Academic Course Description

BHARATH UNIVERSITY

Faculty of Engineering and Technology

Department of Mechanical Engineering

BGE012 – MEMS AND NANOTECHNOLOGY

Eighth Semester, 2015-16 (Even Semester)

Course (catalog) description

Familiarize the students with the fundamental concepts the general issues relating to nanotechnology and nanofabrication

Compulsory/Elective course : Non Major Elective

Credit &contact hours : 3 & 45

Course Coordinator : Dr.Shanmuganandh

Instructors :

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
Dr.G.Balakrishnan	IV Year Mech	JR002		Balakrishnan.phy@bharathuniv.ac.in	9.00 to 9.50 am

Relationship to other courses:

Pre –requisites **:** Material science and metallurgy

Assumed knowledge : To expose the students to the evolution of Nano systems, to the various fabrication techniques. Also to impart knowledge to the students about nano materials and various nano measurements techniques.

Following courses : nil

Syllabus Contents

UNIT – I
INTRODUCTION **9 Hours**

Historical background development of microelectronics, evolution of micro sensors, MEMS, emergence of micro machines. Micro sensors: Introduction, thermal sensors, mechanical sensors, flow sensors and Introduction to SAW DEVICES

UNIT – II MEMS MATERIALS AND PROCESSING **9 Hours**
Overview, metals, semiconductors, ceramic, polymeric and composite materials, Microstereolithography: Introduction, Scanning Method, Projection Method, Applications. LIGA Process: Introduction, Basic Process and Application.

UNIT – III
MICRO SYSTEM FABRICATION PROCESSES **9 Hours**

Photolithography, Chemical Vapor Deposition, Etching, Bulk and Surface Micro Manufacturing.

UNIT – IV
NANO-TECHNOLOGY **9 Hours**

Introduction to Nanotechnology, The nanoscale. Consequences of the nanoscale for technology and society. - Technologies for the Nanoscale, Top-down versus bottom-up assembly. Visualisation, manipulation and characterisation at the nanoscale, Proximal probe technologies. Self-assembly.

UNIT – V
NANO SCALE MANUFACTURING: **9 Hours**

Nanomanipulation, Nanolithography - An introduction to tribology and its industrial applications – Nanoscale Materials and Structure, Nanocomposites, Safety issues with nanoscale powders - Applications, Applications in energy, informatics, medicine, etc

Total : 45 Hours

TEXT BOOKS:
1. Mark Ratner & Daniel Ratner , Nano Technology, Pearson Education,2003.
2. Tai – Ran Hsu, " MEMS & MICROSYSTEMS Design and Manufacturing", TATA McGRAW- HILL, 2002
3. S.M. Sze, Semiconductor Sensors, John Wiley & Sons, INC., 1994.

REFERENCES:
1. Marc J. Madou, "Fundamentals of Microfabrication", II Edition, CRC Press, 2002.
2. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press, 2002
3. M.Elwenspoek, R.Wiegerink, Mechanical Microsensors, Springer-Verlag Berlin Heidelberg, 2001
4. David Ferry, Transport in Nanostructures, Cambridge University Press, 2000.
5. S. Datta, Electron Transport in Mesoscopic Systems, Cambridge University Press, 1995.
6. Beenaker and Van Houten, Quantum Transport in Semiconductor Nanostructures, in Solid State Physics v. 44, eds. Ehernreich and Turnbull, Academic Press, 1991.
7. P. Rai-Choudhury, Handbook of Microlithography, Micromachining &Microfabrication, SPIE, 1997.
8.www.springer.com/us/book/9783319007793

Computer usage:

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	100%
Professional subject	-	0%

Broad area : Nano technology

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	August 1st week	Session 1 to 14	2 Periods
2	Cycle Test-2	September 2nd week	Session 15 to 28	2 Periods
3	Model Test	October 2nd week	Session 1 to 45	3 Hrs
4	University Examination	TBA	All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

• To inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale. • To expose the students to the evolution of Nano systems, to the various fabrication techniques. Also to impart knowledge to the students about nano materials and various nano measurements techniques.	Correlates to program outcome		
	H	**M**	**L**
The students are expected to understand MEMS		a	
Methods for Processing MEMS materials	e,i	h	
Characteristic techniques of micro system fabrication process	i	a	
To expose the students to the evolution of Nano technology	e,i		j
Also to impart knowledge to the students about nano materials and various nano measurements techniques	c,e,i	a	
Introduction of nano scale manufacturing		a	

H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT – I INTRODUCTION			
1.	Historical background development of microelectronics	no	[T2] chapter - 5, [R1] chapter -3
2.	evolution of micro sensors	no	
3.	MEMS	no	
4.	emergence of micro machines	no	
5.	Micro sensors	no	
6.	Introduction thermal sensors	no	
7.	mechanical sensors	no	
8.	flow sensors	no	
9.	Introduction to SAW DEVICES	no	
UNIT – II MEMS MATERIALS AND PROCESSING			
10.	Overview MEMS MATERIALS AND PROCESSING	no	[T3] chapter -2, [R3] chapter -1 [R8] chapter -3
11.	metals,	no	
12.	semiconductors,	no	
13.	ceramic, polymeric and composite materials,	no	
14.	Microster eolithography: Introduction,	no	
15.	Scanning Method,	no	
16.	Projection Method,	no	
17.	Applications.	no	
18.	LIGA Process: Introduction, Basic Process and Application.	no	
UNIT – III MICRO SYSTEM FABRICATION PROCESSES			
19.	MICRO SYSTEM FABRICATION PROCESSES	no	[T1] chapter -5, [R2] chapter -1 [R6] chapter -4
20.	Photolithography,	no	
21.	Chemical Vapor Deposition	no	
22.	Bath deposition	no	
23.	Sputtering	no	
24.	Physical vapour deposition	no	
25.	Pulse vapour deposition	no	
26.	, Etching,	no	
27.	Bulk and Surface Micro Manufacturing.	no	
28.	Dip coating	no	
UNIT – IV NANO-TECHNOLOGY			
29.	Introduction to Nanotechnology,	no	[T1] chapter -5, [R7] chapter -5 [R2] chapter -6
30.	The nanoscale.	no	
31.	Consequences of the nanoscale for technology and society.	no	
32.	- Technologies for the Nanoscale,	no	
33.	Top-down versus bottom-up assembly.	no	

34.	Visualisation nanoscale	no	
35.	manipulation at the nanoscale,	no	
36.	characterisation at the nanoscale,	no	
37.	Proximal probe technologies. Self-assembly.	no	
UNIT – V NANO SCALE MANUFACTURING:			
38.	Nanomanipulation,	no	[T1] chapter 3, [R6] chapter -8 [R2] chapter -8
39.	Nanolithography -	no	
40.	An introduction to tribology and its industrial applications	no	
41.	Nanoscale Materials and Structure,	no	
42.	Nanocomposites	no	
43.	Safety issues with nanoscale powders	no	
44.	- Application informatics, medicine, etc	no	
45.	Applications in energy	no	
46.	Applications medicine, etc	no	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	5%
Cycle Test – II	-	5%
Model Test	-	10%
Assignment / Seminar / Online Test / Quiz	-	5%
Attendance	-	5%
Final exam	-	70%

Prepared by : Dr.Balakrishnan

Addendum

ABET Outcomes expected of graduates of B.Tech / MECH / program by the time that they graduate:

a) The ability to apply knowledge of mathematics, science, and engineering fundamentals.

b) The ability to identify, formulate and solve engineering problems.

c) The ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d) The ability to design and conduct experiments, as well as to analyze and interpret data

e) The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

f) The ability to apply reasoning informed by the knowledge of contemporary issues.

g) The ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

h) The ability to understand professional and ethical responsibility and apply them in engineering practices.

i) The ability to function on multidisciplinary teams.

j) The ability to communicate effectively with the engineering community and with society at large.

k) The ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.

l) The ability to recognize the need for, and an ability to engage in life-long learning.

Program Educational Objectives

PEO1: PREPARATION:
Mechanical Engineering graduatesare enthusiastic to provide strong foundation in mathematical, scientific and engineering fundamentals necessary to analyze, formulate and solve engineering problems in the field of Mechanical Engineering.

PEO2: CORE COMPETENCE:
Mechanical Engineering graduates have competence to enhance the skills and experience in defining problems in the field of Mechanical Engineering and Technology design and implement, analyzing the experimental evaluations, and finally making appropriate decisions.

PEO3: PROFESSIONALISM:
Mechanical Engineering graduates made competence to enhance their skills and embrace new thrust areas through self-directed professional development and post-graduate training or education.

PEO4: PROFICIENCY:
Mechanical Engineering graduates became skilled to afford training for developing soft skills such as proficiency in many languages, technical communication, verbal, logical, analytical, comprehension, team building, inter personal relationship, group discussion and leadership skill to become a better professional.

PEO5: ETHICS:
Mechanical Engineering graduates are morally merged to apply the ethical and social aspects of modern Engineering and Technology innovations to the design, development, and usage of new products, machines, gadgets, devices, etc.

Course Teacher	Signature
Dr.Balakrishnan	

Course Coordinator **HOD/MECH**

Dr.Shanmuganandh