Imperial College London

MODULE 3 CLASS

Aidan Hogg & Patrick Naylor - Autumn Term 2020
ELEC50013: Signal and Systems
Department of Electrical and Electronic Engineering

PEER INSTRUCTION

Method:

1: Conceptual question posed - students individually come up initial answer **(5 mins)**

2: Explanation/discussion of correct answer **(5 mins)**

QUESTION 1:

What is the effect on the frequency spectrum if a continuous signal $x(t)$ is sampled?

A: The spectrum becomes periodic

B: The spectrum becomes real

C: The spectrum becomes periodic and real

D: The spectrum becomes periodic and symmetric

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EXPLANATION

One Domain	Other Domain
Discrete	Periodic
Symmetric	Symmetric
Antisymmetric	Antisymmetric
Real	Conjugate Symmetric
Imaginary	Conjugate Antisymmetric
Real & Symmetric	Real & Symmetric
Real & Antisymmetric	Imaginary & Antisymmetric

QUESTION 2:

What is the sampling frequency that would satisfy the Nyquist Sampling Criterion of the signal:

$$x(t) = 5 + \cos(4000\pi t) + \sin(8000\pi t)$$

A: $f_s > 4000$ Hz

B: $f_s > 12000$ Hz

C: $f_s > 8000$ Hz

D: $f_s > 16000$ Hz

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EXPLANATION

Given

$$x(t) = 5 + \cos(4000\pi t) + \sin(8000\pi t)$$

Highest frequency component in 5 is 0Hz

Highest frequency component in $\cos(4000\pi t)$ is $\omega = 4000\pi$

Highest frequency component in $\sin(8000\pi t)$ is $\omega = 8000\pi$

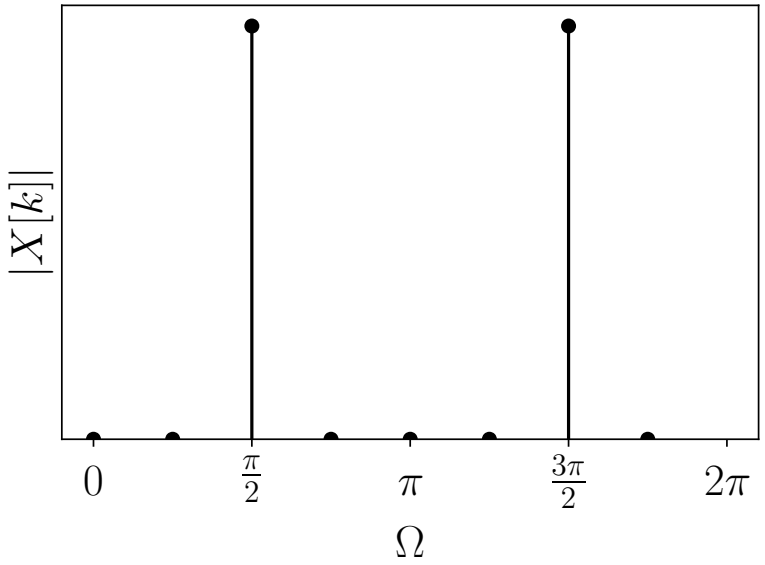
So the maximum frequency component in $x(t)$ is $\omega = 8000\pi$

$$\therefore \quad 2\pi f = 8000\pi \qquad \therefore \quad f = 4000$$

Nyquist Sampling Criterion, $f_s > 2f = 8000$ Hz

QUESTION 3:

A sine wave of frequency f is sampled 8 times at a sampling frequency of f_s.



If the plot shows the magnitude response of the 8 samples what were the values of f and f_s?

A: $f = 2000\text{Hz} \quad f_s = 16000\text{Hz}$

B: $f = 1000\text{Hz} \quad f_s = 6000\text{Hz}$

C: $f = 15000\text{Hz} \quad f_s = 12000\text{Hz}$

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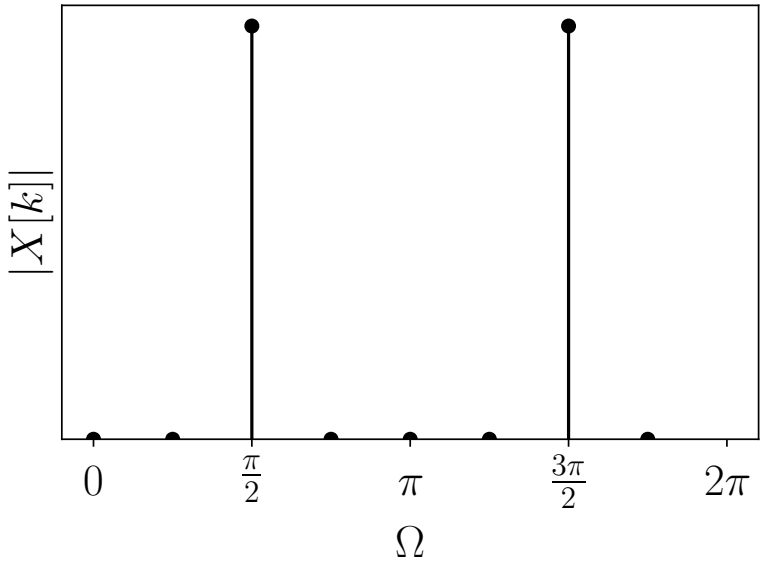

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EXPLANATION

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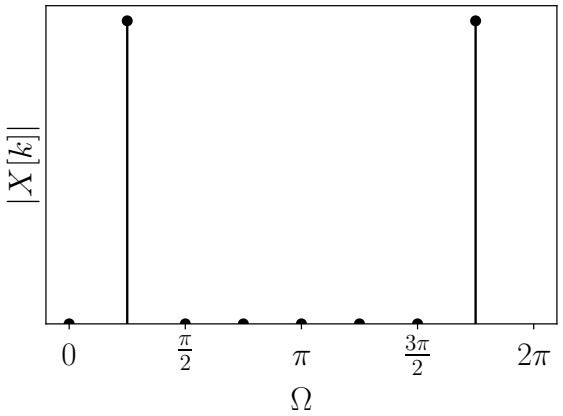
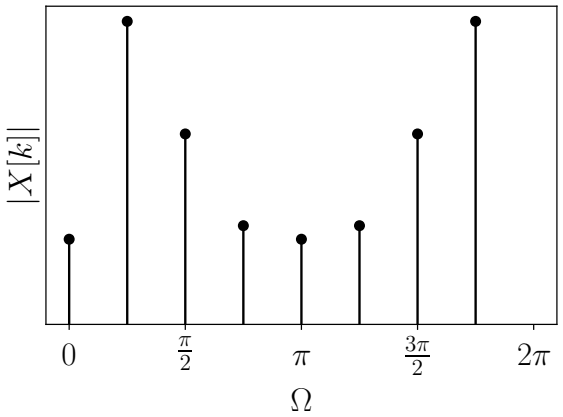
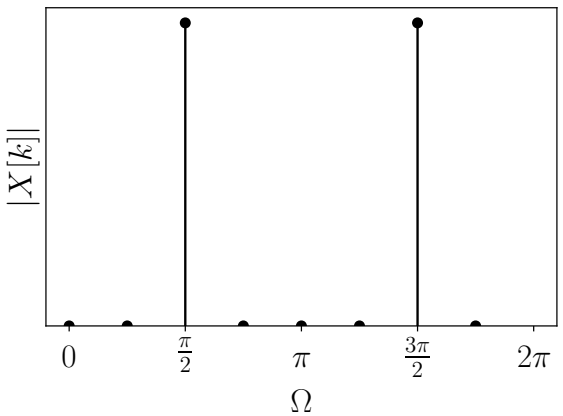


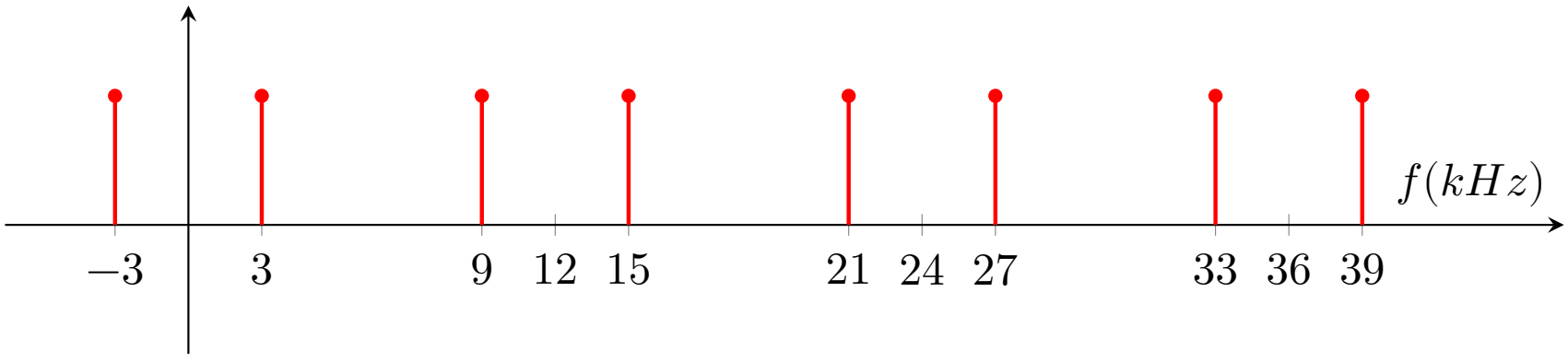
B: $f = 1000\text{Hz} \quad f_s = 6000\text{Hz}$



C: $f = 15000\text{Hz} \quad f_s = 12000\text{Hz}$



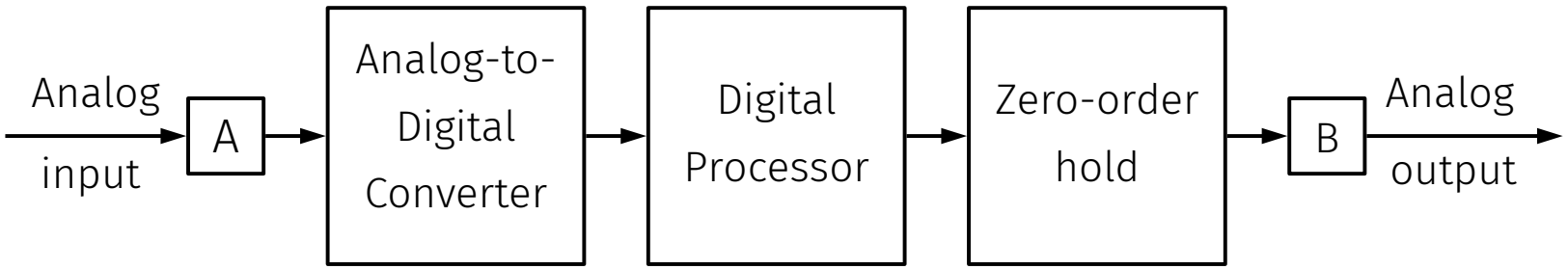
EXPLANATION



Effect of aliasing in the frequency domain

QUESTION 4:

It is now common practice to process analog signals digitally:



What is the purpose of B?

A: A low pass filter to remove spectral images

B: A low pass filter to prevent aliasing

C: A high pass filter to remove spectral images

D: A high pass filter to prevent aliasing

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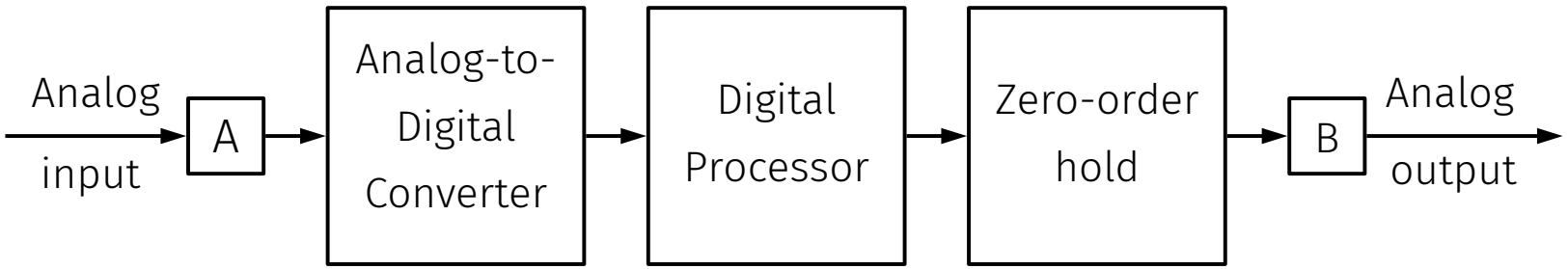

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QUESTION 5:

Which of these statements are true? (multiple options allowed)

Oversampling is used because...

A: ...it relaxes the requirements of the anti-aliasing filter

B: ...it relaxes the requirements of the anti-imaging filter

C: ...it reduces the computational complexity and the cost

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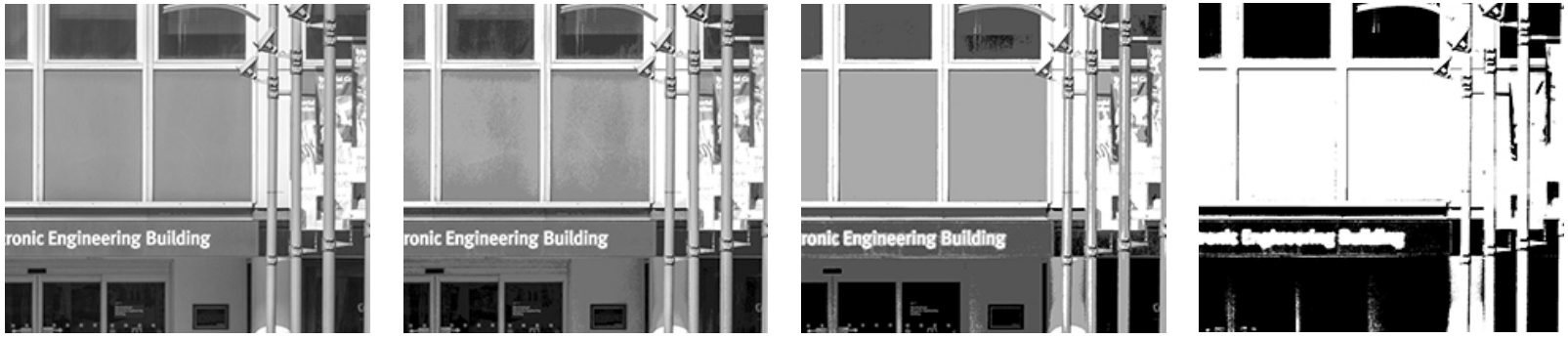
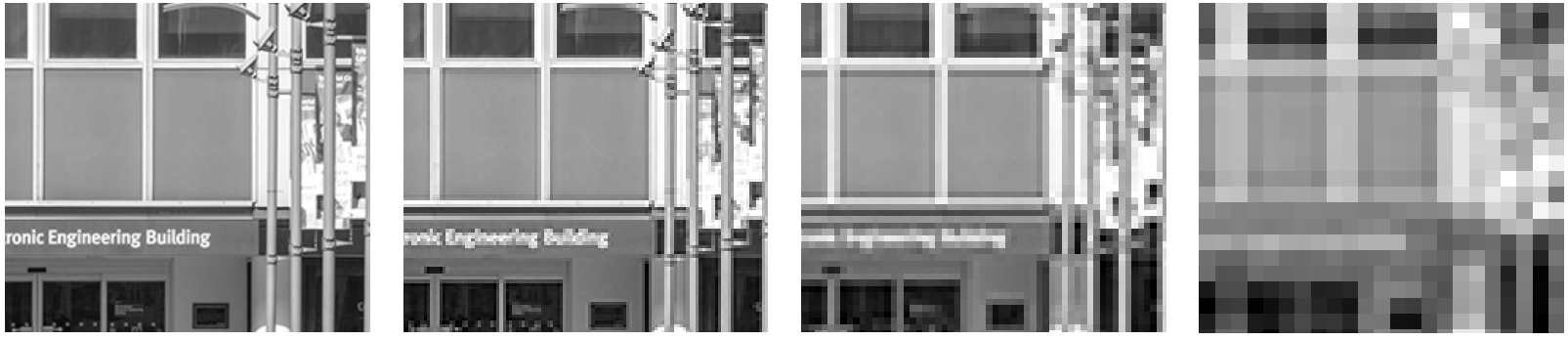
QUESTION 6:

Which row shows the process of quantization?

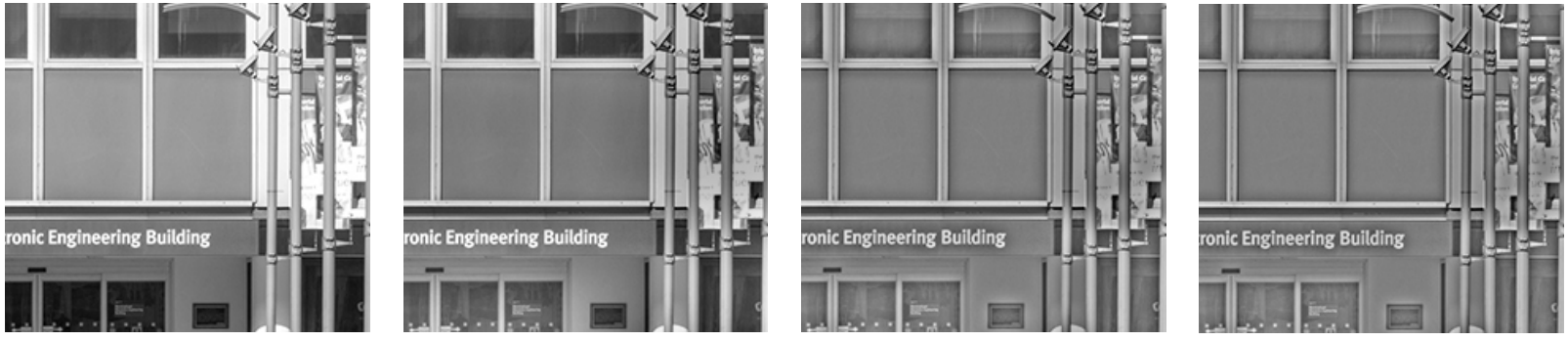
A:



B:

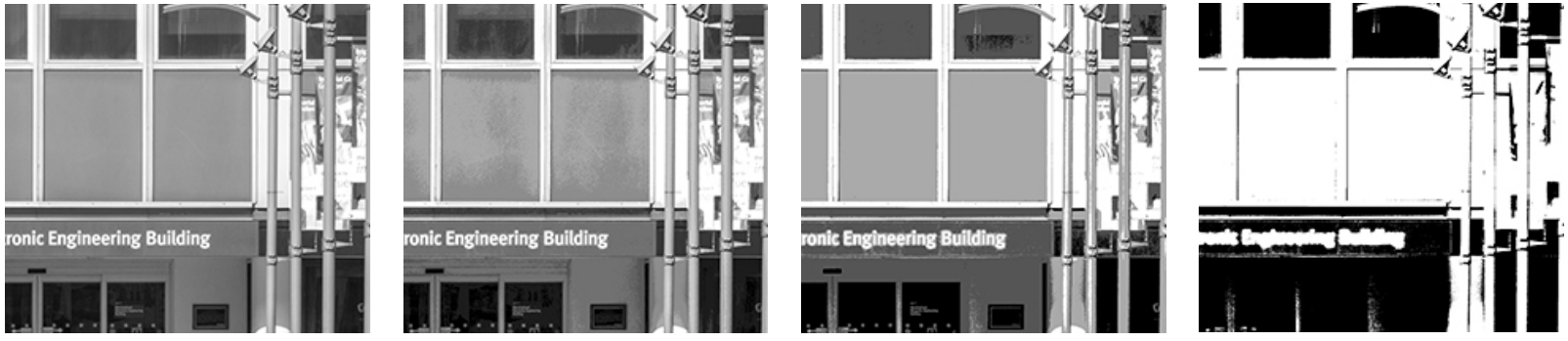


C:

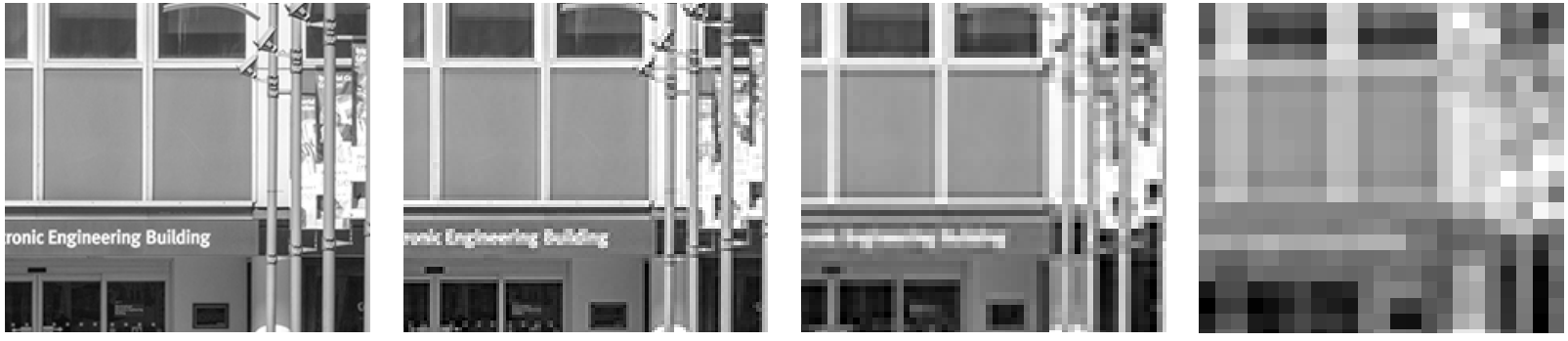


Which row shows the process of quantization?

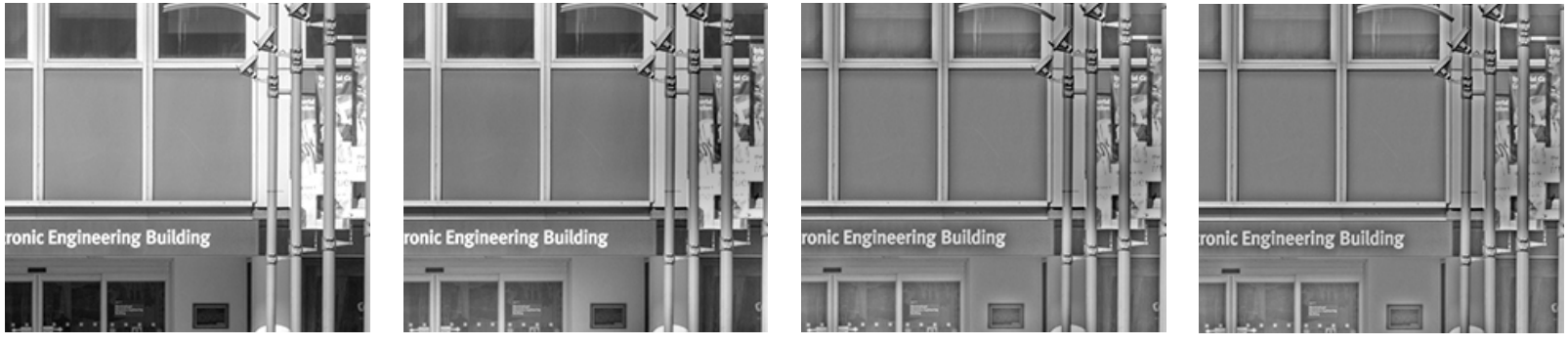
A:



B:



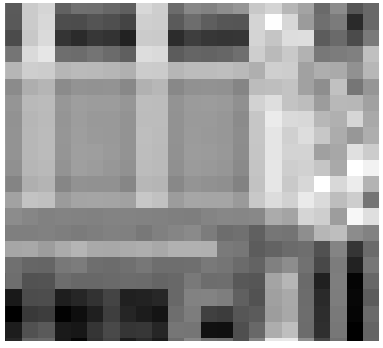
C:



EXPLANATION

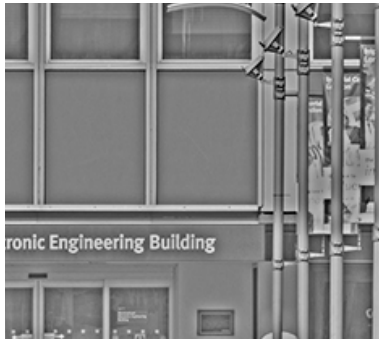

Quantization

(only 1 bits to represent all the colours)

Undersampling

(fewer pixels available to represent the image)

High-pass Filtering

(detects edges in the image)