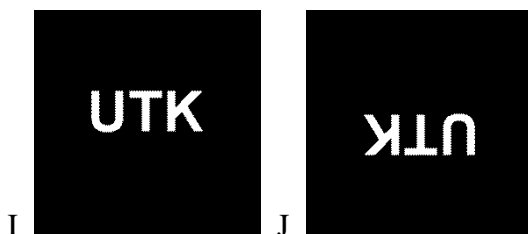


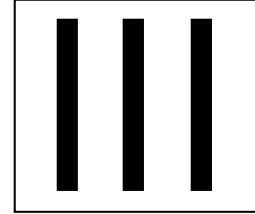
1. (a) Describe steps to remove the stripes in the figure A. (8%)
- (b) Describe steps to remove the white-dots noise in the figure B. (8%)
- (c) What is the pattern in the figure C? Describe how to produce this pattern. (8%)
2. Describe how to do centering of the spectrum of an image $f(x, y)$ before performing the discrete Fourier transform. (6%)
3. What is the discrete Fourier transform $F(u)$ of a function of elements $\{2, 1, 2, 1\}$? (Hint:
$$F(u) = \sum_{x=0}^{M-1} f(x) e^{-j2\pi u x / M}$$
) (10%)
4. What are the discrete Fourier transforms of (15%)
 - (a) $\delta(x, y)$, (b) 1, (c) $\cos(\frac{2\pi\mu_0x}{M} + \frac{2\pi\nu_0y}{N})$. (Hint:
$$F(u, v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) e^{-j2\pi(ux/M + vy/N)}$$
)



5. The image I was obtained by multiplying by -1 the phase angle of the image J, and then computing the IDFT. Explain why this operation caused the image to be reflected about both coordinate axes. (10%)

6. Show how the Butterworth highpass filter transfer function, $H(u, v) = \frac{1}{1+[D_0/D(u, v)]^{2n}}$, follows from its lowpass counterpart, $H(u, v) = \frac{1}{1+[D(u, v)/D_0]^{2n}}$. (10%)

7. The **black** bars in the test pattern shown in the following are 7 pixels wide and 200 pixels high. The separation between bars is 10 pixels. What would be the **widths of the black bars** after application of (a) A 3×3 **median** filter? (b) A 7×7 **min** filter? (c) A 9×9 **max** filter? (15%)



8. From $H_{NR}(u, v) = \prod_{k=1}^Q H_k(u, v) H_{-k}(u, v)$, obtain equations for an ideal notch filter transfer function. (10%)