Academic Course Description

BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Electronics and Communication Engineering
BEC008 -MEMS AND NEMS
FIFTH Semester, 2016-17 (Odd Semester)

Course (catalog) description

- This course introduces to have a concept on the scope and recent development of the science and technology of micro- and nano-systems.
- Gain the physical knowledge underlying the operation principles and design of micro- and nano-Systems.
- Learn some typical or potentially applicable micro- and nano-systems at the frontier of the Development of the field.

Compulsory/Elective course: Elective Course

Credit & contact hours : 3 & 45

Course Coordinator : Dr.E.Kanniga, Professor

Instructors :

Name of the instructor	**Class handling**	**Office location**	**Office phone**	**Email (domain:@ bharathuniv.ac.in**	**Consultation**
Dr.E.Kanniga	Second year	SA003		Kanniga.etc@bharathuniv.ac.in	9.00-9.50 AM
Mr.SRINIVASAN	Second year	SA003		Srinivasan.etc@bharathuniv.ac.in	12.45-1.15 PM

Relationship to other courses:

Pre –requisites **:** Engineering Physics- I & II , Engineering Chemistry - I & II

Assumed knowledge : The students will have a physics and mathematics background obtained at a high school (or equivalent) level. In general Student may have knowledge about sensors, Switches and Actuators.

Following courses : Communication System, Broad band Communication

Syllabus Contents

UNIT I - OVERVIEW AND INTRODUCTION 9

New trends in Engineering and Science: Micro and Nanoscale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems, Microelectromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals

UNIT II - MEMS FABRICATION TECHNOLOGIES 9

Microsystems fabrication processes: Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials

UNIT III - MICRO SENSORS 9

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor

UNIT IV - MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, and Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators

UNIT V - NANOSYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Total : 45 Periods

TEXT BOOKS:

1. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.
2. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001
3. Tai Ran Hsu,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.
4. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006
5. www.tutorials point.com

Computer usage: YES

Professional component

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

Broad area : sensors | Electronics | Switching system | broadband communication

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 develop problem solving skills and understanding of circuit theory through the application of techniques and principles of electrical circuit analysis to common circuit problems. This course emphasizes:	Correlates to program outcome		
	H	M	L
1. To develop an understanding of the fundamental laws and elements of electric circuits.	A,h,j	E,f,I,l	
2. To develop the ability to apply circuit analysis to DC and AC circuits	g	a,b,c,e,l	
3. To understand advanced mathematical methods such as Laplace and Fourier transforms along with linear algebra and differential equations techniques for solving circuits problem	B,k	A,d,f	
4. To learn the "alphabet" of circuits, including wires, resistors, capacitors, inductors, voltage and current sources	b	A,c.g,h,j	
5. Introduce students to different methods involves in analysis both linear and non-linear network.	E,f	B,c,f,h,I,l	

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

Draft Lecture Schedule

Session	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I - OVERVIEW AND INTRODUCTION			
1.	New trends in Engineering and Science	No	[T3] Chapter -1,8
2.	Micro and Nano scale systems	No	
3.	Introduction to Design of MEMS and NEMS	No	
4.	Overview of Nano and Micro electro mechanical Systems	No	
5.	Applications of Micro and Nano electro mechanical systems	No	
6.	Micro electro mechanical systems	No	
7.	Materials for MEMS	No	
8.	Silicon, silicon compounds,	No	
9.	polymers, metals	No	
UNIT II MEMS FABRICATION TECHNOLOGIES			
10.	Microsystems fabrication processes	No	[T1] Chapter -8,9,10,11
11.	Photolithography concepts of impedance	No	
12.	Ion Implantation, Thin film depositions	No	
13.	LPCVD, Sputtering, Evaporation	No	
14.	Electroplating & Etching techniques	No	

15.	Dry and wet etching ,electrochemical etching	No	
16.	Micromachining: Bulk Micromachining, Surface Micromachining	No	
17.	High Aspect-Ratio (LIGA and LIGA-like) Technology	No	
18.	Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials	No	
UNIT III MICRO SENSORS			
19.	MEMS Sensors	No	[T1] Chapter – 4,11 Page-419 And notes
20.	Design of Acoustic wave sensors	No	
21.	Resonant sensor	No	
22.	Vibratory gyroscope	No	
23.	Capacitive Pressure sensors	No	
24.	Piezo Resistive Pressure sensors	No	
25.	engineering mechanics behind Micro sensors	No	
26.	Case study: Piezo-resistive	No	
27.	pressure sensor	No	
UNIT IV MICRO ACTUATORS			
28.	Design of Actuators	No	[T1] Chapter -2
29.	Actuation using thermal forces	No	
30.	Actuation using shape memory Alloys	No	
31.	Actuation using piezoelectric crystals	No	
32.	Actuation using Electrostatic forces	No	
33.	Parallel plate, Torsion bar	No	
34.	Comb drive actuators	No	
35.	Micromechanical Motors and pumps	No	
36.	Case study: Comb drive actuators	No	
UNIT V NANOSYSTEMS AND QUANTUM MECHANICS			
37.	Atomic Structures and Quantum Mechanics	No	[T1] Chapter -1 [T5]
38.	Molecular and Nanostructure Dynamics	No	
39.	Schrodinger Equation and Wave function Theory	No	
40.	Density Functional Theory	No	
41.	Nanostructures and Molecular Dynamics	No	
42.	Electromagnetic Fields and their quantization	No	
43.	Molecular Wires	No	
44.	Molecular Circuits	No	
45.	Review of all units	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.E.Kanniga , professor**.** **Dated :**

Addendum

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

a. An ability to apply knowledge of mathematics, science, and engineering

b. An ability to design and conduct experiments, as well as to analyze and interpret data

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

d. An ability to function on multidisciplinary teams

e. An ability to identify, formulate, and solve engineering problems

f. An understanding of professional and ethical responsibility

g. An ability to communicate effectively

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

i. A recognition of the need for, and an ability to engage in life-long learning

j. A knowledge of contemporary issues

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Program Educational Objectives

PEO1: PREPARATION

Electronics Engineering graduates are provided with a strong foundation to passionately apply the fundamental principles of mathematics, science, and engineering knowledge to solve technical problems and also to combine fundamental knowledge of engineering principles with modern techniques to solve realistic, unstructured problems that arise in the field of Engineering and non-engineering efficiently and cost effectively.

PEO2: CORE COMPETENCE

Electronics engineering graduates have proficiency to enhance the skills and experience to apply their engineering knowledge, critical thinking and problem solving abilities in professional engineering practice for a wide variety of technical applications, including the design and usage of modern tools for improvement in the field of Electronics and Communication Engineering.

PEO3: PROFESSIONALISM

Electronics Engineering Graduates will be expected to pursue life-long learning by successfully participating in post graduate or any other professional program for continuous improvement which is a requisite for a successful engineer to become a leader in the work force or educational sector.

PEO4: SKILL

Electronics Engineering Graduates will become skilled in soft skills such as proficiency in many languages, technical communication, verbal, logical, analytical, comprehension, team building, interpersonal relationship, group discussion and leadership ability to become a better professional.

PEO5: ETHICS

Electronics Engineering Graduates are morally boosted to make decisions that are ethical, safe and environmentally-responsible and also to innovate continuously for societal improvement.

Course Teacher	Signature
DR.E.KANNIGA	
Mr.V.SRINIVASAN	

Course Coordinator **HOD/ECE**