Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: EC465

Course Name: MEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the operating principle of two types of micro motors with suitable schematics. (10)

b) Explain the operating principle of Thermal bimorphs with figures (5)

2 a) Give one application of MEMS in automobiles. Illustrate its working with neat sketches. (5)

b) State the reasons for intrinsic stress in thin film materials under room temperature and zero loading conditions. (10)

3 a) Explain with figures two types of sensing schemes used in inertial sensors and micro accelerometer. (10)

b) Explain the constitutive relations between electrical displacement and stress of piezoelectric sensors. (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive equations for acceleration a, time t and power density P/V based on the Trimmer Force Scaling Vector? What information does the force scaling vector provide to the MEMS designer? (10)

b) What are the advantages of use of polymers in micro systems? Give two examples of Polymers (full chemical/commercial names). (5)

5 a) Why electrostatic actuation is preferred over electromagnetic actuation in micro motors? (5)

b) Explain the Langmuir- Blodgett process with relevant figures. What are the advantages of LB films? (10)

6 a) Explain with figures one method to produce single crystal Silicon (5)

b) A silicon substrate is doped with boron ions at 100 KeV. Assume the maximum concentration after the doping is 30 x 10^{18}/cm3. Find: (a) the dose, Q, (b) the dopant concentration at the depth 0.15 μm, (c) the depth at which the dopant

concentration is at 0.1% of the maximum value. (Given: Rp = 307 nm = $307x10^{-7}$ cm and $\Delta Rp = 69 \times 10^{-7}$ cm at 100 KeV energy level). (10)

PART C

Answer any two full questions, each carries 20 marks.

7 a) State two advantages of LIGA process over other micro machining techniques. Explain with block diagram the steps in LIGA process. State atleast one commonly used chemical in each of the steps. (10)

b) Explain anodic bonding with figures. (5)

c) Explain any one application of MOEMS with figures. (5)

8 a) Explain the following bonding techniques with figures a) Silicon-on-Insulator b) Wire bonding (10)

b) Describe the role of sacrificial layers in surface micromachining with figures. Give examples of two sacrificial materials used in micro system fabrication. (5)

c) State the challenges involved in designing packages for micro systems. (5)

9 a) Explain with figures the steps in surface micro machining. Discuss the various fabrication challenges associated with surface micromachining. (10)

b) Explain with figures two RF MEMS applications. (10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: EC465

Course Name: MEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) State five characteristics of micro sensors and actuators (10)

b) With reference to pure bending of longitudinal beam, derive the expression for the magnitude of applied bending moment. (5)

2 a) State a commercial product which uses MEMS technology. Explain with figures its operating principle of the product. (5)

b) Explain the purpose of micro cantilevers in MEMS systems. What is the relevance of spring constant (k) of the mechanical structure in the micro system? (10)

3 a) Explain with figures the working principle of micro grippers. (5)

b) Explain Lorentz force. Explain the operating principle of magnetic actuators with relevant figures. (10)

PART B

Answer any two full questions, each carries 15 marks.

4 a) State the constraints in pumping fluids in micro channels. What pumping scheme is usually used in micro fluidics, give one example. (10)

b) State three relevant properties of Silicon Carbide and Silicon Nitride for use in Microsystems. (5)

5 a) With relevant figures/ schematics state one application of Silicon Piezo resistors. (5)

b) Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions. (10)

6 a) Explain the oxide growth process in Silicon with relevant figures. (5)

b) With reference to scaling of electromagnetic forces, derive the expressions for electromagnetic potential energy and force. (10)

PART C

Answer any two full questions,each carries 20 marks.

7	a)	Discuss the criteria for selecting materials for the masks used in etching.	(5)
	b)	Give five relevant points of comparison between bulk and surface micromachining.	(5)
	c)	What is meant by BioMEMS. Discuss the challenges involved in BioMEMS. List three applications of BioMEMS.	(10)
8	a)	Explain with figure the DRIE and Plasma etching	(10)
	b)	Explain Anodic bonding and Silicon Fusion Bonding.	(10)
9	a)	Explain the levels of micro system packaging.	(10)
	b)	Explain with figures two application which use NEMS technology	(10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: EC465

Course Name: MEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the basic building blocks of MEMS with neat diagrams. (8)

b) Explain the principle of operation of thermal sensors and actuators with neat diagrams. (7)

2 a) Derive the equation for pull in voltage. Also explain the advantages and limitations of electrostatic actuation methods. (8)

b) Describe the principle of micro-accelerometer with a neat schematic. (7)

3 a) Explain the operating principle of two types of micro motors with suitable schematics (8)

b) Determine the moment of inertia for a beam under longitudinal strain and also find the flexural formula (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain Trimmer force scaling vector. Use scaling laws to estimate the changes in acceleration and time to actuate a MEMS component if its weight is reduced by a factor of 10. (8)

b) Explain with figures one method to produce single crystal silicon. Why is silicon used as a substrate material for MEMS. (7)

5 a) With reference to scaling of electrostatic forces explain why electrostatic actuation is preferred over electromagnetic actuation in micro motors. (8)

b) Explain the steps involved in photolithography with neat sketches. (7)

6 a) Explain scaling in fluid mechanics .What are the advantages of piezoelectric pumping. (7)

b) Discuss different types of polymers used in MEMS. (8)

PART C

Answer any two full questions, each carries 20 marks.

7	a)	Explain surface micro machining process for fabricating a mechanical structure with neat sketches.	(10)
	b)	State the objectives and explain the general considerations in micro system packaging	(10)
8	a)	Explain LIGA process in detail.	(10)
	b)	Explain with figures two RF MEMS applications	(10)
9	a)	Explain the three levels of micro system packaging	(10)
	b)	Explain Anodic bonding and Silicon Fusion Bonding	(10)

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh semester B.Tech examinations (S), September 2020

Course Code: EC465

Course Name: MEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain different types of micro-accelerometers with diagrams. (7)

b) Explain the principle of operation of MEMS based electrostatic sensors and actuators. (8)

2 a) Derive the expression for longitudinal strain under pure bending in flexural beams (8)

b) Explain the general stress -strain relationship with neat sketches (7)

3 a) Explain the working principle of micro-grippers and micro pumps (8)

b) Explain the operating principle of thermal bimorphs with figures.State any two applications of thermal sensors. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) With reference to scaling of electrostatic forces, derive the expressions for electrostatic potential energy and force (8)

b) Compare the properties of Silicon, SiO_2 and SiC (7)

5 a) Compare different chemical vapour deposition processes. (8)

b) Explain various scaling laws in miniaturization. (7)

6 a) Derive equations for acceleration a, time t and power density P/V based on the Trimmer Force Scaling Vector. What inference can a MEMS designer draw from the force scaling vector? (8)

b) Explain two processes used for doping silicon substrate and also specify two n and p type dopants. (7)

PART C

Answer any two full questions, each carries 20 marks.

7	a)	Explain with figures the steps in surface micromachining. Discuss the various fabrication challenges associated with surface micromachining.	(10)
	b)	Explain the levels of micro system packaging.	(10)
8	a)	Explain any two bonding techniques for MEMS	(10)
	b)	Explain with diagrams any two applications of RFMEMS.	(10)
9	a)	Describe steps of fabrication of a square tube using LIGA process.	(10)
	b)	Explain two applications which use NEMS technology.	(10)

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