Ref No: Ex / PG/ EE/T/ 127 B / 2018

M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER 2018

TRANSDUCER TECHNOLOGY

Full Marks 100

Time: Three hours (50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer any *TWO* questions	
1.	**Answer the following in brief.**	
(a)	**Can any property of cross-correlation function be exploited for devising a transducer for non-contact measurement of linear velocity of sheet steel? Why is this measurement required? Explain.**	6
(b)	**What are the motivations for deploying capacitive sensing in industry? Elaborate.**	4
(c)	**In a certain factory, paper labels for cartons are under production. A glue dispenser pours water-based glue on to the back-sides of these labels, as they travel along a conveyor in the production line. Explore the type of sensing that can be utilized to sense the presence and the adequacy of the amount of glue being delivered by the dispenser. Substantiate your solution by appropriate sketches.**	5
(d)	**Examine the possibility of employing two perfectly matched transistors to constitute a proportional-to-absolute temperature (*PTAT*) sensor.**	5
(e)	**Define '*d*' and '*g*' constants for a piezoelectric sensor. Derive the relation between the two. Justify or correct the following statement in connection these sensors, with the help of relevant derivations.** ***"The charge sensitivity in μC/mm is a material property, while the voltage sensitivity in mV/mm depends on the sensor material as well as on sensor dimensions."***	5
2. (a)	**Examine the dynamic performance of constant-current bridge anemometer, when the velocity of the measured fluid is fluctuating about a steady-state value. Give necessary derivations.**	

No. of Questions	PART I	Marks
	State clearly the assumption(s) made. Point out the flaws of this arrangement and explain in details any appropriate method for improving the dynamic performance.	10+7
	OR	
	Bring out clearly the principle of operation of a seismic accelerometer. Write down the equation of motion. Develop and sketch the amplitude response function of the system.	10+7
	Consider an open loop electrical accelerometer where the displacement of the proof mass is measured by a piezoelectric sensor, and the connections from the sensor are taken to a charge amplifier through a coaxial cable. The output voltage of the amplifier is expected to give a measure of the acceleration. Comment on the static and the dynamic performance of the complete system. Give relevant derivations and sketches. What is the bandwidth of the system? Explain how the lower limit of the working range of frequencies can be decreased even after the complete accelerometer system has been set up. *Expression for the transfer function of the electrical part of the system may be considered without proof.*	
(b)	Introduce an operational amplifier based logarithmic amplifier circuit and explain its working principle. Indicate how change in ambient temperature affects its performance adversely and also suggest an improvement wherein this error is minimized.	8
3.	Write short notes on any *two* of the following.	
(a)	Software linearization arrangements for NTC thermistor based temperature measurements systems, with ratiometric analog-to-digital conversion.	12 ½
(b)	Ultrasonic transit-time flowmeter of non-invasive variety and its advantages.	+ 12 ½
(c)	Capacitive sensor for monitoring moisture-content of fabrics.	

No. of Questions	PART I	Marks
4. (a)	**Comment on the different types of fabrications of flat circular diaphragms for use as elastic elements for measuring pressure of fluids. Give necessary illustrations and point out their relative merits and demerits.**	
	Elucidate, with appropriate derivations, the functioning of a diaphragm based capacitive pressure transducer. What measures can be taken to improve the dynamic sensitivity of the sensor?	6+10
	OR	
	A capacitive liquid level sensor consists of two identical parallel metal plates each 3 cm wide and having a height h= 30 cm. Separation between the plates is 4 mm. The liquid level changes in a direction parallel to the plates (i.e. in the direction h). The sensor is calibrated for a liquid with a relative permittivity =3. The permittivity of air is 8.842 pF/m. Calculate the sensitivity of the gauge in pF/m.	
	This sensor forms the timing capacitor of an astable multivibrator using 555 timer IC, and the timing resistors are each 500 kΩ. Examine whether it is the time period or the frequency of the output pulse train that should preferably be measured, to have a measure of the liquid level. *The relation between the time-period / frequency and the timing resistances and capacitance, may be assumed.* Derive all other expressions used. Determine the sensitivity of the complete arrangement in μs/m or Hz/m, whichever is applicable. To what extent is the calibration upset, if the relative permittivity of the liquid increases by 10%.	8+8
(b)	**Inspect the necessity of using a quadrature decoder circuit with motion encoders. Develop any suitable quadrature decoder circuit and explain its functioning-**	9

Master of Electrical Engineering Second Semester Examination, 2018

Transducer Technology

Time: Three Hours **Full Marks: 100**

(50 Marks for each part)

Use a separate Answer Script for each Part

PART-II

Answer *Any Two* Questions

Q1a) Explain the principle of operation of non destructive liquid inspection testing method. Explain the role of developer in this testing. How does the nature of defects affects liquid inspection testing? Mention common uses of this testing method. **10**

Q1b) What is ultrasonic transducer? Briefly discuss the design characteristics of this type of transducer. **6**

Q.1c) What are the basic differences between the acoustic emission testing with that of other non-destructive testing? What are the limitations of eddy current testing method. **6**

Q.1d) What is couplant? Discuss the importance of it in ultrasonic testing. **3**

Q.2a) Explain the dry oxidation and wet oxidation processes for growing oxide on silicon substrate and give the relative merits and demerits of each process. **3+4**

Q.2b) With the help of process flow diagrams, explain the lift-off process to realize a metallic pattern on silicon wafer. Briefly describe the LPCVD process to deposit silicon nitride. **6+4**

Q.2c) Briefly describe the process steps involved in the bulk micromachining technology for realizing the cantilever beam. **8**

Q.3a) Show how damping ratio can be increased by compensation in a second order system. **10**

Q.3b) Briefly discuss about the different types of fibers. What is meant by dispersion in optical fibers? Explain the different kinds of dispersion mechanisms in the fiber. **5+5+5**

Q4. Write short notes on :

i) Field Bus.

ii) Radiographic Testing. **(12.5×2)**