Texas State Technical College Waco
Course Syllabus

Course Rubric & Number: NANO 2405 (2-6-4)

CIP Code: 15.0304

Course Title: Nano Characterization

Course Description: An advanced and detailed study of the Nano scale materials characterization process. Emphasis will be on the study of surface roughness, adhesion, scratch, wear, film thickness, surface potential, micro-nano indentation, and mapping of micro and nano materials. Students will engage in the characteristics of nano materials measurements, processes and analysis at micro and nano level, improvement techniques, repeatability and reproducibility will be emphasized. Data to be provided from student's LOTT 2471 real-time notebook.

Prerequisites: SMFT 1341, SMFT 2450

Co-Requisite: NANO 2407

Master Instructor: John Simcik

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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. Demonstrate and practice safety skills, both written and practical, while performing work in the laboratory environment.
2. Recognize nanotechnology characterization methods and summarize the current state of the art in this field.
3. Identify nanoscale characterization methods and summarize the potential of these processes.
4. Distinguish the potential relationships between each method of measurement.
5. Explain and identify applications for each method of measurement.
6. Sketch and label the schematic diagram of each characterization method.
7. Interpret patterns and solve problems using each characterization method.
8. Document results from the characterization of nano-scale materials.
9. Calculate and graph results of each characterization method.
10. Assemble data into spreadsheet form.
11. Characterize performance of Micro-Electronic Mechanical Systems (MEMS) and Nano-Electronic Mechanical Systems (NEMS) via measurements.
12. Explain, in detail, the problems of in-situ measurements in thin films process.
13. Analyze the operation of each measurement method.
14. Verify the correct operation of equipment used in nanotechnology characterization.
15. Analyze and Characterize Tribological Systems Thin Films.
16. Analyze and Characterize Optical Thin Films.
17. Analyze and characterize various nanotechnology detectors and devices;
18. Repair equipment used in support of nanotechnology.
19. Analyze and defend the processes and techniques chosen in the development and construction of a nanodevice.
20. Convey findings by formal presentations and defend data in an analytical manner by the appropriate use of error bars and understanding statistically valid conclusions

Resources:

Textbook

- *Encyclopedia of Materials Characterization Tools/Equipment*, Brundle, Evans Jr. Watson, Manning Publishing, 1992.

Tools & Materials Students Purchase

Quantity	Item Description
1	64MB Jump Drive
1	Scientific Calculator (TI-36X or equivalent)
1	Spiral Notebook Paper (Class Room use only)
1	Spiral Notebook Clean Room
1	15Cm Steel Scale Metric
2	Pen Clean Room
2	Pens Blue
1	Safety Glasses (Industrial grade, clear lenses side shields)
3	Latex/Nitral Gloves Box = 200

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.

Course Schedule:

Student Objectives	References
1. Demonstrate and practice safety skills, both written and practical, while performing work in the laboratory environment.	LOTT 1372 Text
2. Recognize nanotechnology characterization methods and summarize the current state of the art in this field.	Text Chapter 1 Page1-56
3. Identify nanoscale characterization methods and summarize the potential of these processes.	Text Chapter 1 Page 1-56
4. Distinguish the potential relationships between each method of measurement.	Text Chapter 1 Page 1-56
5. Explain and identify applications for each method of measurement.	Text Chapter 1 Page 1-56
6. Sketch and label the schematic diagram of each characterization method.	Text Chapter Various see chapter on method.
7. Interpret patterns and solve problems using each characterization method.	Refer to SMFT 1341 SPC text
8. Document results from the characterization of nano-scale materials.	Review lab practices manual.
9. Calculate and graph results of each characterization method.	Text Chapter 1 Page 4-6
10. Assemble data into spreadsheet form.	
11. Characterize performance of Micro-Electronic Mechanical Systems (MEMS) and Nano-Electronic Mechanical Systems (NEMS) via measurements.	Text Chapter 2 Page 70 - 99
12. Explain, in detail, the problems of in-situ measurements in thin films process.	Refer to SMFT 2450 materials, Text Page 121, 199, 402

13. Analyze the operation of each measurement method.	Text: See chapter on method.
14. Verify the correct operation of equipment used in nanotechnology characterization.	Equipment manufacture dependant.
15. Analyze and Characterize Tribological Systems Thin Films.	Refer to SMFT 2450 materials
16. Analyze and Characterize Optical Thin Films.	Refer to SMFT 2450 materials
17. Analyze and characterize various nanotechnology detectors and devices	Web-based Activity
18. Repair equipment used in support of nanotechnology.	
19. Determine if task method electrical or mechanical or chemical.	
20. Use reference handbooks to construct statements that identify nano characterization tools for task assigned.	
21. Compare pros and cons for various measurement systems used for NANO task assigned.	
22. Identify measurement systems needed for NANO Task assigned.	Text: Chapter 1 page 1-56
23. Follow appropriate system startup requirements.	Equipment Manual and operating instructions.
24. Clean and mount sample as per procedures	Manual and operating instructions.
25. Perform test as required, characterize both test results and test methods.	Chapter on Tools
26. Use appropriate method to perform statistics.	

Course Assessment:

- Written Assessments (lecture)
    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.
    3. The lecture grade for the course will be an average of all the lecture tests and the final.

- Performance Assessments (laboratory)
    1. Lab Reports will be submitted weekly at the beginning of each lab.
    2. A performance-based lab final will be given at the end of the semester.

Grading Scheme:

- Students must average a 70% for all written assessments and a 70% for all performance assessments to successfully pass the course. A final grade of “C” or above is required for course completion. The course must be retaken if a grade lower than a “C” has been earned.

Activity		*Total Points*
29 Lecture Tests	100 points per test	2900
Comprehensive Final	100 points (must pass with at least a 70)	100
Total possible points (must average 70%)		**3000**
13 Lab Reports	100 points per report	1300
Lab Final	100 points (must pass with at least a 70)	100
Total possible points (must average 70%)		**1400**
Total Possible Points for Course		***4400***

A = 3960 min B = 3520 min C = 3080 min D = 2640 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.

  Turn off all gasses at the end of the lab!

- *Late Work:* No late work will be accepted. All work, including labs, must be completed on time. If you have an excused absence (see Excused Absences below), then the work missed during the absence must be completed and submitted within one week of the return from the excused absence.

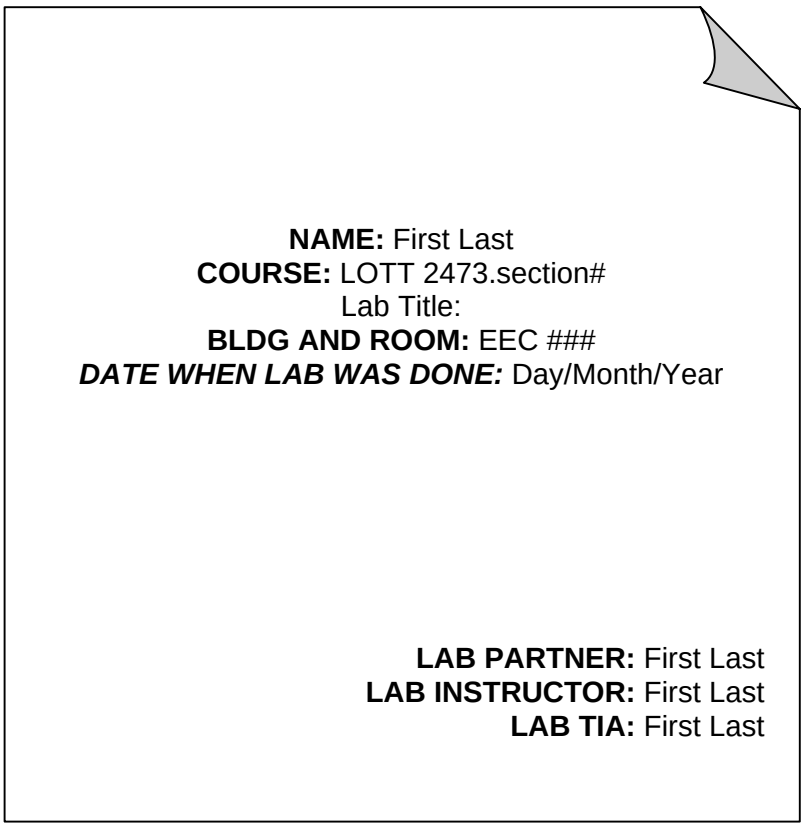
- *Excused Absences:* For Lectures – only the Lecture Instructor can give an excused absence for lectures. Only the Lab Instructor can give an excused absence for labs. To

qualify for an excused absence, you must call (254)867-4857 leave a message as to why you will miss class, examples: Jury duty, military recall/duty, sick but not hung over, court summons etc.

Lab Report Format: Content

All lab reports must be a minimum of twelve (12) pages in length unless noted.
Reports must be typed (Arial, 12 point font).
Do not use first person format in formal lab reports (avoid I, me, we, us, my).
All lab reports are use one week after lab has been completed and within the first 10 minutes of the start of the lab.
All lab must be completed and all lab reports submitted to pass the course.
Reports must contain the items listed below.

Page 1: **Cover Page** (5 points)



Page 2: **Abstract** (5 points)

In this section, you provide a condensed version of your report. What you did, how you did it, what you found about what you did and how you did it. Three paragraphs maximum.

Page 3: **Objective** (5 points)

Provide the specific goals of the lab as explained by the instructor.

Page 4: **Experimental Setup** (5 points)

Provide a neat drawing (no free-hand images) or the lab setup including important dimensions such as distances between components. Provide an explanation of how the lab was setup.

Page 5: **Materials List** (5 points)

In a table format, provide a listing of all the materials used in this lab. Headers for your table include quantity, description of item, manufacturer, manufacturer's model number, and manufacturer's serial number. Use "NA" for unknown information.

Page 6: **Procedure** (5 points)

Provide a complete step-by-step description of what you did to perform the lab. List every step separately. This section could be several pages long (numbered 6, 6A, 6B, etc).

Page 7: **Data** (5 points)

In a table format, list the data you gathered during the lab. This will be used to prove what you did in the lab. Do not provide data calculations in this section. Columns in the table might include laser wavelength, SEM magnification.

Page 8: **Formulas** (5 points)

Provide all the formulas you used to gather data for this lab.

Page 9: **Calculations** (10 points)

Using all the formulas listed on page 8, provide the math to prove your data. Every calculation you did should be listed.

Page 10: **Graphs** (5 points)

Using graph paper, provide graphs that prove your data. Graphs can be hand drawn.

Page 11: **Analysis** (40 points)

In this section, you provide an analysis of your data. Analyze how you got the data. Analyze the results of what you did. Provide possible uses.

Page 12: **Conclusion** (5 points)

Provide a summary of the lab. Did it work? What could be done to make the lab better? Complaints? Any issues not covered in the previous pages?

Formal Lab Report: Style

	Presentation	**Sentences & Grammar**	**Logical Flow**
Supervisor (A) Industry Standard	Report bound with plastic cover. Report contains a title page & Table of Contents page. Report contains illustrations & Charts. Margins & footers are consistent. Footers contain title of report & page numbers. Consistent use of fonts.	Proper verb tenses. Smooth transitions between paragraphs. Active writing.	Sections titled. Charts & illustrations are labeled. Graphics, charts & illustrations are legible & understandable.
Senior Technician (B) Industry Standard	Report bound. Footers contain title of report & page numbers. Uses section titles & uses boldface for section titles. Consistent use of fonts.	No comma faults. Proper paragraphing.	Separate sections of paragraphs used for complex ideas.
Entry-level Technician (C) Industry Standard	Report pages are stabled. Paper free of smudges, stains & rips. Consistent use of fonts. Pages are numbered.	Complete sentences. No misspelled words. Proper capitalization.	Use of one paragraph per idea.