GUJARAT TECHNOLOGICAL UNIVERSITY

NANO TECHNOLOGY (39)

FABRICATION OF NANO- DEVICES

SUBJECT CODE: 2153901

B.E. 5th SEMESTER

Type of course: Nanotechnology

Prerequisite: Fundamental of Soli state technology, Synthesis of Nano materials, Physics of Nano materials

Rationale: To make students understand the use of nanotechnology based devices in the industries and day by day life in consumer products

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	**BULK NANOSTRUCTURED MATERIALS:** Quantum wells, wires and Dots – Size and dimensionality effects, Carbon nanotubes (CNTs)- Single walled carbon nanotubes (SWNTs), Multi walled carbon nanotubes (MWNTs), Graphenes, Fullerenes- Structure and Properties, Metal/oxide nanoparticles, Nano rods, Nanowires, Nanotubes, and Nano fibres, Semiconductor Quantum Dots- Excitons, Magnetic Nanoparticles- Nanostructured Ferromagnetism, Polymer nanoparticles, Core-Shell Structures, Nano crystals, Single electron tunnelling – Applications.	8	16%
2	**GAS SENSOR MATERIALS:** Criteria for the choice of materials, Experimental aspects – materials, properties, measurement of gas sensing property, sensitivity; Discussion of sensors for various gases, Gas sensors based on semiconductor devices.	8	16%
3	**BIOSENSORS:** Principles- DNA based biosensors – Protein based biosensors – materials for biosensor applications- fabrication of biosensors - future potential	6	14%
4	**SEMICONDUCTOR NANODEVICES-I:** Single Electron devices- Nano scale MOSFET – Resonant Tunnelling Transistor – Single Electron	9	19%

	Transistors - Single Electron Dynamics - Nano robotics and Nano manipulation - Mechanical Molecular Nano devices - Nano computers: Theoretical Models - Optical Fibres for Nano devices - Photochemical Molecular Devices – DNA Based Nano devices – Gas based Nano devices - Micro and Nano mechanics		
5	**SEMICONDUCTOR NANODEVICES-II:** Schottky devices - Quantum Structures and Devices - Quantum layers, wells, dots and wires - Mesoscopic Devices - Carbon Nanotube based logic gates, optical devices - Connection with quantum dots, quantum wires, and quantum wells- Single Molecule electronic devices – photonic band gap systems: applications and devices	**9**	**19%**
6	**X-RAY LITHOGRAPHY:** Ion beam lithography - Focusing ion beam lithography - Ion projection lithography - Projection focused ion multi-beam - Masked ion beam lithography - Masked ion beam direct structuring - atom lithography	**8**	**16%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**19**	**30**	**7**	**--**	**--**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. INTRODUCTION TO NANOTECHNOLOGY, Charles P. Poole Jr and. Frank J. Owens, Wiley Inter science, 2003.
2. NANOSTRUCTURES AND NANOMATERIALS: SYNTHESIS, PROPERTIES AND APPLICATIONS, G. Cao, Imperial College Press, 2004.
3. NANOBIOTECHNOLOGY, CONCEPTS, APPLICATIONS AND PERSPECTIVES", C.M. Niemeyer and C. A. Mirkin, WILEY-VCH, 2004.
4. NANOTECHNOLOGY - MOLECULARLY DESIGNED MATERIALS, G. M. Chow and K. E. Gonsalves American chemical society Symposium series 622, 1996.
5. PHYSICS OF SEMICONDUCTOR NANOSTRUCTURES", K. P. Jain Narosa Publishers, 1997

Course Outcome:

After learning the course the students should be able to:

1. Understand bulk and Nanostructured materials.
2. Understand preparation of Gas sensor, properties of gas sensor and application of gas sensor.
3. Understand Basic of Biosensor, and application of Bio sensor.
4. Understand semiconductor based Nano device, their properties and application of nanomaterial in semiconductor devices.

List of Experiments:

Experiment-1
Verification of Lambert Beer's law and determination of concentration of unknown solution by UV-Vis spectrophotometer.

Experiment-2
Determination of the band gap of semiconductor nanoparticle.

Experiment-3
Experiment on optical properties of metal oxide nanoparticle.

Experiment-4
Experiment on environmental effect on metal oxide particle.

Experiment-5
Experiment on UV –Vis spectroscopy of semiconductor Nanoparticle.

Experiment-6
Experiment on absorption spectra of TiO_2 Nanoparticles.

Experiment-7
Experiment on Preparation of Nano composite.

Experiment-8
Experiment of absorptions spectra of Nano composite.

Design based Problems (DP)/Open Ended Problem:
Open Ended /design based project: Apart from above experiments a group of students (Maximum Three) has to undertake one open ended problem/design problem. **(Students are free to select any area of science and technology may be based on their branch to define the project).**

Aims:

1. To provide experience in laboratory based experimentation, data recording and analysis and drawing of conclusions.
2. To develop report writing skills for scientific material.
3. To develop the ability to undertake investigations where, as part of the exercise, the goals and methods have to be defined by the investigator.
4. To develop skills in literature searches and reviews.

Evaluation of Open ended / design based small project

1. Open ended / design based small project will be evaluated by external examiner with appropriate marks allotment given by GTU time to time.
2. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.

3. Evaluation should be done on **the approach of the student on his/her efforts** (not on completion) to study the design module of given task.

Examples

1. Make organic solar cell.
2. Make magnetic or gas sensor using nanoparticles.

Major Equipment:

1. UV-Visible Spectrometer
2. Spin coater
3. Distil Water Unit
4. PH Meter
5. Solar cell testing kit
6. Necessary Chemicals and glassware for sol-gel and chemical synthesis

List of Open Source Software/learning website:

www.virtual.itg.uiuc.edu

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.