**Technological Institute of the Philippines-Quezon City**

**Computer Engineering Program**

**CPE027 – Digital Signal Processing Applications**

**Preliminary Examination**

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1. **Question and Answer.** Answer the following questions as concisely and as clearly as possible.
2. Differentiate Analog vs. Digital Signals

Analog signals are continuous signals, mostly they are found in the real world and in real time. They have an infinite number of values in between two points and are therefore almost computationally impossible to fully utilize. On the other hand, digital signals are discrete signals, they can be characterized as snapshots of analog signals in a specific period. Digital signals are easier to use in calculations due to their discrete nature and is used in computational analysis.

1. Explain the advantages in processing digital signals as compared to analog signals.

Digital signals are discrete signals that have a finite number of values in between two points. Meanwhile, analog signals are continuous signals that have an infinite number of possible values in between two points. Therefore, digital signals will be more computationally possible to be used due to their limits and discreteness than analog signals.

1. Cite three (3) possible signal domains. Describe their differences and purposes.

Some examples of signal domains are time domain, frequency domain, and spatial domain. The time domain has snapshots of time per step in the x-axis and is used in monitoring change of a value per time step. A frequency domain on the other hand is used to visualize the distribution of frequency within given ranges. Lastly, spatial domains are used to show the distribution of values in an image for image processing.

1. Describe **“System”** in the context of signal processing.

A system is a set of functions, an algorithm, or a line of code that accepts an input signal, performs calculations and manipulations, may it be linear or non-linear, and outputs an altered signal. Linear Systems are those that apply the same manipulation to all signals that pass through. Meanwhile, non-linear systems are those that apply manipulations to an input signal in accordance with a specified criterion.

1. **Problem Solving.** Show your solutions or illustrate your explanation as necessary.
2. A data acquisition system received the following array: [25 14 16 17 19 21 24 45 66 77 100]. Solve for the output array when the signal is subjected to:
   1. Moving Average filter with a size 3 kernel

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = 25/3 = 8.33

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (25+14)/3 = 13.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (25 + 14 + 16)/3 = 18.33

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (14 + 16 + 17)/3 = 15.67

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (16 + 17 + 19)/3 = 17.33

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (17 + 19 + 21)/3 = 19.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (19 + 21 + 24)/3 = 21.33

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (21 + 24 + 45)/3 = 30.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (24 + 45 + 66)/3 = 45.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (45 + 66 + 77)/3 = 62.67

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (66 + 77 + 100)/3 = 81.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (77 + 100)/3 = 59.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = 100/3 = 33.33

output\_array = [8.33, 13.0, 18.33, 15.67, 17.33, 19.0, 21.33, 30.0, 45.0, 62.67, 81.0, 59.0, 33.33]

sum\_output\_array = 423.99

average\_output\_array = 32.61

* 1. Moving Average filter with a size 4 kernel.

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = 25/4 = 6.25

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (25 + 14)/4 = 9.75

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (25 + 14 + 16)/4 = 13.75

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (25 + 14 + 16 + 17)/4 = 18.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (14 + 16 + 17 + 19)/4 = 16.50

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (16 + 17 + 19 + 21)/4 = 18.25

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (17 + 19 + 21 + 24)/4 = 20.25

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (19 + 21 + 24 + 45)/4 = 27.25

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (21 + 24 + 45 + 66)/4 = 39.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (24 + 45 + 66 + 77)/4 = 53.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (45 + 66 + 77 + 100)/4 = 72.00

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (66 + 77 + 100)/4 = 60.75

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = (77 + 100)/4 = 44.25

[25, 14, 16, 17, 19, 21, 24, 45, 66, 77, 100] = 100/4 = 25.00

output\_array = [6.25, 9.75, 13.75, 18.0, 16.5, 18.25, 20.25, 27.25, 39.0, 53.0, 72.0, 60.75, 44.25, 25.0]

sum\_output\_array = 424.0

average\_output\_array = 30.29

1. Given the following table, generate the calibration function using linear regression.

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| **Actual (x)** | **Expected (y)** |
| 12 | 54 |
| 13 | 65 |
| 17 | 74 |
| 21 | 83 |
| 26 | 96 |