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Math 362 Fourier Analysis

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Class Prep 13

Section 6.3

Key Concepts - The MDCT is modified DCT IV that acts on overlapping blocks of **x**. Unlike the IDCT IV, the IMDCT does not reconstruct **x** from the MDCT output. However, the IMDCT together with the TDAC method can be used to reconstruct **x**. As with the DCT II and DCT IV, the FFT can be used to compute the MDCT and IMDCT. We will illustrate these MDCT methods using basic examples.

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| Input Commands | Output (Plot if Applicable) |
| >> x=[1,2,3,4,5,6,7,8]';  >> MDCT(x,2)  >> x=[1,2,3,4,5,6,7,8]';  >> MDCT(x,2)  >> x=[1,2,3,4,5,6,7,8]';  >> IMDCT(x,2) | XB =  0 1 3 5 7  0 2 4 6 8  1 3 5 7 0  2 4 6 8 0  CB =  -1.9598 -4.8436 -7.4567 -10.0698 -0.2706  -0.8118 -1.2409 -2.3233 -3.4057 0.6533  XB =  0 1 3 5 7  0 2 4 6 8  1 3 5 7 0  2 4 6 8 0  CB =  -1.9598 -4.8436 -7.4567 -10.0698 -0.2706  -0.8118 -1.2409 -2.3233 -3.4057 0.6533  YB =  0.0000 -0.5000 -0.5000 -0.5000 -0.5000  -0.0000 0.5000 0.5000 0.5000 0.5000  1.5000 3.5000 5.5000 7.5000 0.0000  1.5000 3.5000 5.5000 7.5000 -0.0000 |

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| Input Commands | Output (Plot if Applicable) |
| >> x=[1,2,3,4,5,6,7,8]';  >> TDAC(x,2)  >> x=[1,2,3,4,5,6,7,8]';  >> TDAC(x,4) | XB =  0 1 3 5 7  0 2 4 6 8  1 3 5 7 0  2 4 6 8 0  CB =  -1.9598 -4.8436 -7.4567 -10.0698 -0.2706  -0.8118 -1.2409 -2.3233 -3.4057 0.6533  YB =  0.0000 -0.5000 -0.5000 -0.5000 -0.5000  -0.0000 0.5000 0.5000 0.5000 0.5000  1.5000 3.5000 5.5000 7.5000 0.0000  1.5000 3.5000 5.5000 7.5000 -0.0000  x\_TDAC =  1.0000  2.0000  3.0000  4.0000  5.0000  6.0000  7.0000  8.0000  XB =  0 1 5  0 2 6  0 3 7  0 4 8  1 5 0  2 6 0  3 7 0  4 8 0  CB =  -4.5306 -12.7106 -0.9309  -1.5909 -2.3875 1.7490  1.0630 2.0555 -0.7084  0.9012 1.5863 -0.7568  YB =  0.0000 -1.5000 -1.5000  -0.0000 -0.5000 -0.5000  0.0000 0.5000 0.5000  -0.0000 1.5000 1.5000  2.5000 6.5000 -0.0000  2.5000 6.5000 -0.0000  2.5000 6.5000 0.0000  2.5000 6.5000 -0.0000  x\_TDAC =  1.0000  2.0000  3.0000  4.0000  5.0000  6.0000  7.0000  8.0000 |

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| Input Commands | Output (Plot if Applicable) |
| >> LinearTDAC(2,-1,8,2) | XB =  0 -1.0000 -0.5000 0 0.5000  0 -0.7500 -0.2500 0.2500 0.7500  -1.0000 -0.5000 0 0.5000 0  -0.7500 -0.2500 0.2500 0.7500 0  CB =  1.1432 0.4223 -0.2310 -0.8843 -0.0676  0.4735 0.3663 0.0957 -0.1749 0.1633  YB =  -0.0000 -0.1250 -0.1250 -0.1250 -0.1250  0.0000 0.1250 0.1250 0.1250 0.1250  -0.8750 -0.3750 0.1250 0.6250 0.0000  -0.8750 -0.3750 0.1250 0.6250 -0.0000  Results\_Matrix\_Below =  'The first column is f and the second column is f\_TDAC.'  Results\_Matrix =  -1.0000 -1.0000  -0.7500 -0.7500  -0.5000 -0.5000  -0.2500 -0.2500  0 0.0000  0.2500 0.2500  0.5000 0.5000  0.7500 0.7500 |

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| Input Commands | Output (Plot if Applicable) |
| >> x=[1,2,3,4,5,6,7,8]';  >> TDACfft(x,2)  >> LinearTDACfft(2,-1,8,2) | XB =  0 1 3 5 7  0 2 4 6 8  1 3 5 7 0  2 4 6 8 0  XTB =  0 0 0 0 0  -3 -7 -11 -15 0  0 0 0 0 0  0 -1 -1 -1 -1  0 0 0 0 0  0 1 1 1 1  0 0 0 0 0  3 7 11 15 0  0 0 0 0 0  3 7 11 15 0  0 0 0 0 0  0 1 1 1 1  0 0 0 0 0  0 -1 -1 -1 -1  0 0 0 0 0  -3 -7 -11 -15 0  CB =  -1.9598 -4.8436 -7.4567 -10.0698 -0.2706  -0.8118 -1.2409 -2.3233 -3.4057 0.6533  YB =  0 -0.5000 -0.5000 -0.5000 -0.5000  0 0.5000 0.5000 0.5000 0.5000  1.5000 3.5000 5.5000 7.5000 0  1.5000 3.5000 5.5000 7.5000 0  Results\_Matrix\_Below =  'The first column is x and the second column is x\_TDAC\_fft.'  Results\_Matrix =  1.0000 1.0000  2.0000 2.0000  3.0000 3.0000  4.0000 4.0000  5.0000 5.0000  6.0000 6.0000  7.0000 7.0000  8.0000 8.0000  XB =  0 -1.0000 -0.5000 0 0.5000  0 -0.7500 -0.2500 0.2500 0.7500  -1.0000 -0.5000 0 0.5000 0  -0.7500 -0.2500 0.2500 0.7500 0  XTB =  0 0 0 0 0  1.7500 0.7500 -0.2500 -1.2500 0  0 0 0 0 0  0 -0.2500 -0.2500 -0.2500 -0.2500  0 0 0 0 0  0 0.2500 0.2500 0.2500 0.2500  0 0 0 0 0  -1.7500 -0.7500 0.2500 1.2500 0  0 0 0 0 0  -1.7500 -0.7500 0.2500 1.2500 0  0 0 0 0 0  0 0.2500 0.2500 0.2500 0.2500  0 0 0 0 0  0 -0.2500 -0.2500 -0.2500 -0.2500  0 0 0 0 0  1.7500 0.7500 -0.2500 -1.2500 0  CB =  1.1432 0.4223 -0.2310 -0.8843 -0.0676  0.4735 0.3663 0.0957 -0.1749 0.1633  YB =  -0.0000 -0.1250 -0.1250 -0.1250 -0.1250  0.0000 0.1250 0.1250 0.1250 0.1250  -0.8750 -0.3750 0.1250 0.6250 0  -0.8750 -0.3750 0.1250 0.6250 0  Results\_Matrix\_Below =  'The first column is f and the second column is f\_TDAC\_fft.'  Results\_Matrix =  -1.0000 -1.0000  -0.7500 -0.7500  -0.5000 -0.5000  -0.2500 -0.2500  0 0  0.2500 0.2500  0.5000 0.5000  0.7500 0.7500 |

Section 6.4

Key Concepts - The MP3 approach to processing audio files is a complex and multistage technique. We focus on the portion that uses the MDCT together with windowing and thresholding. We show how the methods work with basic examples, encode the steps into MATLAB, and then apply them to sound waves.

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| Input Commands | Output (Plot if Applciable) |
| >> x=[1,2,3,4,5,6,7,8]';  >> MDCTthresh(x,2,40) | XB =  0 1 3 5 7  0 2 4 6 8  1 3 5 7 0  2 4 6 8 0  XBW =  0 0.5412 1.6236 2.7060 3.7884  0 2.6131 5.2263 7.8394 10.4525  1.3066 3.9197 6.5328 9.1459 0  1.0824 2.1648 3.2472 4.3296 0  CB =  -1.5607 -4.5355 -7.3640 -10.1924 -1.8033  -0.6464 -0.2929 -0.2929 -0.2929 4.3536  CBT =  -1.5607 -4.5355 -7.3640 -10.1924 -1.8033  0 0 0 0 4.3536  YB =  -0.4223 -1.2273 -1.9927 -2.7580 -3.3321  0.4223 1.2273 1.9927 2.7580 3.3321  1.0196 2.9630 4.8107 6.6585 -0.0000  1.0196 2.9630 4.8107 6.6585 -0.0000  YBW =  -0.2286 -0.6642 -1.0784 -1.4926 -1.8033  0.5518 1.6036 2.6036 3.6036 4.3536  1.3321 3.8713 6.2855 8.6997 -0.0000  0.5518 1.6036 2.6036 3.6036 -0.0000  Results\_Matrix\_Below =  'The first column is x and the second column is xt.'  Results\_Matrix =  1.0000 0.6679  2.0000 2.1553  3.0000 2.7929  4.0000 4.2071  5.0000 4.7929  6.0000 6.2071  7.0000 6.8964  8.0000 7.9571  Percent\_Reduction =  'The percent reduction is 40.000000 percent.'  Compression\_Ratio =  'The compression ratio is 10 to 6, or 1.666667 to 1.' |

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| Input Commands | Output (Plot if Applicable) |
| >> [z,sr]=audioread('FourierAnalysisIntro.wav');  >> MDCTsound(z,sr,18,95,6000)  >> DCTIIsound(z,sr,256,95,6000)  >> MDCTsound(z,sr,128,95,6000) | Percent\_Reduction =  'The percent reduction is 94.999627.'  Compression\_Ratio =  'The compression ratio is 80334 to 4017, or 19.998506 to 1.'    Percent\_Reduction =  'The percent reduction is 94.921875.'  Compression\_Ratio =  'The compression ratio is 256 to 13, or 19.692308 to 1.'    Percent\_Reduction =  'The percent reduction is 94.999503.'  Compression\_Ratio =  'The compression ratio is 80512 to 4026, or 19.998013 to 1.' |