

Trabalho 1: DFT, filtragem, segmentação e operações morfológicas

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1 - DFT e IDFT

```
void exercio01() {  
    std::vector<double> input = { 1, 2, 0, 1 };  
    std::vector<double> reconstructed;  
    std::vector<std::array<double, 2>> output;  
  
    showRealVector(input);  
    std::cout << "-----" << std::endl;  
  
    dft(input, output);  
    showComplexVector(output);  
  
    std::cout << "-----" << std::endl;  
    idft(output, reconstructed);  
    showRealVector(reconstructed);  
}
```

1 - DFT e IDFT

X0: 1
X1: 2
X2: 0
X3: 1

Original

X0: 1 0
X1: 0.25 0.25
X2: -0.5 1.53081e-16
X3: 0.25 -0.25

DFT

X0: 1
X1: 2
X2: -1.16743e-16
X3: 1

IDFT

1 - DFT e IDFT

X0: 1

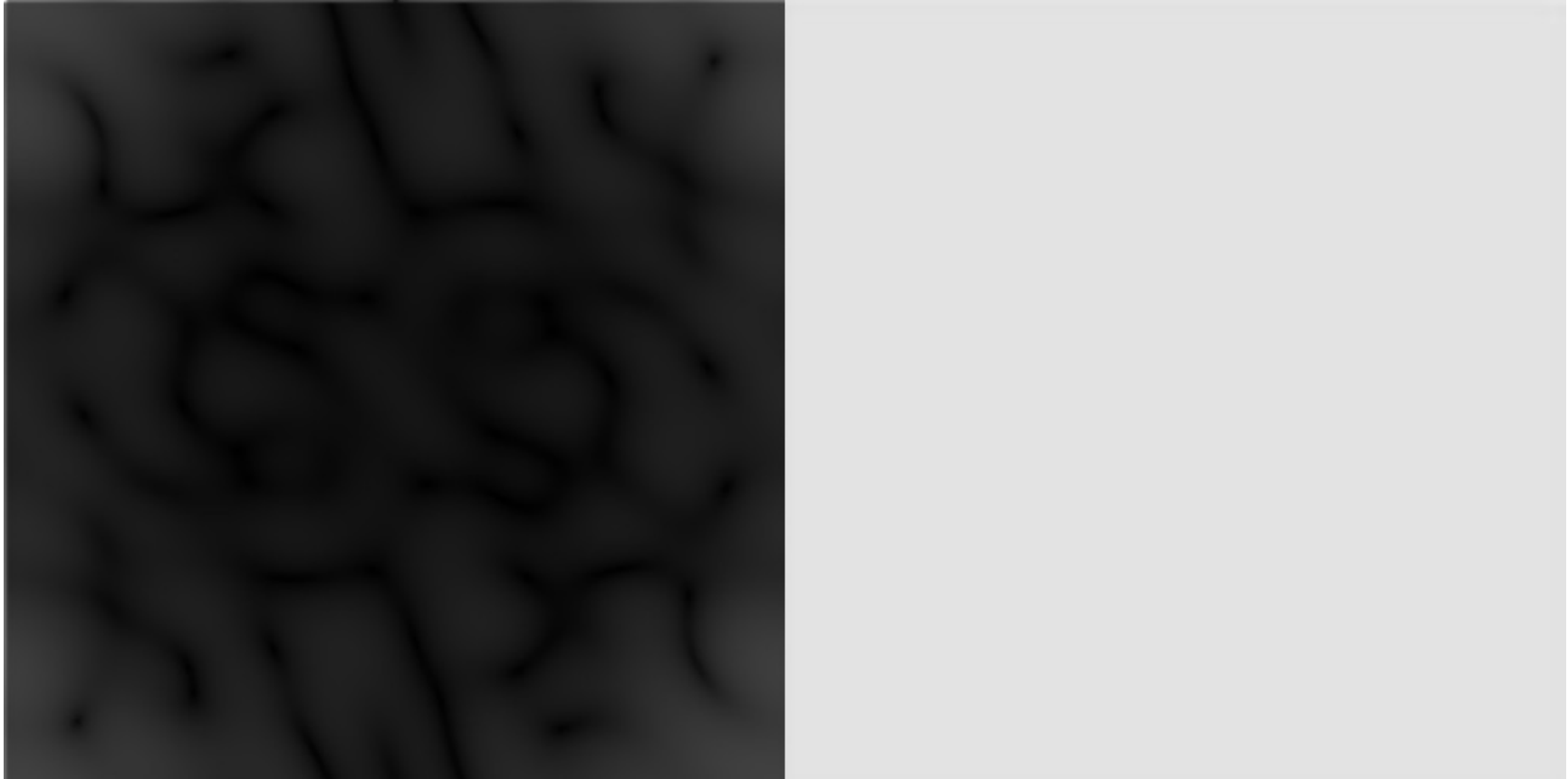
X1: 0.353553

X2: 0.5

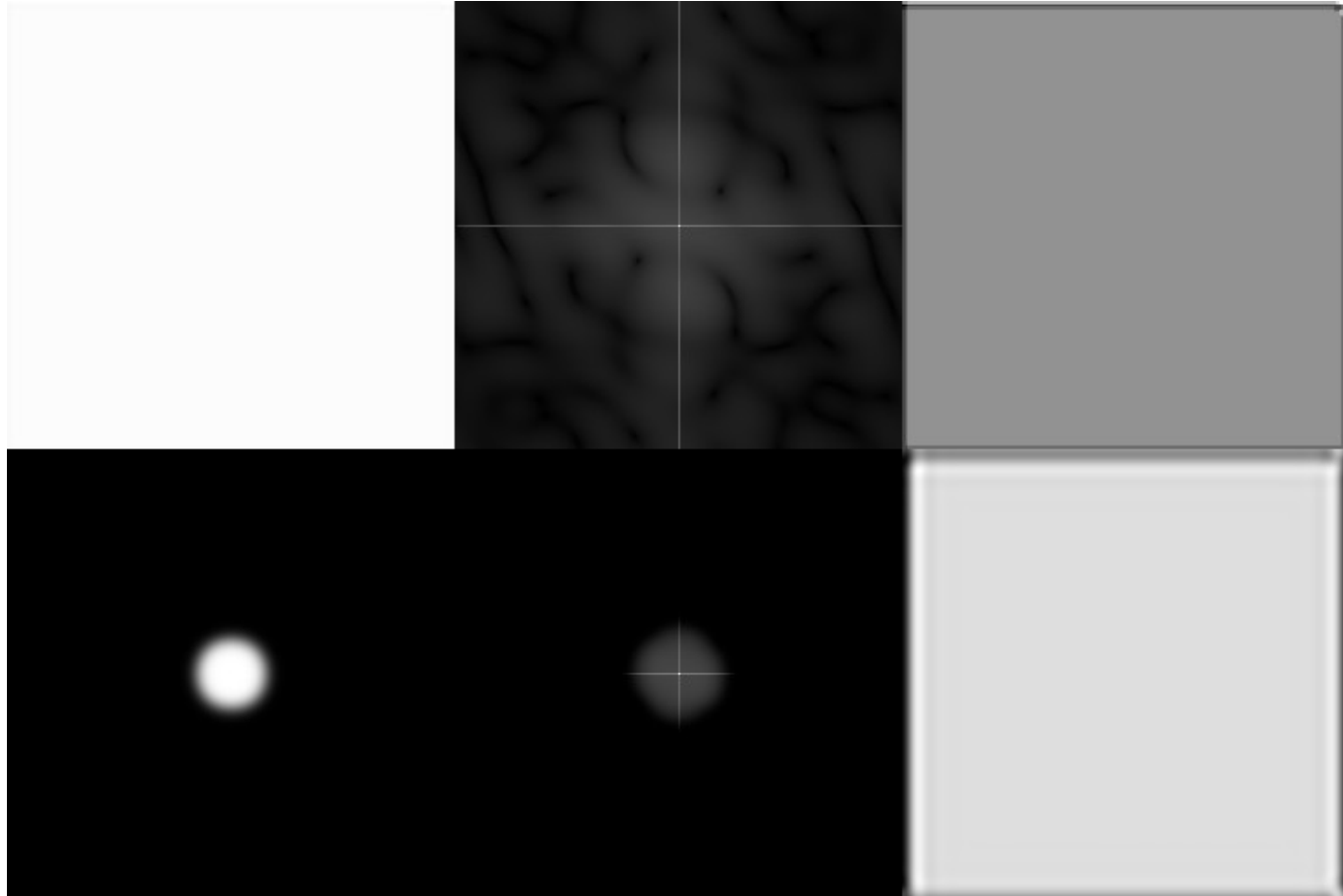
X3: 0.353553

← Magnitude

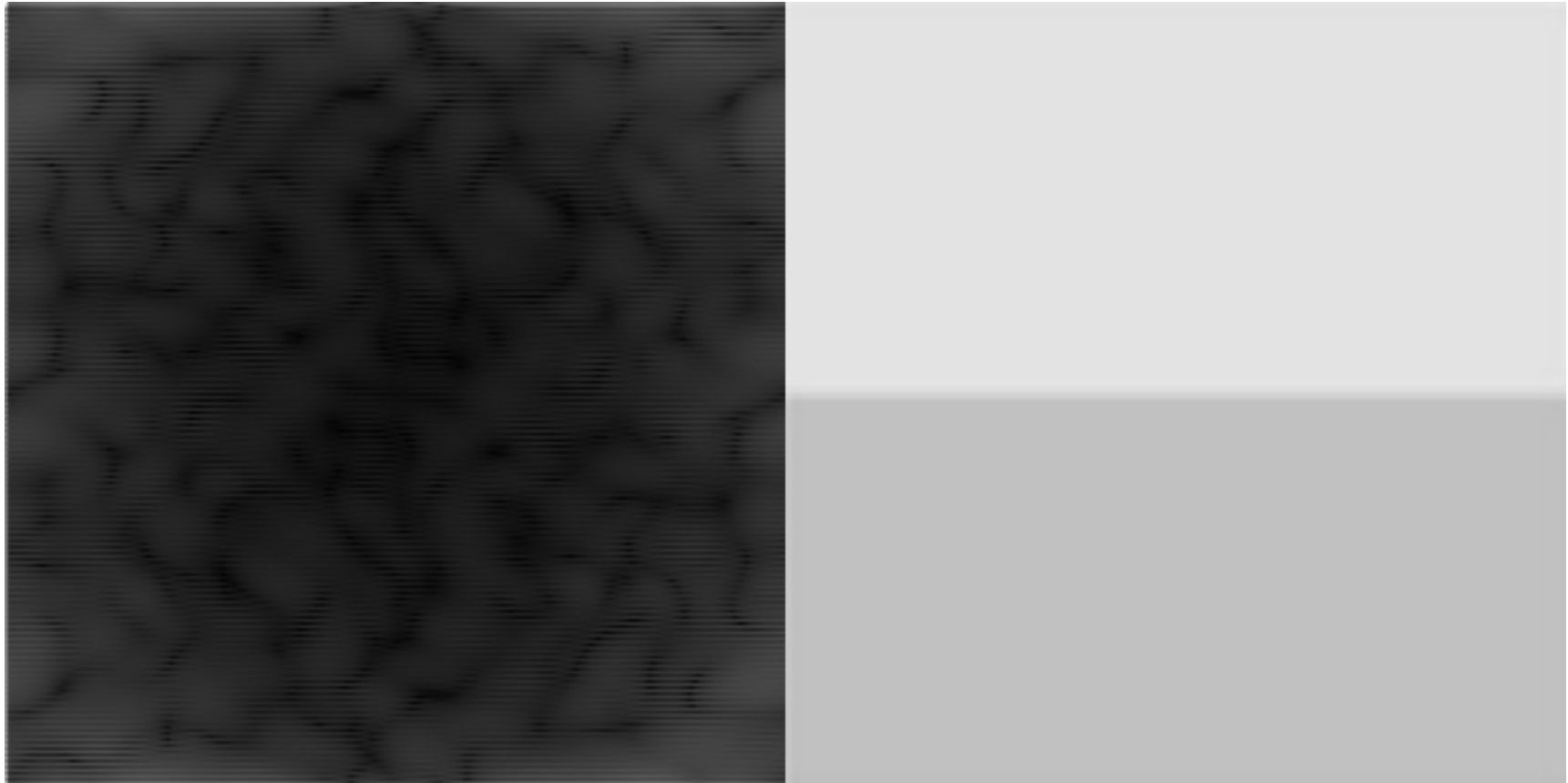
2 – DFT, Máscara e IDFT – Img1



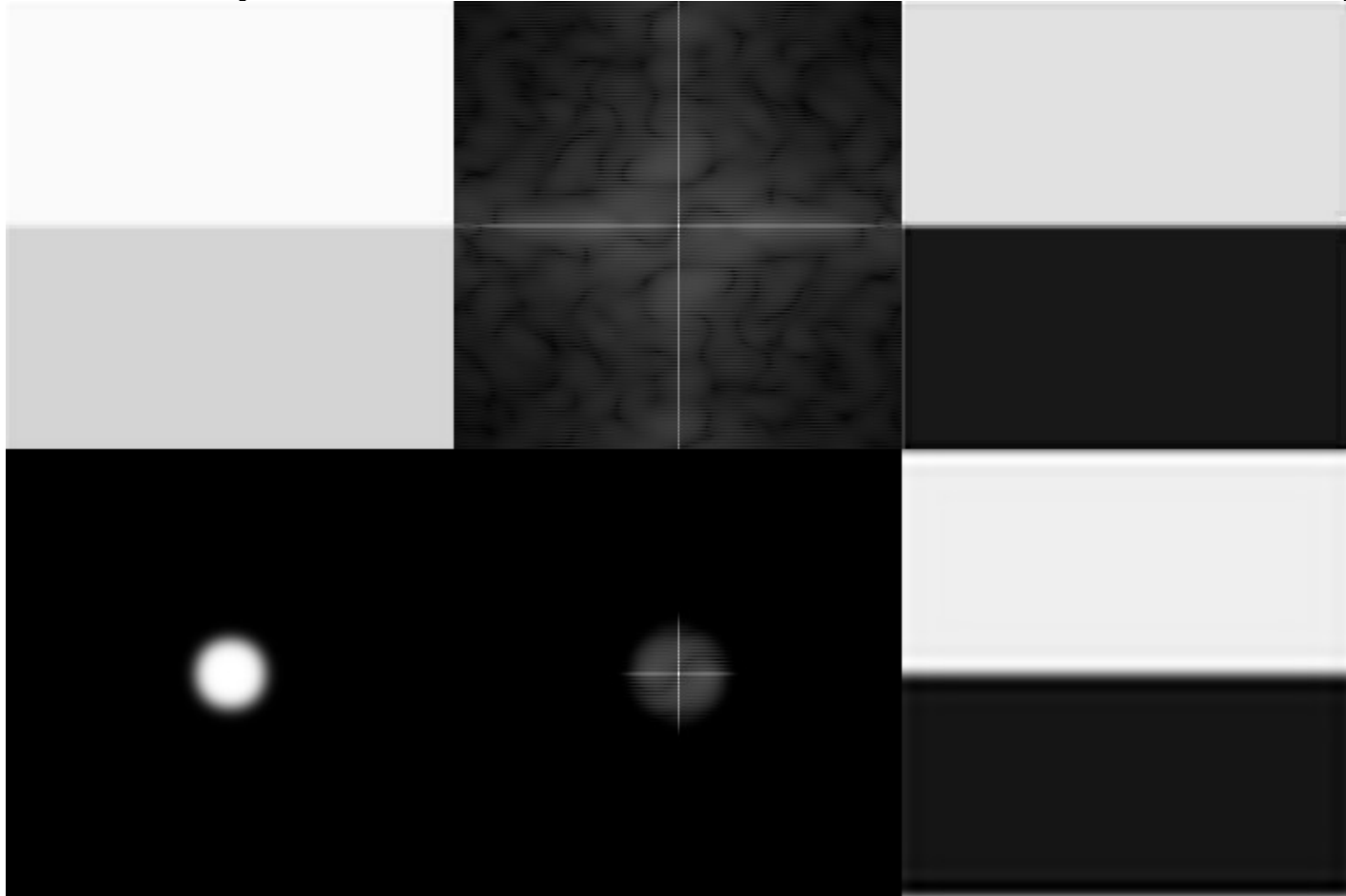
2 – DFT, Máscara e IDFT – Img1



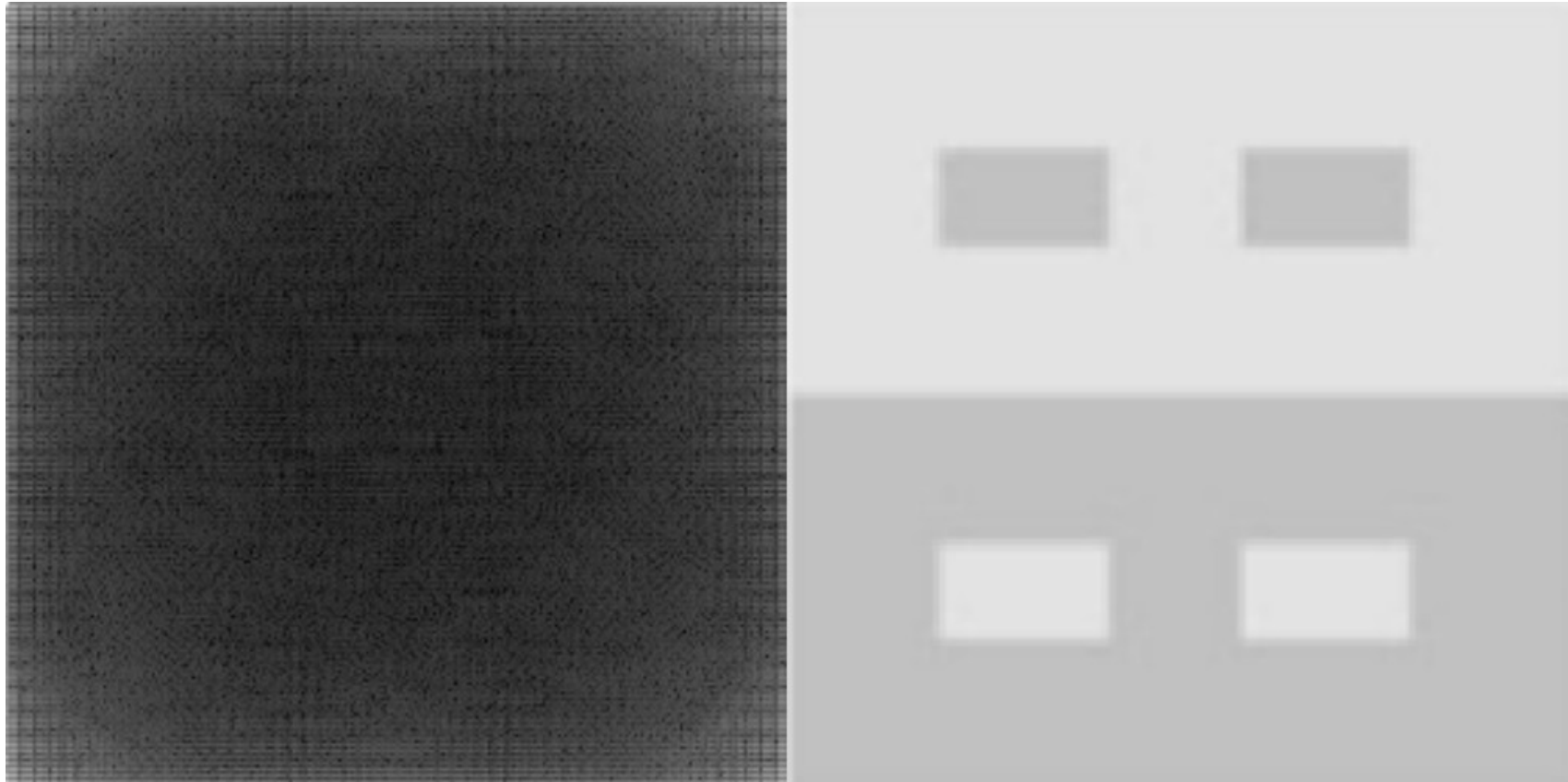
2 – DFT, Máscara e IDFT – Img2



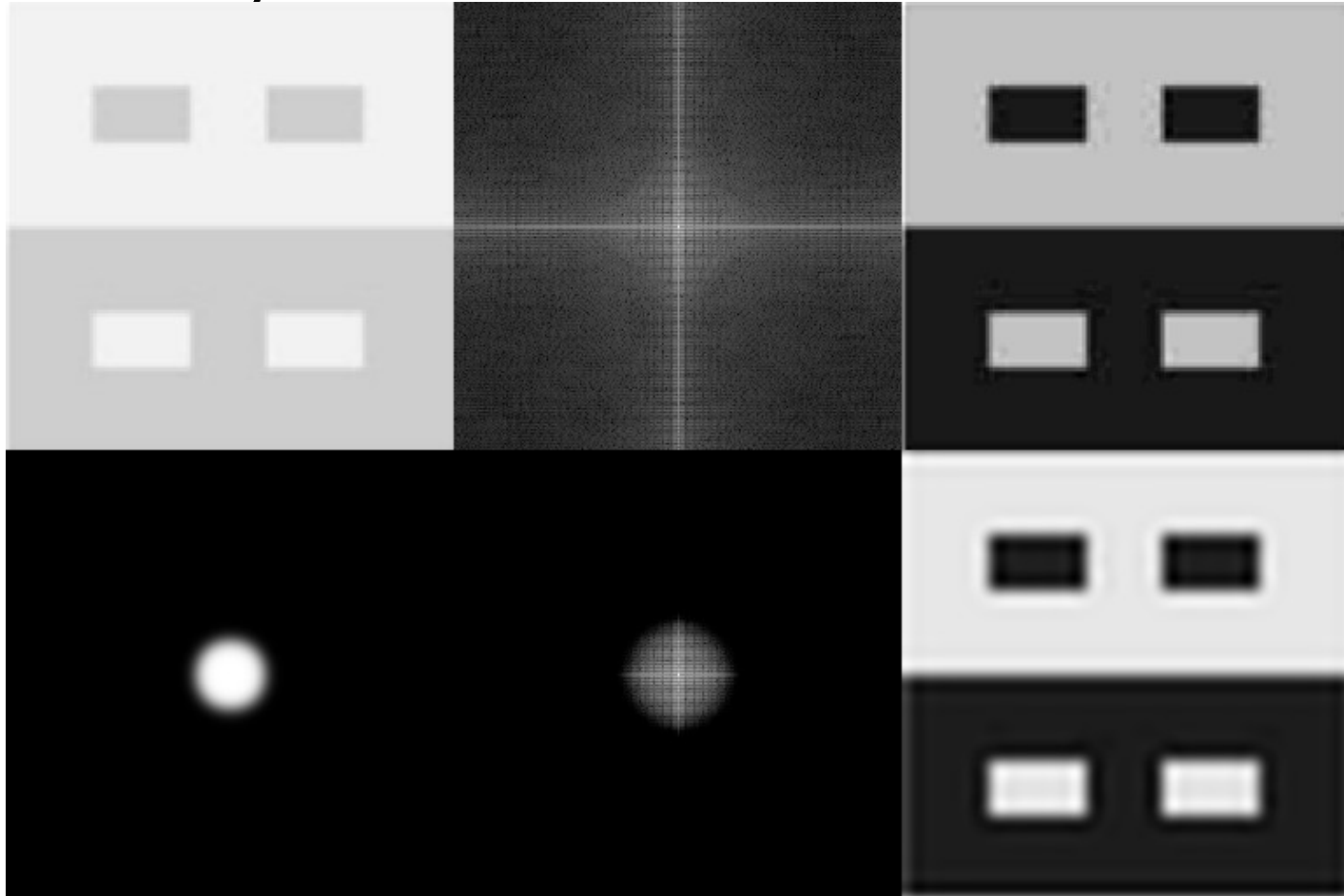
2 – DFT, Máscara e IDFT – Img2



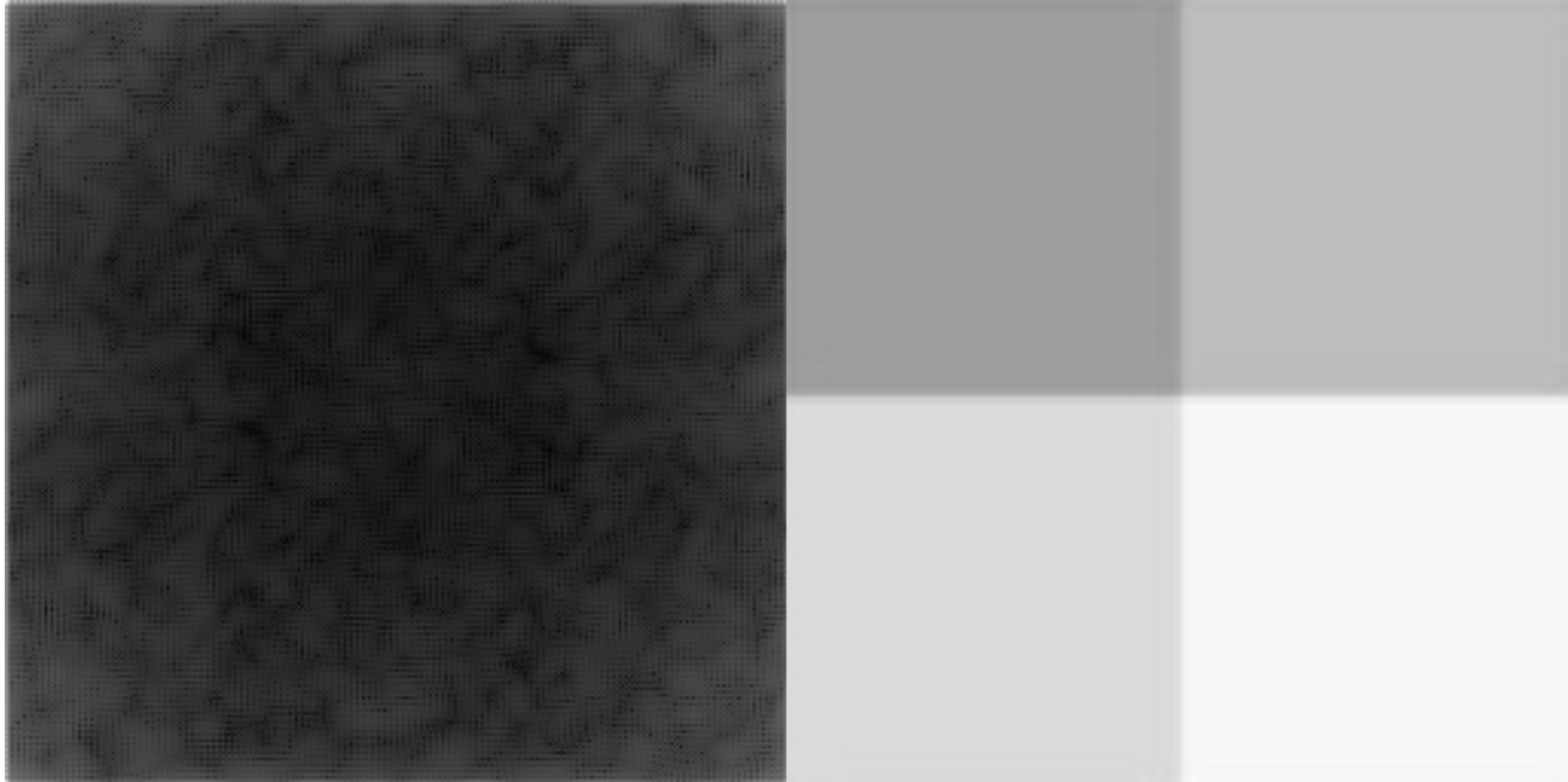
2 – DFT, Máscara e IDFT – Img3



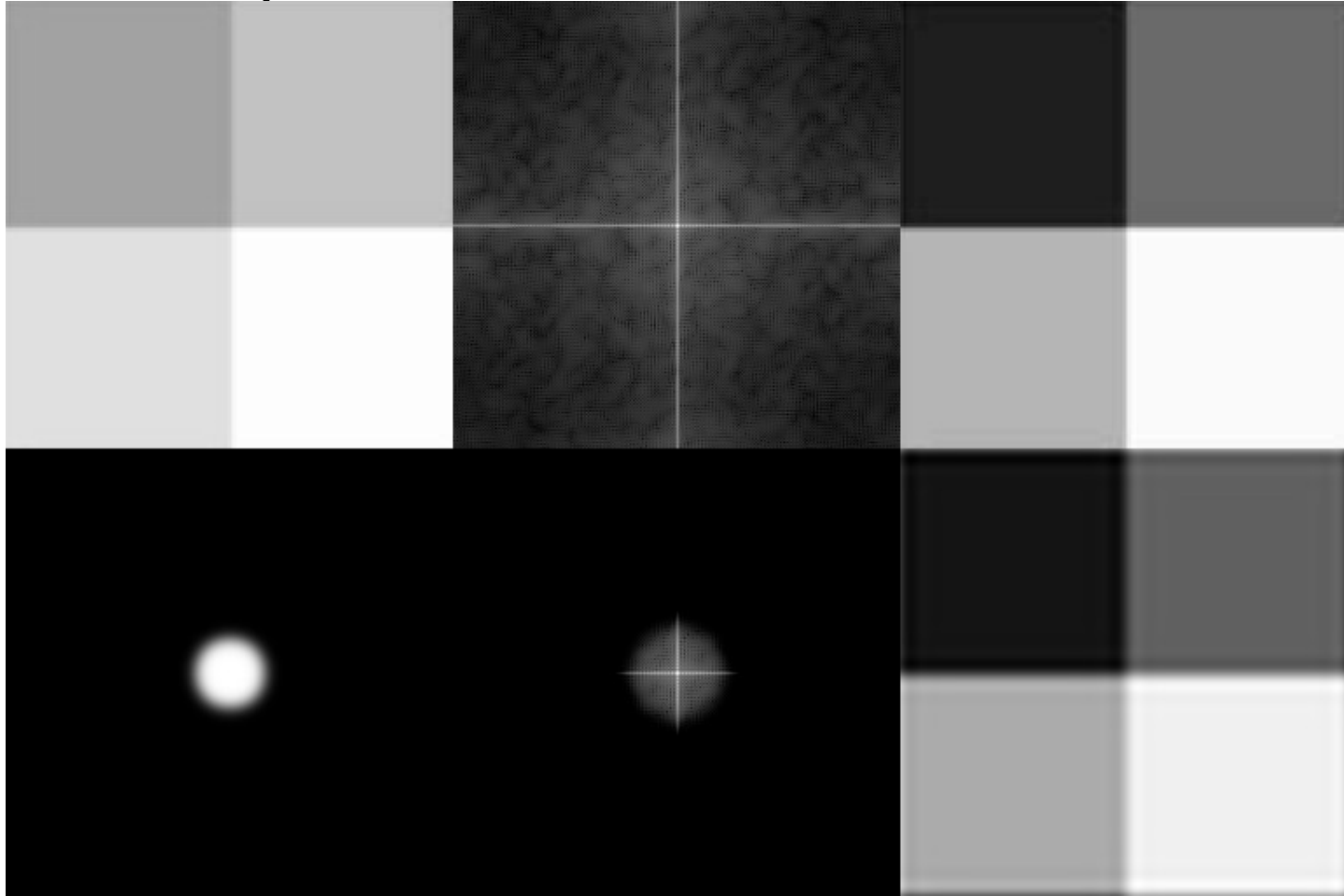
2 – DFT, Máscara e IDFT – Img3



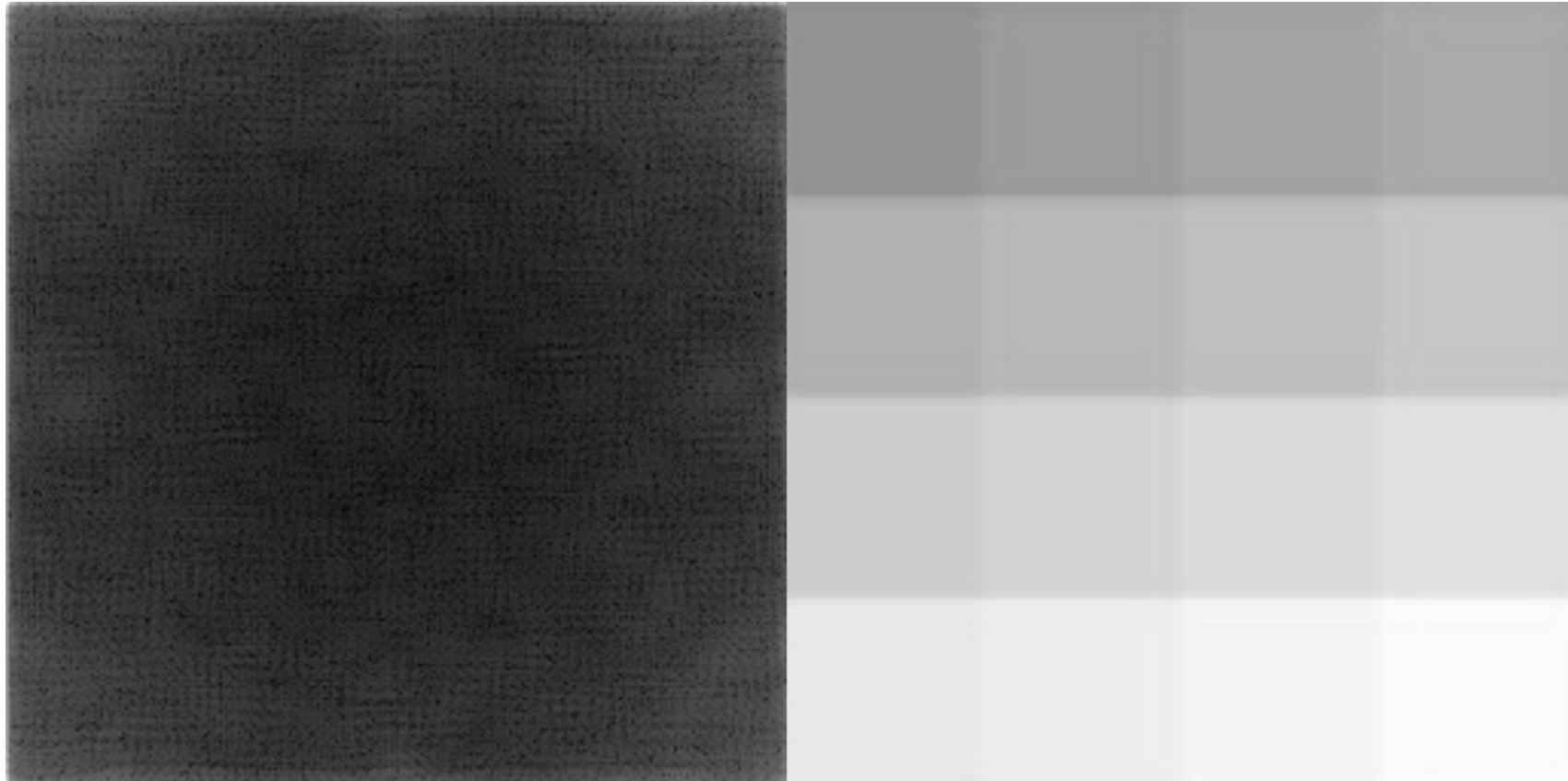
2 – DFT, Máscara e IDFT – Img4



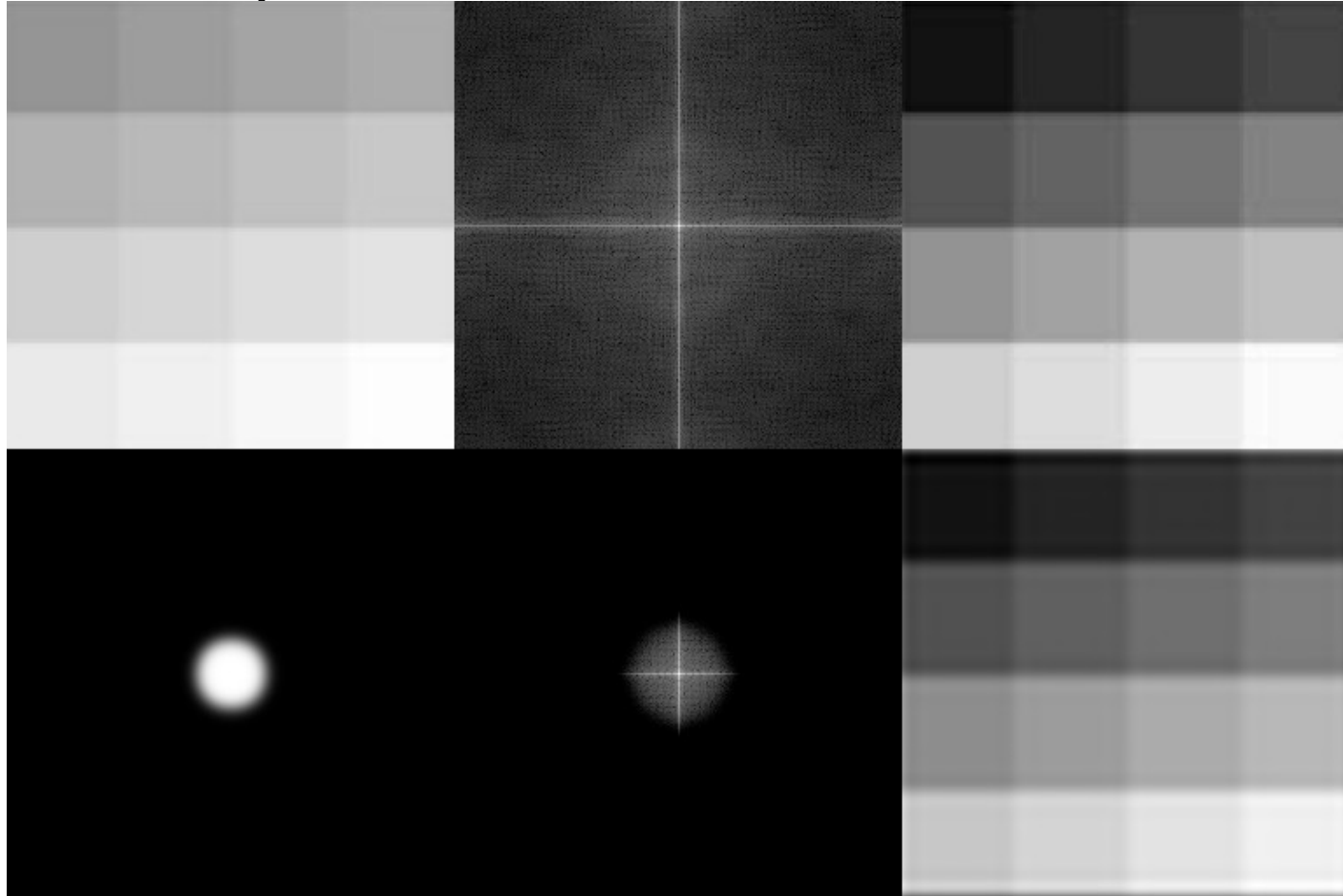
2 – DFT, Máscara e IDFT – Img4



2 – DFT, Máscara e IDFT – Img5



2 – DFT, Máscara e IDFT – Img5



Etapas do Exercício 3

Imagem Original

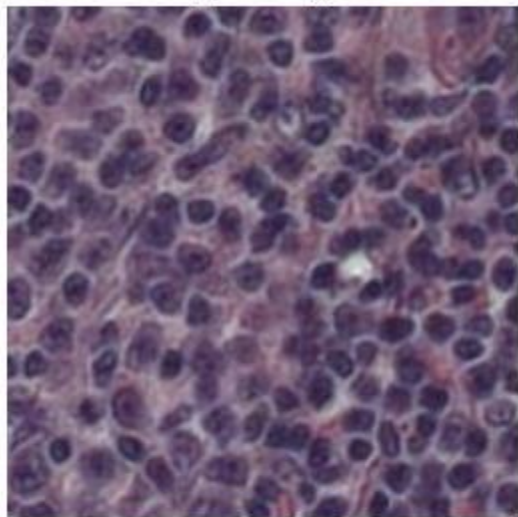


Imagem em Níveis de Cinza

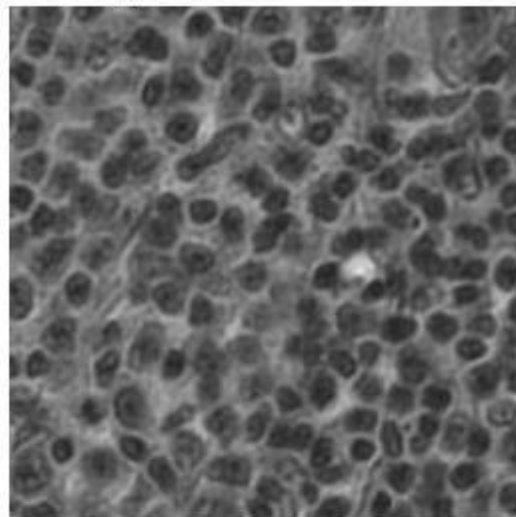


Imagem no Domínio de Fourier Centralizada

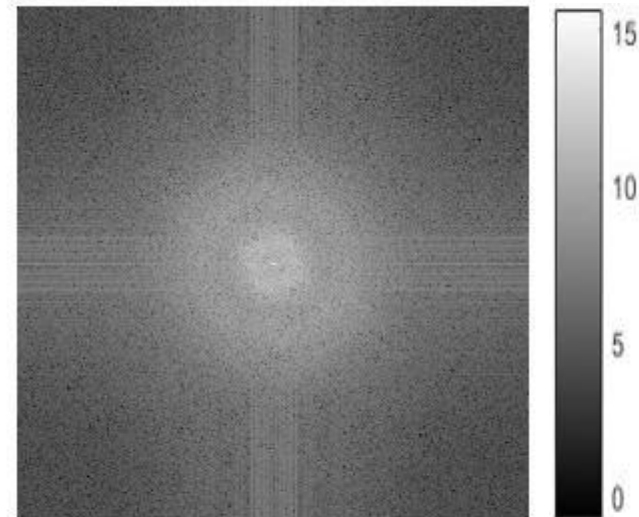
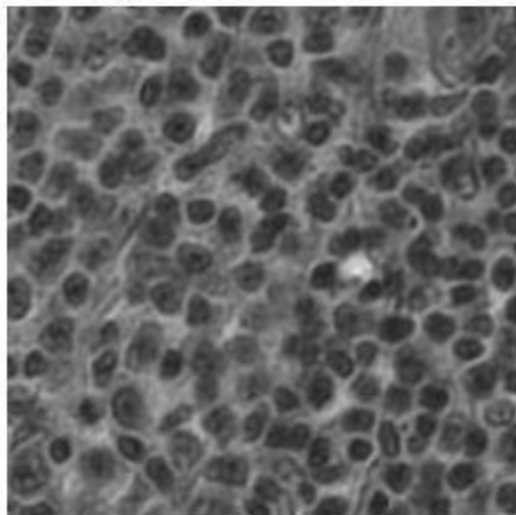
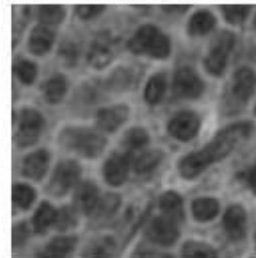


Imagem dividida em 4 blocos

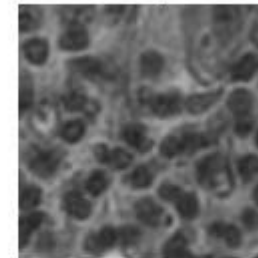
Imagem em Níveis de Cinza



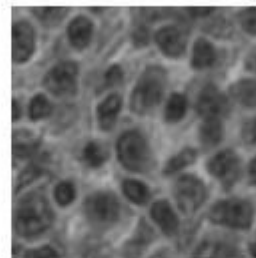
Quadrante Superior Esquerdo



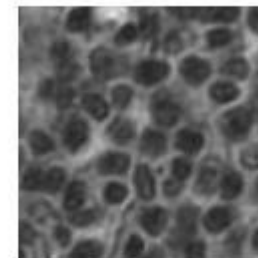
Quadrante Superior Direito



Quadrante Inferior Esquerdo



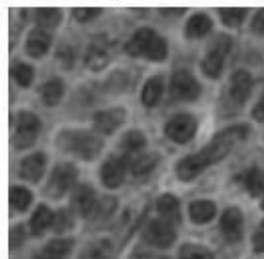
Quadrante Inferior Direito



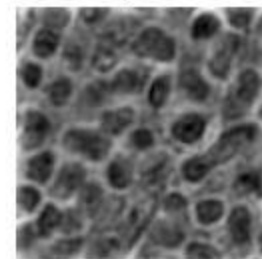
Filtro Passa-Alta



Quadrante Superior Esquerdo



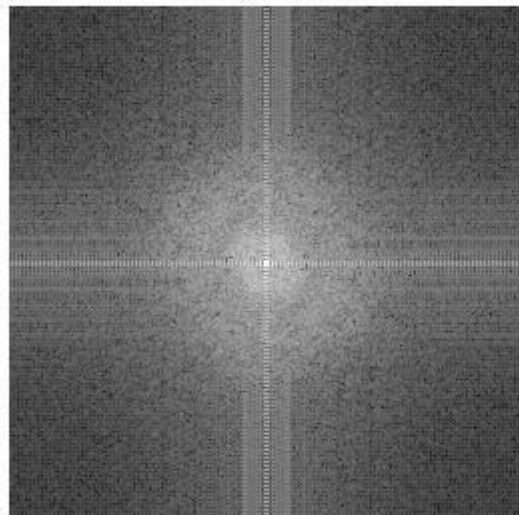
Quadrante Superior Esquerdo



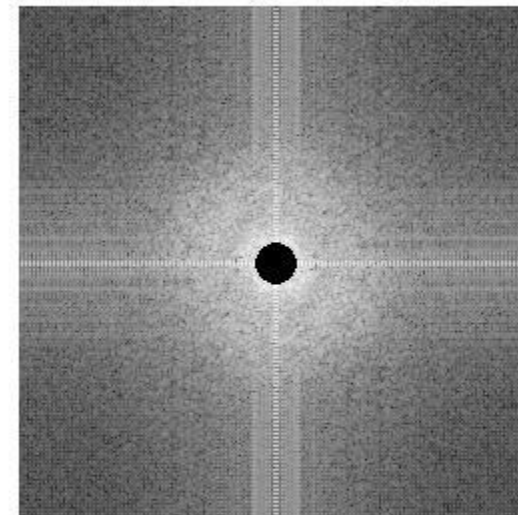
Filtro Passa-Alta



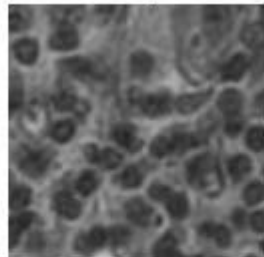
Quadrante Superior Esquerdo



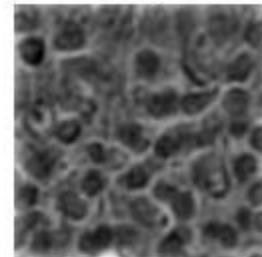
Quadrante Superior Esquerdo



Quadrante Superior Direito



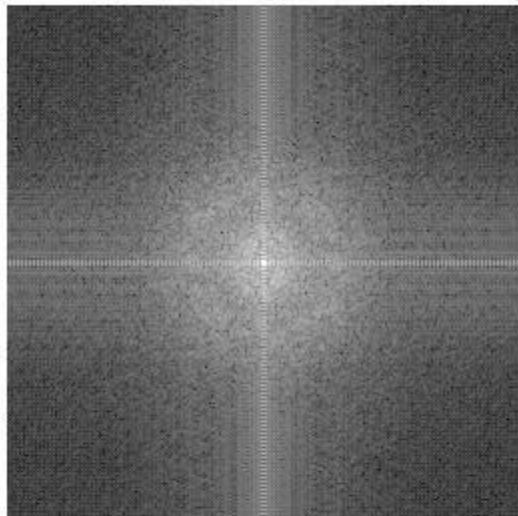
Quadrante Superior Direito



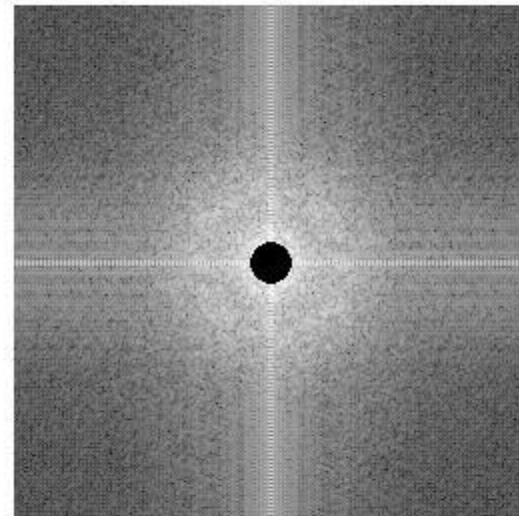
Filtro Passa-Alta



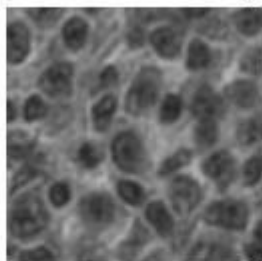
Quadrante Superior Direito



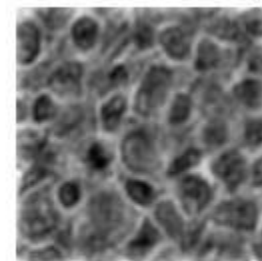
Quadrante Superior Direito



Quadrante Inferior Esquerdo



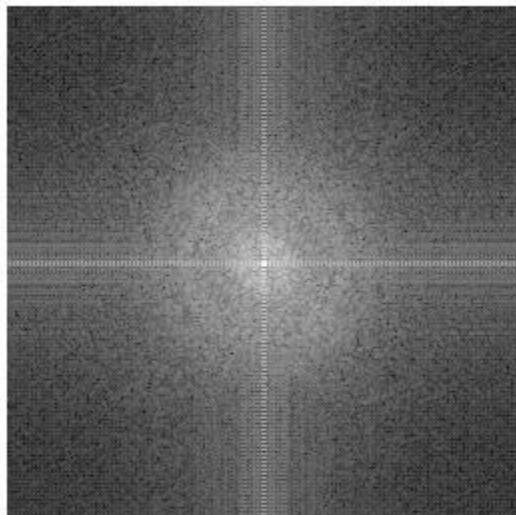
Quadrante Inferior Esquerdo



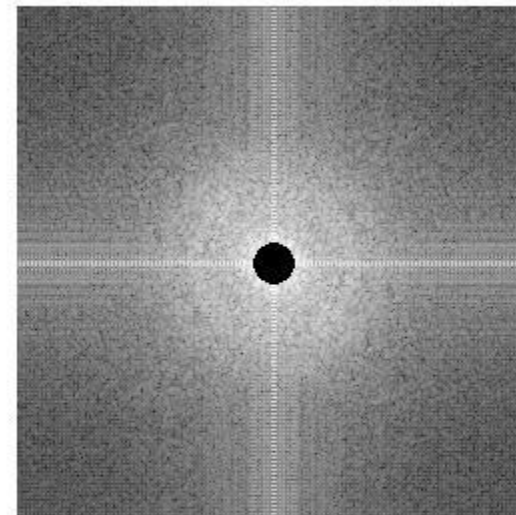
Filtro Passa-Alta



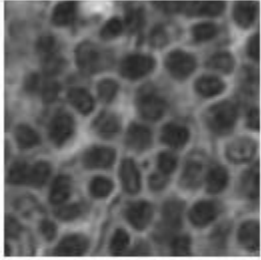
Quadrante Inferior Esquerdo



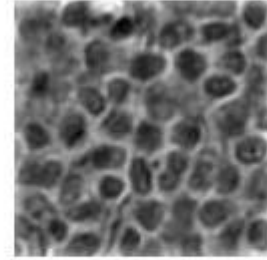
Quadrante Inferior Esquerdo



Quadrante Inferior Direito



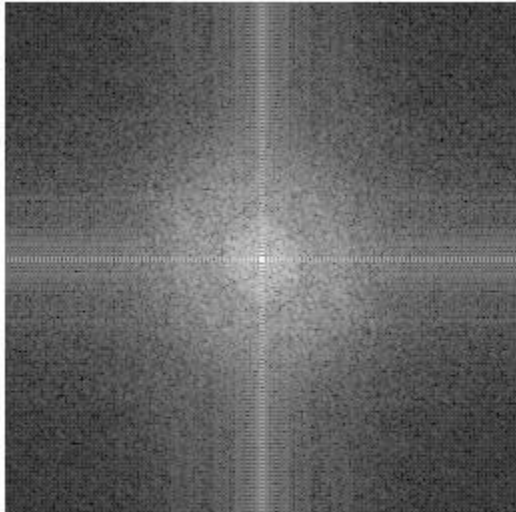
Quadrante Inferior Direito



Filtro Passa-Alta



Quadrante Inferior Direito



Quadrante Inferior Direito

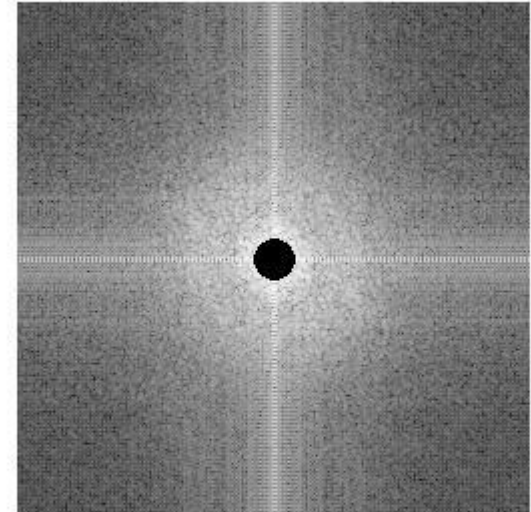


Imagem em Níveis de Cinza

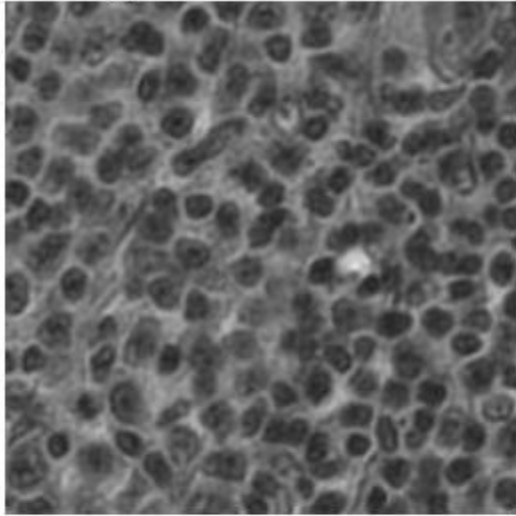
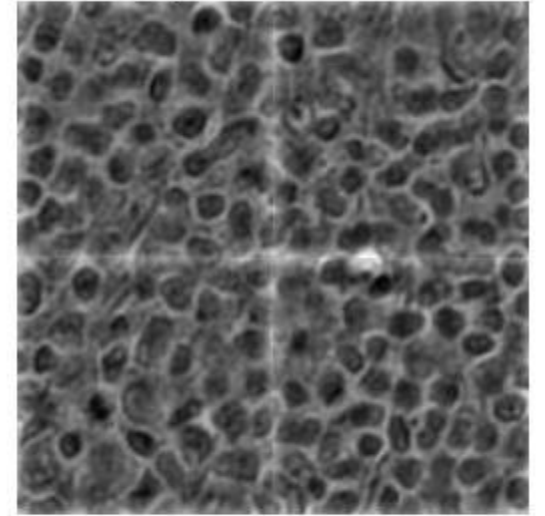


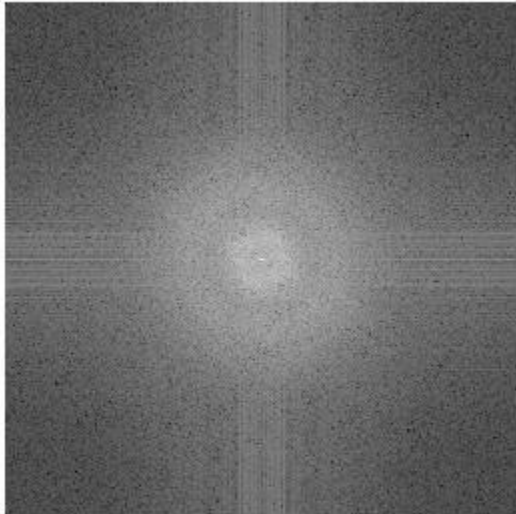
Imagem Reconstruída



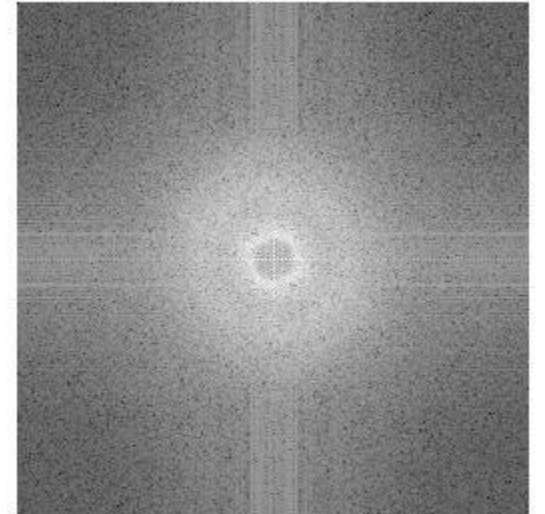
Filtro Passa-Alta



Imagem no Domínio de Fourier Centralizada



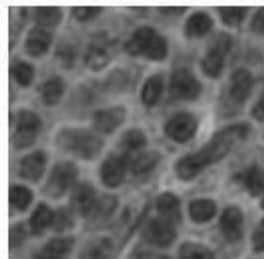
Espectro da Imagem Reconstruída



Filtro Passa-Baixa



Quadrante Superior Esquerdo

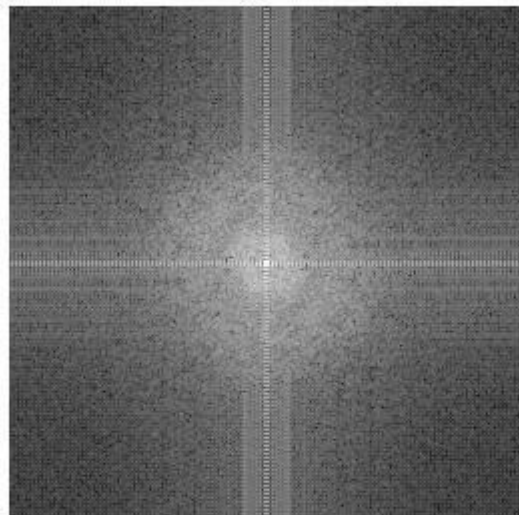


Quadrante Superior Esquerdo

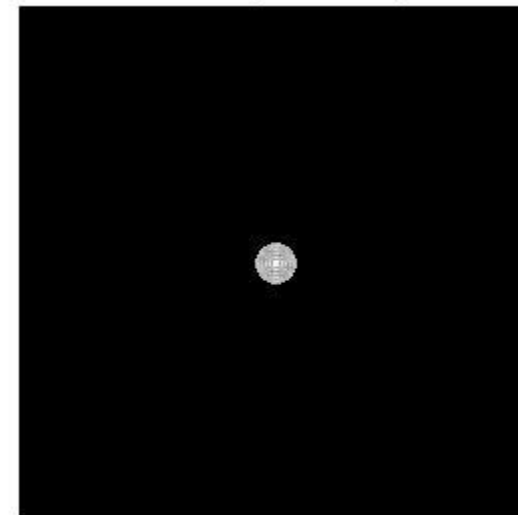


Filtro Passa-Baixa

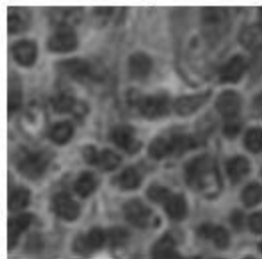
Quadrante Superior Esquerdo



Quadrante Superior Esquerdo



Quadrante Superior Direito

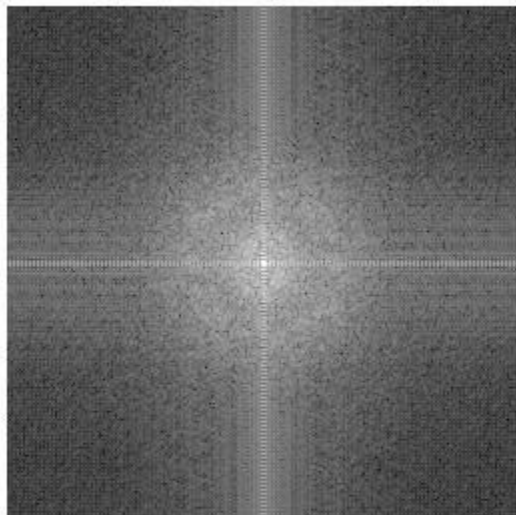


Quadrante Superior Direito

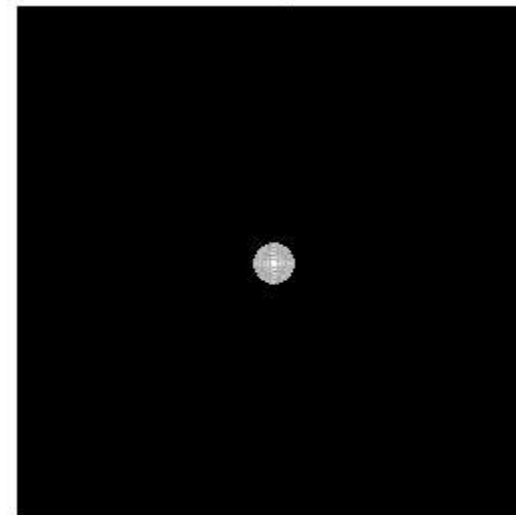


Filtro Passa-Baixa →

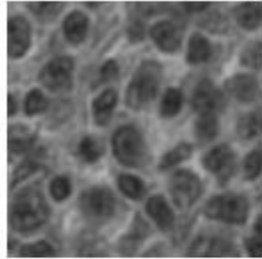
Quadrante Superior Direito



Quadrante Superior Direito



Quadrante Inferior Esquerdo

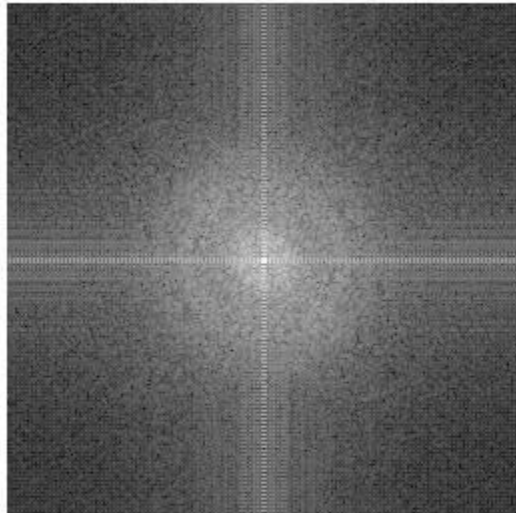


Quadrante Inferior Esquerdo

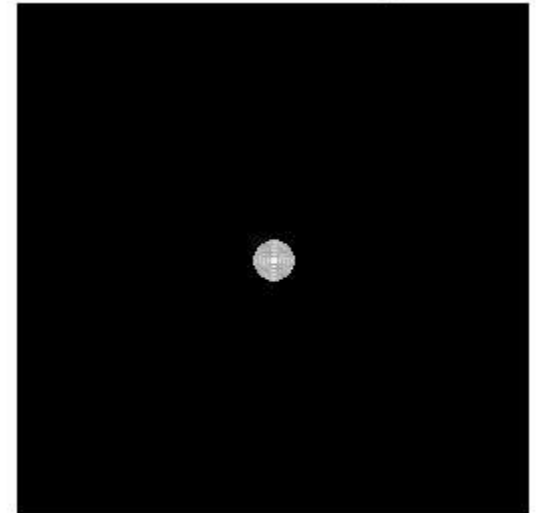


Filtro Passa-Baixa

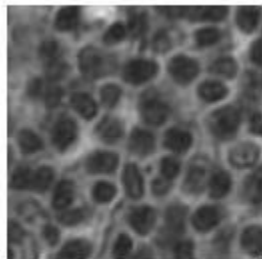
Quadrante Inferior Esquerdo



Quadrante Inferior Esquerdo



Quadrante Inferior Direito



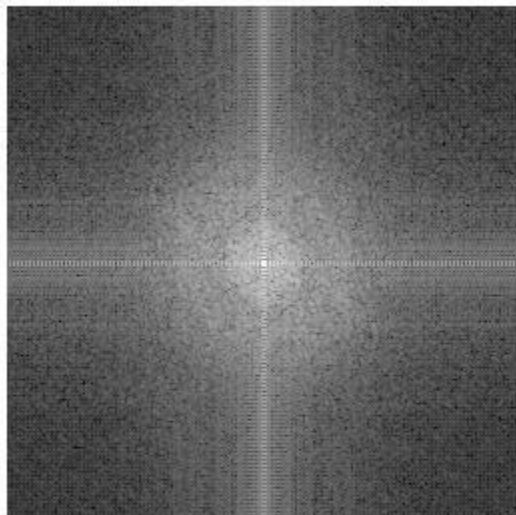
Quadrante Inferior Direito



Filtro Passa-Baixa



Quadrante Inferior Direito



Quadrante Inferior Direito

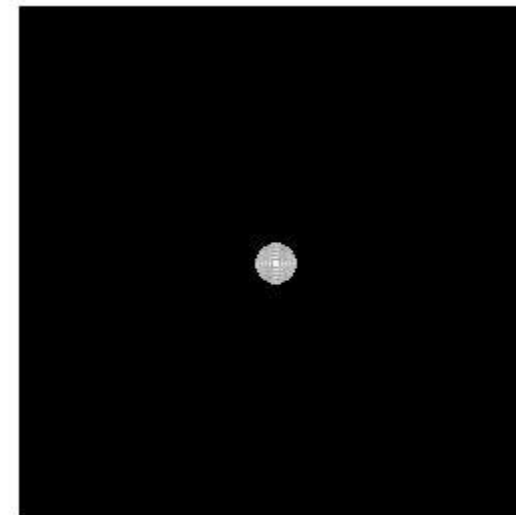


Imagem em Níveis de Cinza

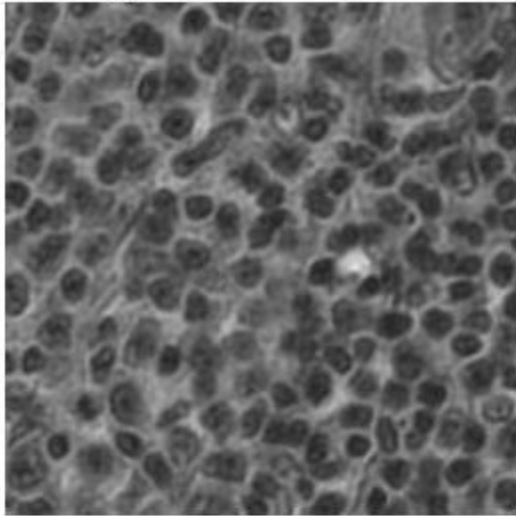
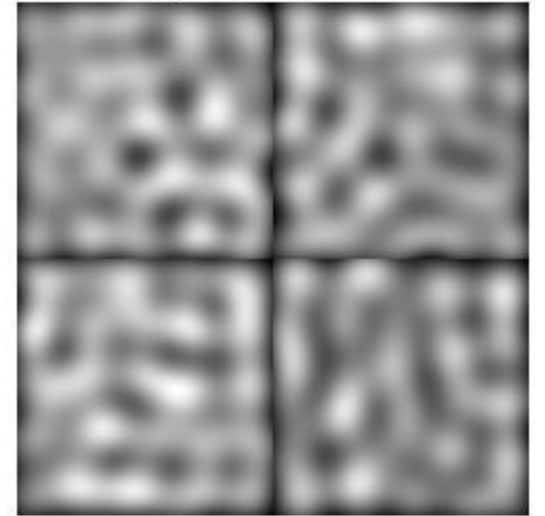


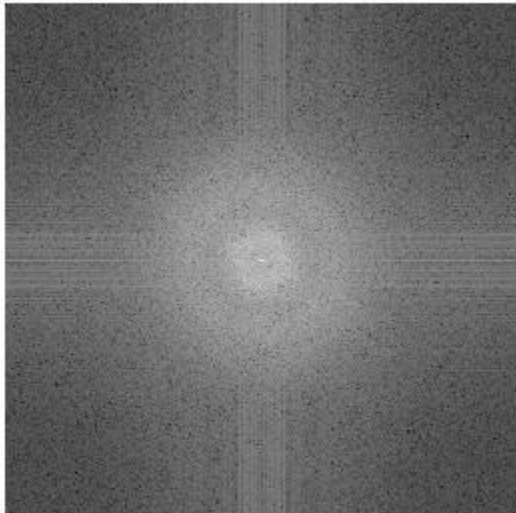
Imagem Reconstruída



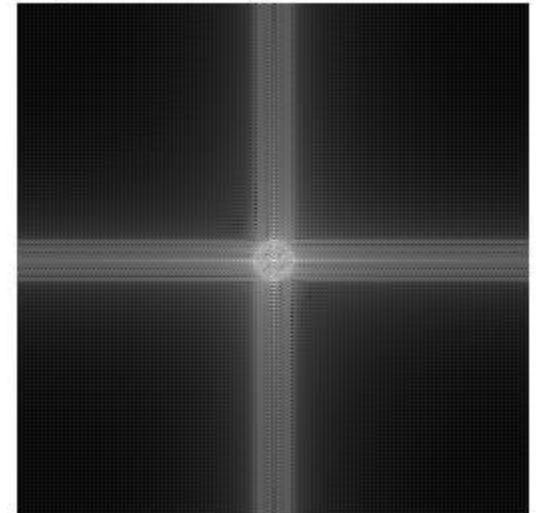
Filtro Passa-Baixa



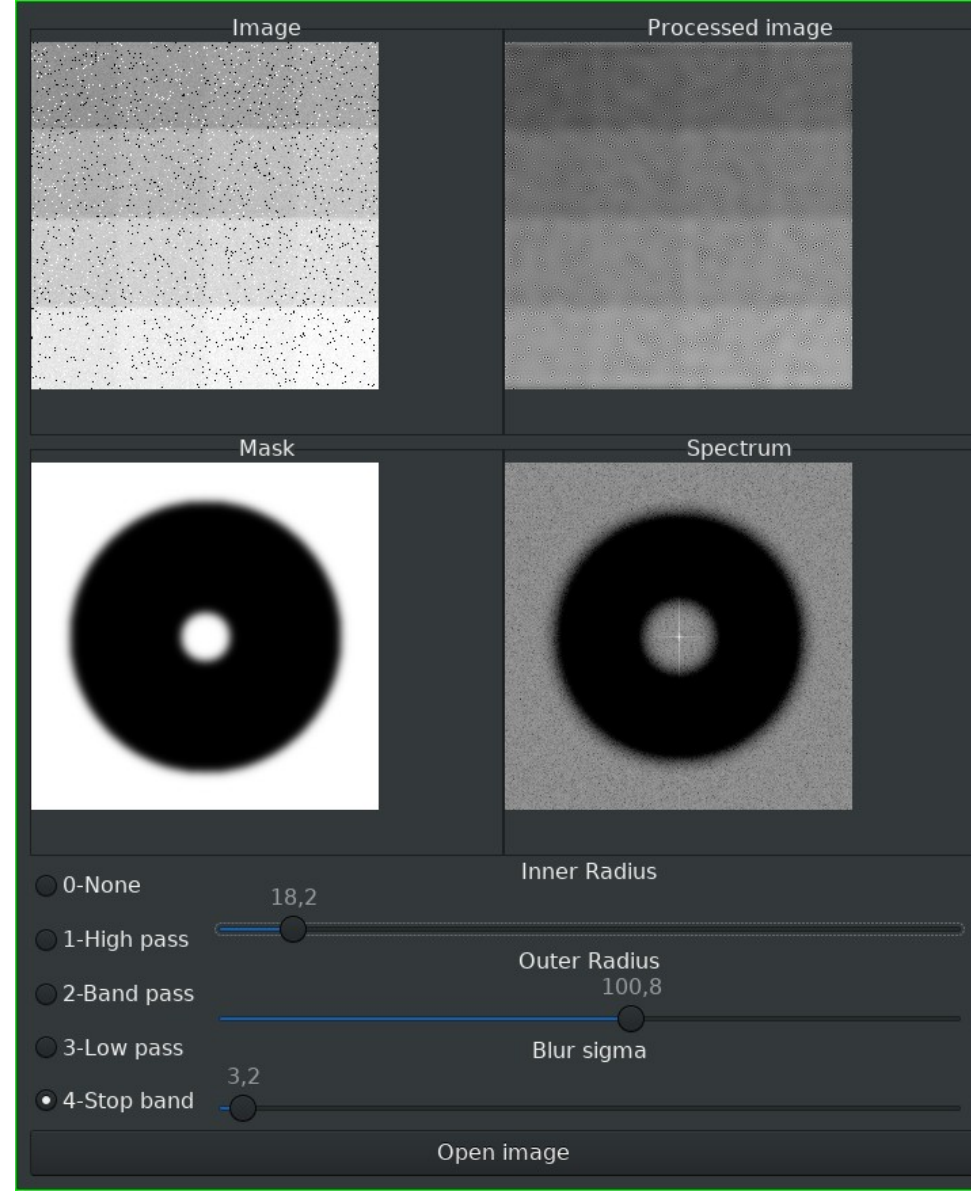
Imagem no Domínio de Fourier Centralizada



Espectro da Imagem Reconstruída



4-Remover ruídos:
A prática pode ser
visualizada a partir
da implementação
ilustrada ao lado.



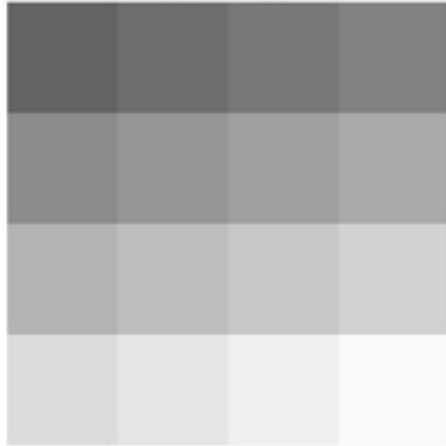
Exercício de Segmentação

Segmentação com o Método de Otsu



Segmentação: Método de Otsu

Imagem Original

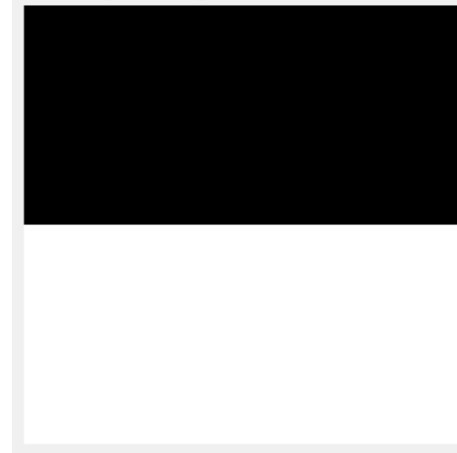


$T = 174$

$T = 127$



Imagem Segmentada por Otsu



Gradiente da Imagem Segmentada por Otsu

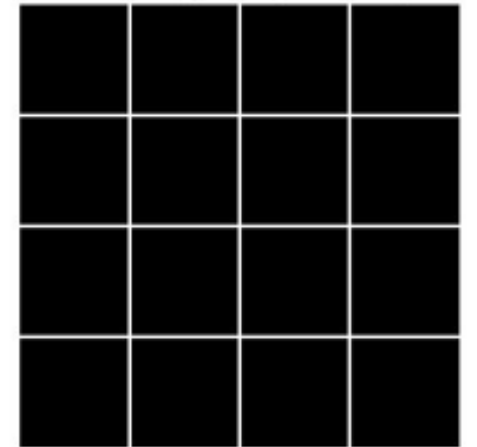
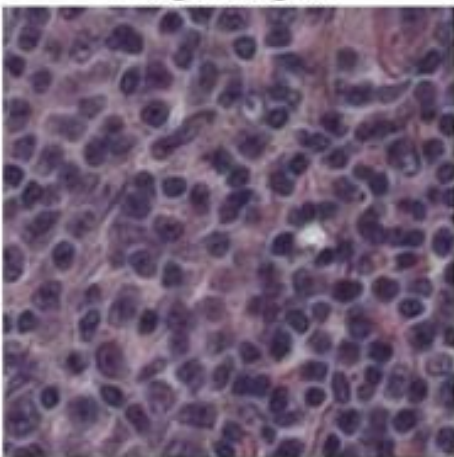


Imagem Original



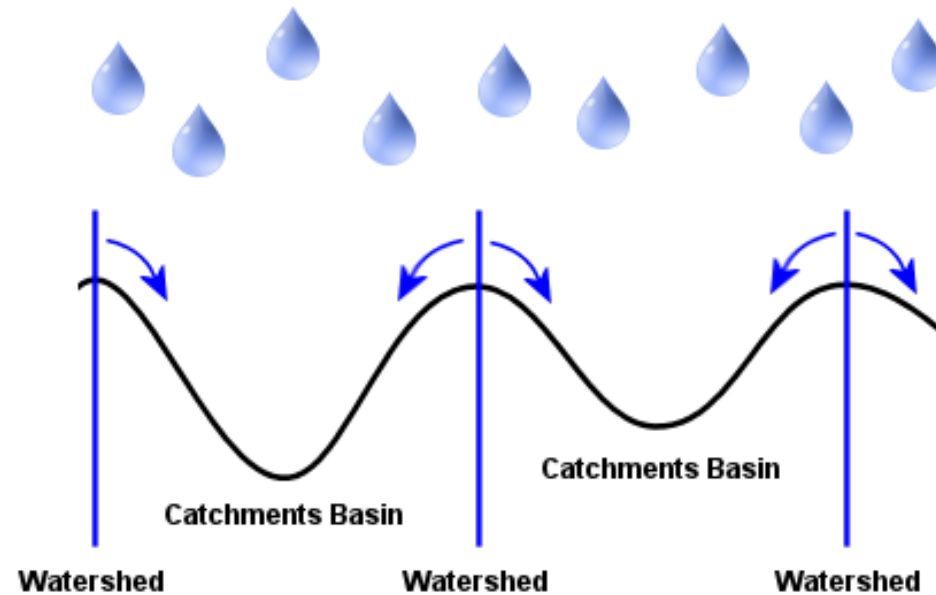
$T = 97$



Imagem Segmentada por Otsu



Segmentação com Watershed



Segmentação: Watershed usando Gradiente

Imagem Original

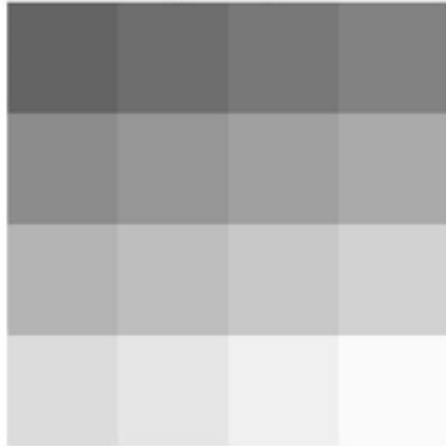


Imagem Segmentada por Watershed sem Marcadores

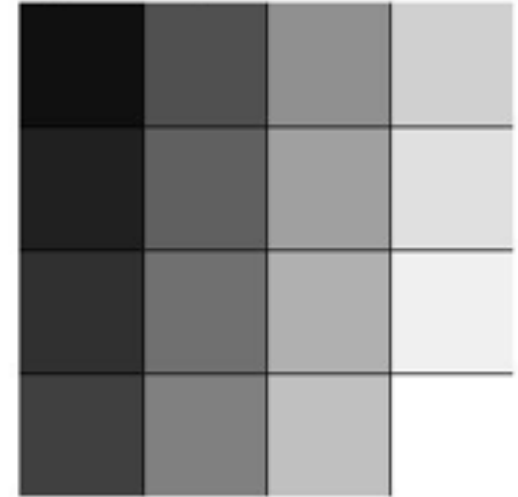
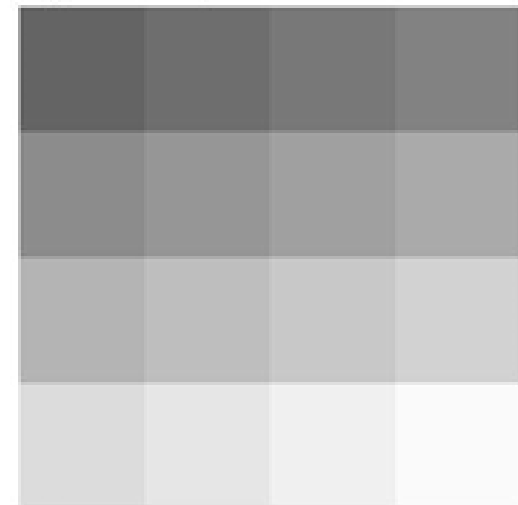


Imagem Segmentada por Watershed com Marcadores



Segmentação: Watershed usando Gradiente

Imagem Original

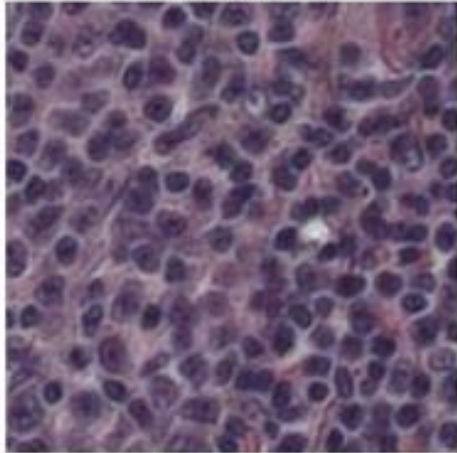


Imagem Segmentada por Watershed sem Marcadores

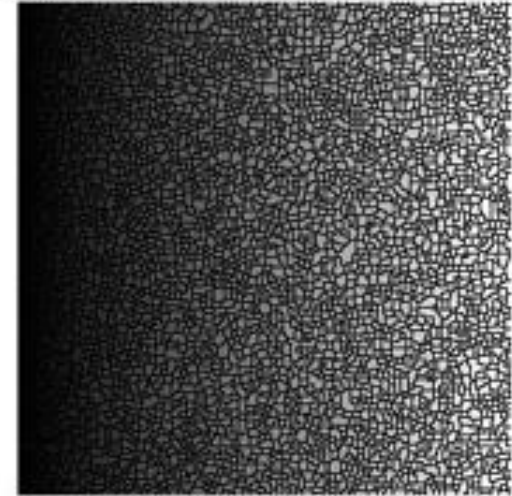
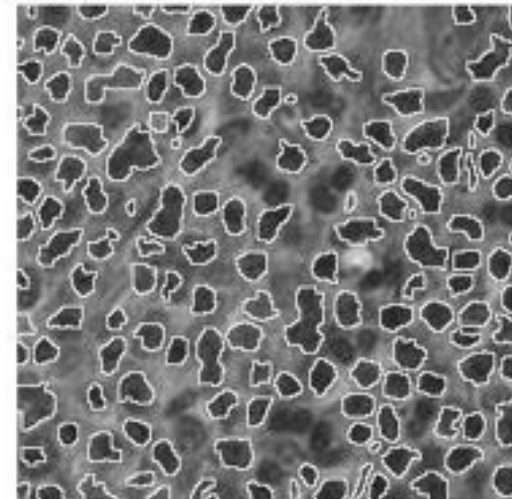
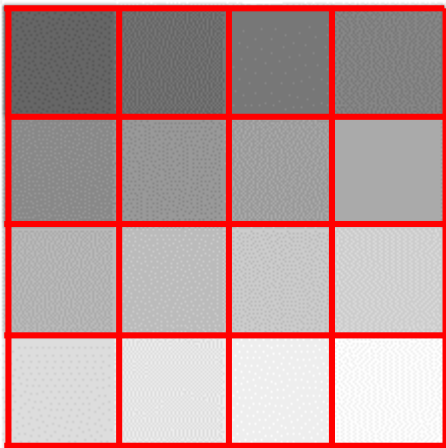
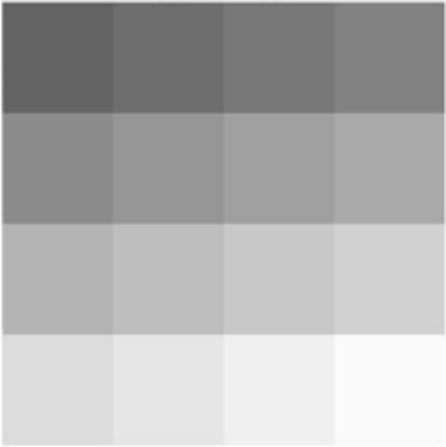


Imagem Segmentada por Watershed com Marcadores



Desempenho: Imagem 1

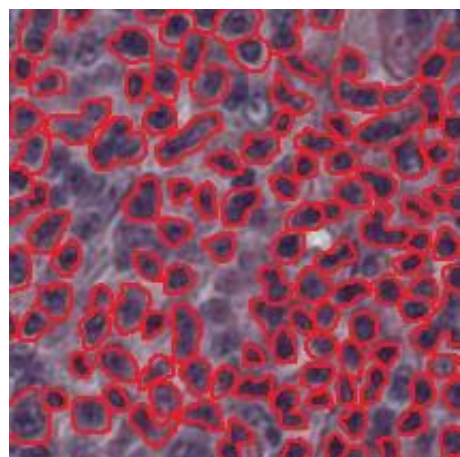
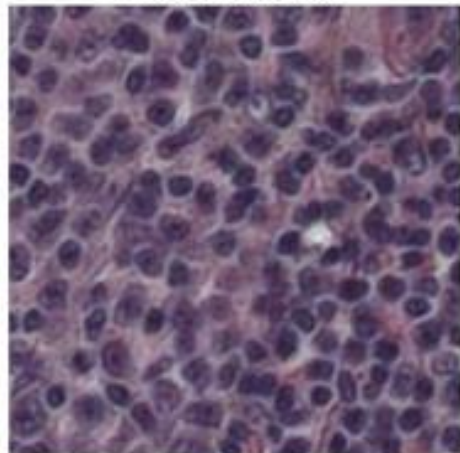
Imagem Original



%	Sensibilidade	Especificidade
Otsu	0	0
Otsu (Gradiente)	100	100
Watershed sem Marcadores	100	100
Watershed com Marcadores	0	0

Desempenho: Imagem 2

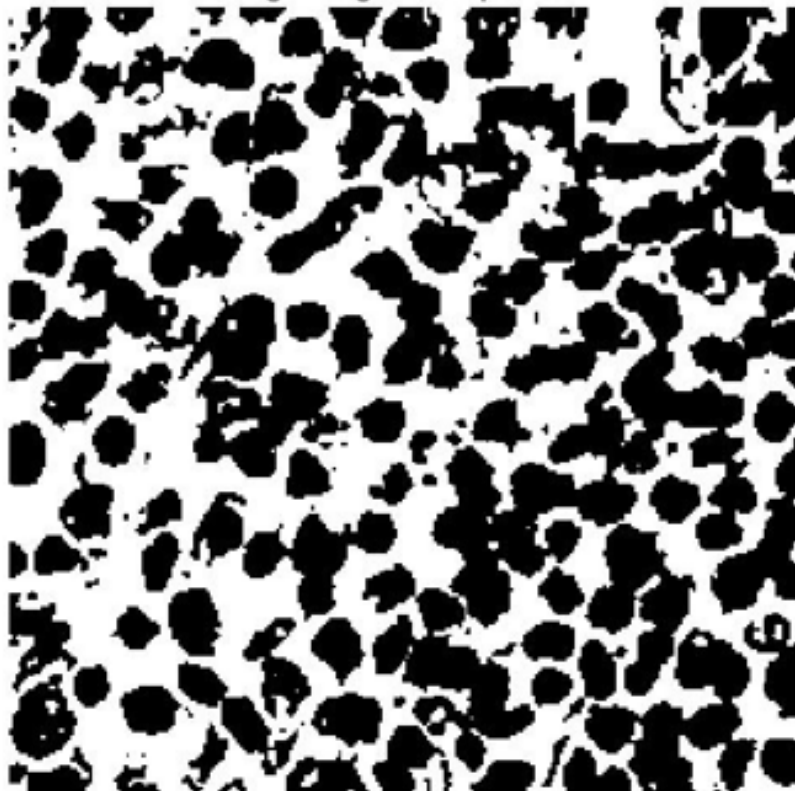
Imagem Original



%	Sensibilidade	Especificidade
Otsu	85	70
Watershed sem Marcadores	80	5
Watershed com Marcadores	65	60

Morfologia após Segmentação

Imagem Segmentada por Otsu



Filtro Morfológico

Abertura

+

Fechamento

Imagem após Filtro Morfológico (A+F)

