

**Andhra University College of Engineering**  
**Department of Instrumentation Engineering**  
**Qualifying Examination for PhD Submission**  
**Syllabus for the Paper –II**

**Nano Science and MEMS Technology**

**Introduction to Nanotechnology:** Scientific Revolutions, Nanotechnology and Nanomachines, The Periodic Table, Atomic Structure, Molecules and Phases, Energy, Molecular and Atomic size, Surfaces and Dimensional Space, Top down and Bottom up approach.

**Molecular Nanotechnology:** Atoms by inference, Electron Microscopes, Scanning electron microscope, Modern transmission electron microscope, Scanning probe microscope-atomic force microscope, Scanning tunneling microscope, Self Assembly.

**MEMS Fabrication Technologies:** Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, 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

**MEMS SENSORS:** Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- piezoelectric accelerometers, MEMS Cantilevers and their applications, engineering mechanics behind these Microsensors. , Biomedical Sensors, Chemical sensors, Optical Sensors , Thermal Sensors. Case study: Piezo-resistive pressure sensor, capacitive and piezoelectric sensors.

**MEMS APPLICATIONS:** Industrial/automotives sensors, Medical systems, aircraft sensors, Structural health monitoring, Telecommunication etc, Nano composite materials.

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**Model question paper**

Time: 3 hrs

Marks: 100

**NANO Science and MEMS Technology**

1. a. Explain in detail various applications of MEMS  
b. Define micro actuator. Explain working principle of chemical sensor  
or  
a. Explain in detail the concept of micro fluidics in MEMS with a suitable application.  
b. Explain how MEMS capacitive switches can be fabricated using IC fabrication technology
2. a. with a suitable application, explain the concept of doping in semiconductors  
b. With suitable diagram, explain the construction of diffusion process  
or  
a) Discuss the fluid flow in micro channels with suitable application  
b) Discuss the intermolecular forces in micro structures
3. a. On what factors the selection of material for MEMS depends. Explain various mechanical and electrical properties of Single crystal silicon  
b. With a neat sketch, explain about 3D packaging. Discuss various advantages of 3D MEMS packaging  
or  
a. Explain about various design considerations in MEMS sensor design  
b. Discuss essential packaging technologies used for MEMS packaging
4. a. On what factors the choice of wafer depends. Explain CZ method for preparation of Silicon wafers  
b) What is spinning resist? Why it is used? With a neat sketch, explain the principle of operation of spin coater.  
Or  
a. What is CVD? Explain how silicon nitride can be grown using CVD process  
b. With neat diagram, explain the principle of operation of PVD process
5. What is accelerometer? Explain principle of operation of capacitive accelerometer. With neat diagram, explain methods of fabrication of piezo electric accelerometer.  
Or  
What is Pressure sensor? Explain principle of operation of capacitive pressure sensor. With neat diagram, explain methods of fabrication of pressure sensor.

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**Sensors and Signal Conditioning**

**Unit I**

**Resistive, Reactance and Self generating sensors:**

Strain gauge, RTD, thermistor, potentiometer, magneto resistors, light dependent resistive sensors. Capacitive and inductive sensors. Thermocouple, piezoelectric and pyroelectric sensors, electrochemical sensors.

**Unit II**

**Advanced sensors:**

Smoke detectors and gas sensors. Environment sensing systems - chemical, air, wind sensors. Humidity and moisture sensors – capacitive sensors, electrical conductivity sensors, thermal conductivity sensors, optical hygrometer and oscillating hygrometer.

**Unit III**

**Signal conditioning for resistive sensors:**

Wheat stone bridge- balance measurements-deflection measurements sensitivity, linearity, analog linearization of resistive sensor bridges, Differential and Instrumentation amplifiers. Grounding and Isolation.

**Unit IV**

**Signal conditioning for capacitive and inductive sensors:**

AC bridges, carrier amplifiers and coherent detection.

**Advanced Optical Instrumentation sensors:**

Optical fibers-modal propagation, signal distortion on optical fibers, optical sources, photo receivers and detectors, fiber amplifiers, optical link design.

**Unit V**

**Case studies:**

Capacitance sensors for nondestructive moisture determination in grain, nuts and bio-fuel materials, Design of an impedance analyzer for moisture determination of in-shell peanuts, Microwave resonator measurements for moisture determination in individual grain kernels,

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**Sensors and Signal Conditioning**

1) Explain about the piezoelectric sensors in measurement of acceleration of a vibrating body with a neat sketch?

Or

2) Derive the Gauge factor equation? And explain about the measurement of torque using a strain gauge?

3) Define relative humidity, wet bulb temperature? And Design a model for measurement of moisture in paper?

Or

4) Explain the Gas Analysis by Thermal conductivity sensor with a sketch?

5) Explain about the three amplifier configuration in an instrumentation amplifier? And derive the expression for output voltage?

Or

6) Explain about the Deflection type Wheatstone bridge provided with zero adjustment and derive the expression for bridge sensitivity?

7) Explain about the Owen's Bridge with a neat sketch and write the bridge balance condition?

Or

8) Describe the construction and working of a phototransistor? Draw their characteristics and explain their advantages and disadvantages?

9) Explain about the moisture determination in grain by capacitance sensor in nondestructive method?

Or

10) Discuss in brief about different bio-fuel materials and their advantages over the conventional materials?