Ref No: Ex/EE/T/221/2017

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING

EXAMINATION, 2017

(2^{nd} YEAR , 2^{nd} SEMESTER)

SUBJECT: - ELECTRICAL INSTRUMENTATION

Time:Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer any THREE questions	
1.	**Justify or correct *any four* of the following statements with suitable reasons/derivations, in brief.**	
(a)	**In a capacitive thickness gauge for dielectric samples, a higher value of the relative permittivity of the dielectric affects the sensitivity as well as the linearity of the gauge adversely.**	$4\times 4\frac{1}{2}=18$
(b)	**An LVDT is used in conjunction with a passive RC network for sensing the direction of displacement of the LVDT core.**	
(c)	**When a charge amplifier circuit is used for processing signals from piezoelectric transducers, the sensor-cable-charge amplifier combination has a low-pass characteristic.**	
(d)	**In a wetted sensor type ultrasonic flowmeter, the differential transit time has a linear relation with the fluid velocity.**	
(e)	**The calibration of a constant current anemometer is dependent on the fluid-sensor combination, but independent of the fluid temperature.**	
2. (a)	**Define 'g' and 'd' constants of a piezoelectric sensor, and derive the relation between the two. Also obtain expressions for the charge sensitivity and the voltage sensitivity in Coulomb/ m and V/ m respectively, in terms of the 'g' and the 'd' constants.**	6

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No. of Questions	PART I	Marks
(b)	Bring out clearly the problems related to the measurement of the output voltage of piezoelectric sensors. Derive and sketch the amplitude and the phase responses of a remedial arrangement wherein the voltmeter is preceded by a buffer amplifier. How can the lower frequency limit of the arrangement be decreased?	10
3. (a)	Consider a capacitive liquid level gauge consisting of two coaxial cylindrical electrodes, each having a height of 50 cm. The liquid level rises in a direction parallel to the axis of the electrodes. The separation between the electrodes is 1/20 the radius of the inner electrode. Determine the sensitivity of the gauge in pF/m, when used for a liquid with relative permittivity of 8. Consider the permittivity of free space as 8.842 pF/m. The above sensor is used as the timing capacitor in an astable multivibrator circuit employing a 555 timer. The timing resistances are each 1.25 MΩ. Determine the nominal frequency of the output. The nominal condition corresponds to the situation when liquid level under measurement is zero. Calculate the % deviation of the frequency from its nominal value, when the liquid level is 20 cm up from the bottom of the electrodes. Derive the expressions used. *However the relation between the frequency of the multivibrator output, and the timing resistance and capacitance values may be assumed.*	10
(b)	Explain how a transformer double-ratio bridge is used for null method of measurements involving capacitive sensors. Point out its merits compared to conventional AC bridges.	6
4. (a)	With the help of relevant sketches and mathematical derivations, elucidate how a constant-current anemometer performs the task of measuring the temporal variation of fluid velocity. Explain the requirement of dynamic compensation for such anemometer. Also point out how such a compensation arrangement can be implemented.	12
(b)	Prove with help of mathematical derivation, that the differential output voltage of an LVDT undergoes a 180° phase shift as the core of the LVDT travels from one side of the electric-zero position to the other.	4

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No. of Questions	PART I	Marks
5.	**Write short notes on *any two* of the following:**	**8×2=16**
(i)	**Measuring circuit for capacitive microphone.**	
(ii)	**Non-wetted sensor type ultrasonic transit-time flowmeter.**	
(iii)	**Electromagnetic flowmeter with unidirectional and bidirectional pulsed excitation.**	
(iv)	**Synchronous demodulation circuit for LVDTs.**	
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B.E.E. 2ND YEAR 2ND SEMESTER EXAMINATION, 2017

SUBJECT: - ELECTRICAL INSTRUMENTATION

Time: Three hours **Full Marks 100**
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART-II	Marks
	Answer any three, 2 marks for well organized answers	
1.	**Justify and/or correct the following statements (any four):**	(4X4=16)
a)	*Lock Range* and *Capture Range* of a Phase Locked Loop (PLL) are same.	
b)	Compensation circuit is required for Cathode Ray Oscilloscope (CRO) to avoid error due to input impedance.	
c)	3 dB Cut off frequency for normalized low pass Butterworth filter is greater than that of Chebyshev filter.	
d)	Successive approximation type ADCs have lowest conversion time among all other ADCs.	
2. a)	Prove that Chebyshev poles are situated on an ellipse in s-plane.	6
b)	Realize the bi-quadratic filter $H(s) = \dfrac{3500s}{s^2 + 3000s + 6\times10^7}$.	10
3. a)	A 4 bit unipolar successive approximation type ADC has an offset error -0.25 LSB. Find the ADC output for an input voltage of 8.25 V with and without offset error. Reference voltage is 12V.	5
b)	Explain with circuit diagram the operation of an R-2R ladder DAC considering 3 bits.	6
c)	The step size of a 8 bit DAC is 15 mV. An offset error of 0.1 mV exists in the DAC. If all zeroes represent 0V without this error, what outputs are produced for input code 10100101 with and without this offset?	5
4. a)	Obtain a 4-bit binary representation of an analog signal value of 10.3 V using dual slope type ADC. Reference voltage is +16 V. Find out the conversion time in seconds and quantization error in volts. The clock frequency is 1kHz.	6
b)	How the quantization error in ADC can be minimized?	4
c)	Derive a linear model of Phase Locked Loop (PLL).	6
5.	Write Short notes on any ***two***	(2X8=16)
a) b) c)	Representation of errors for DACs. Phase Locked Loop (PLL) as frequency demodulator Active band pass filter using switched capacitor representation	