflected and transmitted power, absorbed power and wavelength used.	

Course Assessment:

- Written Assessments
    1. Written tests will be distributed at the beginning of each lecture period. The tests will comprise questions from the assigned reading and previous lecture information.
    2. A comprehensive final test will be given at the end of the semester.

Grading Scheme:

Activity		*Total Points*
26 Daily Tests	100 points per test	2600
4 Tests	300 points per test	1200
Comprehensive Final	300 points	300
	Total Possible Points for Course	***4100***

A = 3690 min B = 3280 min C = 2870 min D = 2460 min

Course Policies:

- *Safety Procedures:*
  Required attire for labs: Shirt (no tank tops), full-length pants, rubber-sole Shoes (no sandals or flops), and **safety glasses**. Remove all jewelry before entering labs.
  Lab behaviors:
  No eating, smoking or drinking in labs.
  No horseplay at any time in this building.
  You are responsible for your safety as well as the others in the lab. Use safety glasses.
  Make sure you stand on a clean rubber mats when using any electronic device.
  Pick up/remove anything unsafe.
  Never probe voltages over 80V.

  I am a safety nut. Think first, move second. Don't break the safety rules.

- *Lab Procedures:*
  Bring your tool box and safety glasses to each lab. If you don't have them, you will not be permitted in the lab – you will go home and get them or be counted absent.

  Leave your lab clean and orderly. A lab attitude grade will be given at the end of each lab. This grade will be based on how you work, what type of work you do, how safely you work, and how clean and orderly you leave the lab.

  If you get equipment out, put it back in the correct place. If the equipment uses batteries, make sure to turn off the device.

  A real-time notebook (RTN) must be kept to record information taken during lab periods. The RTN will be a cleanroom spiral notebook and must contain all the information needed to write a formal lab report.

  Turn off all gasses at the end of the lab!

- *Late Work:* **LATE WORK is not accepted if the absence is unexcused.** An excused absence is one that has been arranged with the instructor in advance. If you are ill you must notify the Department prior to the ending of the lecture period for the absence to be considered as an excused absence. It is your responsibility to get any missed assignments. Your excused late work must be turned by the second class day after you have returned to class.