NE 413 – NANO-SYSTEM DESIGN

Course Code	Course Name		Semester	
NE 413	Nano-System Design		Fall ☒ Spring ☐ Summer ☐	
Hours			Credit	ECTS
Theory	Practice	Lab	4	5
4	0	2		

Course Details	
Department	Nanotechnology Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☒ Elective ☐
Course Objectives	To introduce the fundamentals of nano-system design including modeling, simulation, fabrication, integration, and performance evaluation of nanostructures and nanosystems in real-world applications.
Course Content	Fundamentals of nano-system architecture, functional nanomaterials, scaling laws, bottom-up and top-down design strategies, simulation tools, nanoscale transducers and actuators, energy harvesting systems, system-level integration, reliability, and emerging applications.
Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☒ Discussion ☒
Prerequisites/ Corequisites	
Work Placement(s)	

Textbook/References/Materials
Textbook: **Introduction to Nanosystems Engineering, D. M. T. Newaz, CRC Press, 2016.** **References:** **Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, K. Goser et al., Springer, 2004.** **Nanosystems: Molecular Machinery, Manufacturing, and Computation, K. Eric Drexler, Wiley, 1992.** **Micro and Nanosystems: Devices and Technology, H. Baltes, Springer, 2011.**

Course Category				
Mathematics and Basic Sciences	☐		Education	☐
Engineering	☒		Science	☐
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☐

Weekly Schedule

No	Topics	Materials/Notes
1	Introduction to Nano-System Design	Definitions, history, system requirements
2	Scaling Laws and Design Constraints	Quantum effects, surface-to-volume ratio
3	Functional Nanomaterials	Properties and selection criteria
4	Design Methodologies	Bottom-up vs. top-down approaches
5	Nanoscale Energy Systems	Energy storage and harvesting mechanisms
6	Nanoelectromechanical Systems (NEMS)	Design principles, fabrication challenges
7	Modeling and Simulation Tools	COMSOL, ANSYS, MATLAB basics

8	Midterm Exam	Covers Weeks 1–7
9	Nanoscale Sensors and Actuators	Types, working principles, integration
10	System-Level Integration	Packaging, signal processing, control
11	Reliability and Failure Analysis	Degradation mechanisms, testing strategies
12	Fabrication Techniques	Lithography, etching, deposition methods
13	Case Studies in Nano-Device Design	Biomedical, energy, communication systems
14	Ethical and Societal Impacts	Safety, sustainability, regulation
15	Emerging Trends in Nanosystem Design	AI, robotics, quantum systems
16	Final Exam	Cumulative assessment

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance		
Lab		
Practice		
Fieldwork		
Course-specific internship		
Quiz/Studio/Criticize		
Homework		
Presentation / Seminar	1	25
Project		
Report		
Seminar		
Midterm Exam	1	25
Final Exam	1	50
	Total	**100%**
Contribution of Midterm Studies to Success Grade	50	50
Contribution of End of Semester Studies to Success Grade	50	50
	Total	**100%**

ECTS Allocated Based on Student Workload			
Activities	**Quantity**	**Duration (Hrs)**	**Total Workload**
Course Hours	14	4	56
Lab			
Practice			
Fieldwork			
Course-specific Work Placement			
Out-of-class study time	14	3	42
Quiz/Studio/Criticize			
Homework			
Presentation / Seminar	1	5	5
Project			
Report			
Midterm Exam and Preparation for Midterm	1	15	15
Final Exam and Preparation for Final Exam	1	24	24
Total Workload			**150**
Total Workload / 25			**150/25**
ECTS Credit			**6**

Course Learning Outcomes	
No	**Outcome**
L1	Understand core concepts of nanosystem design.
L2	Apply modeling and simulation tools for analysis.
L3	Design functional nanosystems with application focus.
L4	Evaluate system performance, reliability, and integration.
L5	Analyze ethical and technological impacts of nanosystems.

Contribution of Course Learning Outcomes to Program Competencies/Outcomes

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**Total**
L1	5	4	2	3	2	1	2	3	2	1	1	26%
L2	4	3	2	5	2	2	3	3	2	1	1	28%
L3	3	5	4	5	3	2	3	3	2	2	2	34%
L4	3	3	3	5	5	3	3	4	3	3	3	38%
L5	2	3	3	4	5	3	4	5	5	4	4	42%
											Total	**168**