*Ref No:* **Ex/EE/PC/B/T/221/2023**

**B. E. ELECTRICAL ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION - 2023**

**SUBJECT: - ELECTRICAL INSTRUMENTATION**

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 Q.5 and any two questions from the rest.*** | |
| 1. | Justify or correct ***any four*** of the following statements with suitable reasons in brief / derivations. **(CO2-K2)** | 4×05=20 |
| (a) | **A piezoelectric displacement transducer system employs an amplifier to increase the steady state gain of the system.** | |
| (b) | **When capacitive transducers are used with transformer ratio bridges, both the unknown capacitance and its loss part are obtained as functions of the transformation ratio.** | |
| (c) | **For a capacitive transducer using differential arrangement and employing the principle of change in distance between the plates, the sensitivity is directly proportional to the separation between the movable plate and each fixed plate.** | |
| (d) | **In a piezoelectric displacement transducer system, the time constant can be increased by connecting a series resistance external to the amplifier.** | |
| (e) | **In absence of a centre-tapped excitation voltage source, null reduction in an LVDT can be achieved using an L-C network.** | |
| 2. (a) | **Draw the equivalent circuit of an LVDT and derive its frequency response, when a voltmeter having an infinite meter resistance is connected to its output terminals. How can the phase shift between the output voltage and the input voltage of this LVDT be made zero by connecting a finite resistance across its output terminals? (CO2-K2)** | 05+05 |

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| No. of Questions | PART I | Marks |
|---|---|---|
| (b) | **What are the main characteristic features in constructing a commercial LVDT? (CO2-K2)** | 05 |
| (c) | **Derive the transfer function of a piezoelectric accelerometer. (CO2-K2)** | 05 |
| 3. (a) | **Show that for a capacitive transducer with a solid dielectric of variable thickness and air gap between parallel plates the sensitivity remains constant. Show that the sensitivity factor and the nonlinearity factor are same for this configuration. (CO2-K2)** | 10 |
| (b) | **Describe the operating principle of a capacitor measurement circuit, built using an astable multivibrator and a monostable multivibrator. Show that the mean output voltage of this circuit is proportional to the change in the sensor capacitance. What are the design considerations employed and assumptions made in this derivation? (CO2-K2)** | 10 |
| 4. | **Write short notes on *any two* of the following: (CO2-K2)** | 10+10 |
| (a) | **Charge amplifier in conjunction with a piezoelectric transducer.** | |
| (b) | **Diode bridge based phase sensitive demodulation in LVDT.** | |
| (c) | **Relative humidity sensors.** | |
| 5. (a) | **"An LVDT, in its basic form, suffers from low sensitivity, high hysteresis and high power consumption problems." – Justify or correct the statement, citing suitable reasons. (CO5-K4)** | 05 |
| (b) | **"A capacitive transducer, developed using the principle of change in distance between a fixed and a moving plate, can arbitrarily choose any distance of separation between the plates." – Justify or correct the statement, citing suitable reasons. (CO5-K4)** | 05 |

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**B.E. ELECTRICAL ENGINEERING2ND. YEAR 2ND. SEM. EXAM.-2023**

**SUBJECT: - ELECTRICAL INSTRUMENTATION**

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

**Use a separate Answer-Script for each part**

**Answer All Questions**

| | | |
|---|---|---|
| 1. | a) | A stationary closed Lissajous pattern on an oscilloscope has 33 horizontal tangencies and 22 vertical tangencies for a horizontal input with frequency 33 kHZ. Find out the frequency of the verticle input.(CO1) **2** |
| | b) | The input resistance and capacitance of a Cathode Ray Oscilloscope (CRO) are 1.0 μF and 2.0 MΩ. What is the matched capacitance of the probe for proper compensation assuming 10kΩ probe resistance? Explain necessary formula.(CO1) **4** |
| | c) | Explain the function of a Delay Line in the vertical deflection system of CRO. (CO1) **2** |
| | | **OR** |
| 1. | a) | Two in-phase, 50Hz sinusoidal waveform of unit amplitude are fed into channel-1 and channel-2 respectively of an oscilloscope. Assuming that the voltage scale, time scale and other settings are exactly the same for both the channels. What would be observe if the oscilloscope is operated in x-y mode and why? (CO1) **3** |
| | b) | Explain with circuit diagram the time base generator circuit of CRO. (CO1) **5** |
| 2. | a) | Why state variable filter is known as universal active filter. Draw the circuit diagram normalized band-stop state vaiable filter and and find out the transfer function, passband gain and bandwidth of the said filter.(CO3) **8** |
| | | **OR** |
| | | What are the different stages of PLL? Explain the functions of each stage. Draw the block diagram of the linear model of PLL and hence deduce the transferfunction of the same. (CO3) **8** |

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**B.E. ELECTRICAL ENGINEERING2ND. YEAR 2ND. SEM. EXAM.-2023**

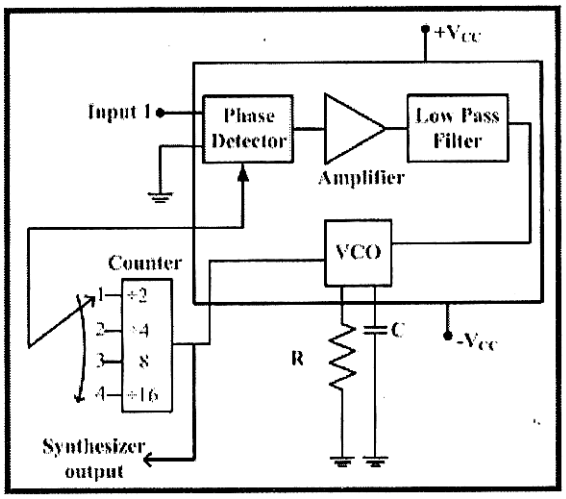
**SUBJECT: - ELECTRICAL INSTRUMENTATION**

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

## PART II

**Use a separate Answer-Script for each part**
**Answer All Questions**

b) The block diagram of a frequency synthesizer consisting of a Phase Locked Loop (PLL) and a divide-by-*N* counter (comprising ÷2 ,÷4, ÷8, ÷16 outputs) is shown below. The synthesizer is excited with a 5 kHz signal (Input 1). The free-running frequency of the PLL is set to 20 kHz. Assume that the commutator switch makes contacts repeatedly in the order 1-2-3-4. What will be the corresponding synthesized frequencies? Give reasons in support of your answer. (CO3)**4**




3. a) An 8-bit DAC has a full-scale output voltage of 2volt and a full scale error of ±5% of full scale output. What is the range of possible outputs for an input of 10000000?(CO4) **4**

b) Explain linearity error of DAC with the help of input/output relationship of it. Why this type of error occurs in DAC?(CO4) **5**

**OR**

Explain the operation of Dual Slope Integrator type Analog to Digital Converter (ADC). (CO4) **5**

c) An 8-bit ADC has a full-scale output voltage of 10.23volt. The clock frequency is 10 MHz.Determine i) the digital equivalent corresponding to 3.728volt, ii)the conversion time andiii)the resolution for both counter type and successive approximation type converters. Also find out the quantization error and how the quantization error can be minimized. (CO4) **5**

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**B.E. ELECTRICAL ENGINEERING2ND. YEAR 2ND. SEM. EXAM.-2023**

**SUBJECT: - ELECTRICAL INSTRUMENTATION**

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

**PART II**

**Use a separate Answer-Script for each part**
**Answer All Questions**

| | | |
|---|---|---|
| 4. | a) | Prove that the poles of Butterworth filter are located on a unit circle. (CO6) **6**<br><br>**OR**<br><br>Mention the properties of Chebyshev filter. Explain why the -3dB cut-off frequency of a normalized chebyshev filter is greater than 1rad/sec.? (CO6) **6** |
| | b) | Find the transfer function of a band pass filter circuit with center frequency $\omega_0$ = 10 krad/sec and bandwidth B = 4 Krad/sec obtained by low pass to band pass transformation from a first order normalized low-pass Butterworth filter. Realize the band pass filter circuit. Also realize the band stop filter circuit from this band pass filter having same center frequency and pass band gain 0db=1. (CO6) **10**<br><br>**OR**<br>Find the transfer function of a normalized Butterworth low pass filter with the following specifications:<br><br>(i) the passband specification is:$\mid \mathbf{H(j0.5)} \mid^2 > \mathbf{0.9}$<br><br>(ii) the stopband specification is: $\mid \mathbf{H(j2)} \mid^2 < \mathbf{0.01}$<br><br>Hence realize the actual low pass filter circuit for the cut-off frequency1000 rad/sec. (CO6) **10** |