Ref. No.: Ex/EE/PE/B/T/414D/2024

# B.E. ELECTRICAL ENGINEERING - FOURTH YEAR - FIRST SEMESTER EXAMINATION, 2024

## SUBJECT: - ADVANCED INSTRUMENTATION -I

Full Marks 100

Time: Three hours (50 marks for each part)

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

| Question No. | PART I | Marks |
|---|---|---|
| | **ANSWER ANY *TWO* QUESTIONS** | |
| 1. (a) | **Point out the motivations behind opting for an oversampling ADC. Sketch the architecture for such an ADC (without noise shaping) and explain the working principle with the help of sketches for relevant spectra and mathematical derivations. Point out the role of the digital decimator in the ADC. [CO3]** | 3+10+2 |
| (b) | **Explain the principle of operation of *any appropriate half-flash* analog-to-digital converter (ADC). Give relevant mathematical derivation. Derive quantitatively the extent to which the slew rate of ADC input would have been sacrificed, if the ADC were not provided with a front-end track and hold amplifier. [CO3]** | 10 |
| 2. (a) | **Explain in short the theory of a Rogowski coil current transducer. Is its performance immune to any externally located time-varying current element? Explain.**<br><br>**Under what condition can it be operated in the current-transformer (CT) mode? Explain with mathematical derivation.**<br><br>**Indicate clearly the advantages of Rogowski coil (with integrator) over conventional CTs with ferromagnetic core. [CO1]** | 6+4+5 |
| (b) | **Elucidate the implementation of 'Proportional to Absolute Temperature' (PTAT) sensor using two transistors. *Consider*** | 10 |

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| Question No. | PART I | Marks |
|---|---|---|
| | *any one of the possible circuits.* [ CO1] | |
| 3. (a) | **Give a neat labeled sketch showing the construction of a force balance accelerometer, point out its salient features and explain its principle considering only static measurement. [CO1]** | **10** |
| (b) | **Explain the physics of the "Hall Effect" phenomenon.**<br>**Elucidate the principle and merit of the closed-loop variety of the Hall-effect current transducer.**<br>**Point-out the application domains of this transducer. [CO1]** | **3+10+2** |
| 4. | **Write short notes on the following.** | |
| (a) | **PTAT sensor using a single transistor.**<br>**OR**<br>**Frequency response and merits of force-balance accelerometer. [CO1]** | **12 ½ +12 ½** |
| (b ) | **Sources of errors in full-flash ADC.**<br>**OR**<br>**Sigma-Delta Modulator ADC. [CO3]** | |

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## B.E.E. 4TH YEAR 1ST SEMESTER EXAMINATION, 2024

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

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

**PART-II**

**Answer any two** **2X25=50**

1. a) What is Sensor Fusion? Explain different levels of such a fusion strategy. 2+8

b) Explain the operation of Direct Digital Synthesis (DDS) based Frequency synthesizer. 9

c) A digital frequency synthesizer employs a 2.097152 MHz crystal oscillator and gives a 512 step-sinusoid. Determine the maximum and minimum output frequency if the number of fractional bit is 4. Also find out the frequency control word for these cases. 6

2. a) A Rough Set based decision rule generation system uses a real valued data table as given below. Generate the discretized decision table using maximal discernible heuristics. Show the optimum set of cuts. Generate the set of rules from this. 15

| Objects | Condition Attributes | | Decision Attribute |
|---|---|---|---|
| | A | B | |
| $U_1$ | 0.25 | 5.5 | 0 |
| $U_2$ | 0.75 | 4.0 | 0 |
| $U_3$ | 1.25 | 5.5 | 1 |
| $U_4$ | 0.25 | 1.5 | 1 |
| $U_5$ | 1.25 | 1.5 | 1 |
| $U_6$ | 0.75 | 4.0 | 0 |
| $U_7$ | 0.75 | 1.5 | 1 |

b) A Rough Set based decision rule generation system uses a data table as given below. Generate the set of decision rules from this table. Also comment on *Reduct* and *Core* values in this case. 10

| Objects | Condition Attributes | | | Decision Attribute |
|---|---|---|---|---|
| | A | B | C | |
| $U_1$ | 0 | 0 | 1 | 0 |
| $U_2$ | 0 | 1 | 1 | 0 |
| $U_3$ | 1 | 1 | 1 | 1 |
| $U_4$ | 1 | 1 | 0 | 1 |
| $U_5$ | 1 | 0 | 0 | 1 |
| $U_6$ | 0 | 1 | 0 | 1 |
| $U_7$ | 1 | 0 | 1 | 0 |

3. a) What is a lock-in-amplifier? Explain with a basic scheme. 5

b) How can you employ digital synthesis technique in such a lock-in-amplifier for better performance? 6

c) What are the properties of a *mother-wavelet*? 4

d) Explain the algorithm for computing Continuous Wavelet Transform of a signal. 6

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| | | |
|---|---|---|
| e) | Samples of a signal is shown as $f = \{1, 3, 6, 7, 0, 1, 8, 3\}$. ↑<br>Find Wavelet coefficients after Haar Transform. Show that energy does not change after Haar transform. | 4 |
| 4. | **Write notes on the following topics** | $(2X12\frac{1}{2}$ |
| a) | Wavelet Transform based denoising technique | $=25)$ |
| b) | Digital vector voltmeter using synchronous detection technique | |