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CMRIT

II INTERNAL ASSESSMENT TEST

Sub:	DIGITAL SIGNAL PROCESSING							Code:	15EC52
Date:	15 / 10 / 2018	Duration:	90 mins	Max Marks:	50	Sem:	V	Branch:	ECE(D)/TCE

Answer any 5 full questions

		Marks	CO	RBT
1	Discuss the symmetry properties of DFT if the sequence is i. Real and circularly even ii. Real and circularly odd iii. Imaginary and circularly even iv. Imaginary and circularly odd	[10]	CO1	L2
2	State and prove the following properties of DFT. i. Circular time shift ii. Circular frequency shift iii. Time reversal	[10]	CO1	L2
3	The 4-point DFT of a sequence $x[n]$ is $X[k] = [1, j, 1, -j]$. Evaluate the DFT of the following sequences. i. $x_1[n] = (-1)^n x[n]$ ii. $x_2[n] = x[(n-1)_4]$ iii. $x_3[n] = x[4-n]$	[10]	CO1	L2

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4	A long sequence $x[n]$ is filtered with $h[n]$ to obtain $y[n]$. If $h[n] = [2,2,1]$ and $x[n] = [3,0,-2,0,2,1,0,-2,-1]$, compute $y[n]$ using overlap-save method. Use 7-point circular convolution.	[10]	CO2	L2
5	Derive radix-2 DIT-FFT algorithm for $N = 8$. Draw the complete signal flow diagram.	[10]	CO3	L2
6	Compute the 8-point DFT of $x[n] = [0,1,2,3,4,5,6,7]$ using DIT-FFT. Clearly show the intermediate results.	[10]	CO3	L2
7	Compute the 8-point DFT of $x[n] = [2,2,2,2,1,1,1,1]$ using DIF-FFT. Clearly show the intermediate results.	[10]	CO3	L2
8	Compute the IDFT of $X[k] = [4,1-2.414j,0,1-0.414j,0,1+0.414j,0,1+2.414j]$ using DIF-IFFT. Clearly show the intermediate results.	[10]	CO3	L2

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Solution and scheme of evaluation

1 $$X(K) = \sum_{n=0}^{N-1} x(n) e^{-j\frac{2\pi}{N}kn}$$

$0 \le k \le N-1$

$$= \sum_{n=0}^{N-1} \left[x_r(n) + j x_i(n)\right]\left[\cos\left(\frac{2\pi}{N}kn\right) - j\sin\left(\frac{2\pi}{N}kn\right)\right]$$

$$X_R(K) = \sum_{n=0}^{N-1} x_r(n)\cos\left(\frac{2\pi}{N}kn\right) + x_i(n)\sin\left(\frac{2\pi}{N}kn\right)$$

$$X_I(K) = \sum_{n=0}^{N-1} x_i(n)\cos\left(\frac{2\pi}{N}kn\right) - x_r(n)\sin\left(\frac{2\pi}{N}kn\right)$$

i) $x(n)$ – real and even (2.5)
$X(K)$ – real and even

ii) $x(n)$ – real and odd (2.5)
$X(K)$ – imaginary and odd

iii) $x(n)$ – imaginary and even (2.5)
$X(K)$ – imaginary and even

iv) $x(n)$ – imaginary and odd (2.5)
$X(K)$ – real and odd

2 i) $x(n) \longleftrightarrow X(K)$

$x(n-l) \longleftrightarrow e^{-j\frac{2\pi}{N}lk} X(K)$ (4)

ii) $x(n) \longleftrightarrow X(K)$

$$e^{j\frac{2\pi}{N}ln} x(n) \longleftrightarrow X(k-l)$$ (3)

iii) $x(n) \longleftrightarrow X(k)$

$x(-n) \longleftrightarrow X(-k)$ (3)

3 $X(k) = (1, j, 1, -j)$

i) $x_1(n) = (-1)^n x(n)$

$$= e^{j\pi n} x(n)$$

$$= e^{j\frac{2\pi}{4}2n} x(n)$$

$$X_1(k) = X[(k-2)]$$

$$= [1, -j, 1, j]$$ (4)

ii) $x_2(n) = x[(n-1)_4]$

$$\therefore X_2(k) = e^{-j\frac{2\pi}{4}1k} X(k)$$

$$= e^{-j\frac{\pi}{2}k} X(k)$$

$$= (1, 1, -1, +1)$$ (4)

iii) $x_3(n) = x(4-n)$

$X_3(k) = X(-k) = (1, -j, 1, j)$ (2)

(3)

4 $h(n) = (2,2,1,0,0,0,0)$

$x_1(n) = (0,0,3,0,-2,0,2)$

$x_2(n) = (0,2,1,0,-2,-1,0)$

$x_3(n) = (-1,0,0,0,0,0,0)$ (2)

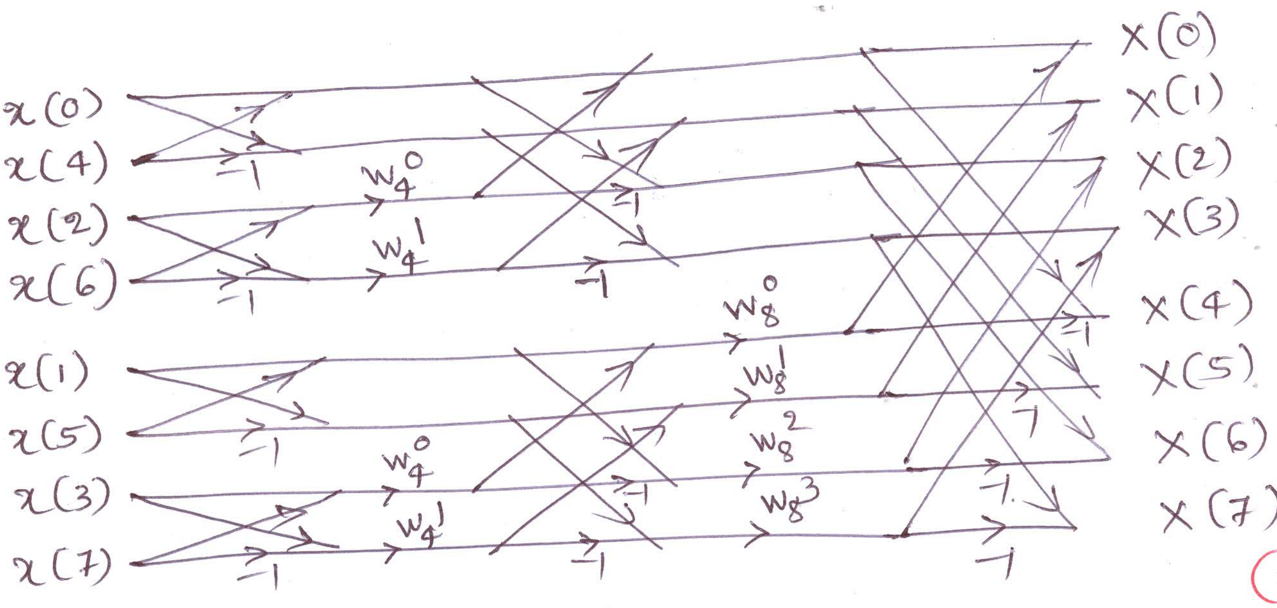
$y_1(n) = (4,2,6,6,-1,-4,2)$ (2)

$y_2(n) = (-1,4,6,4,-3,-6,-4)$ (2)

$y_3(n) = (-2,-2,-1,0,0,0,0)$ (2)

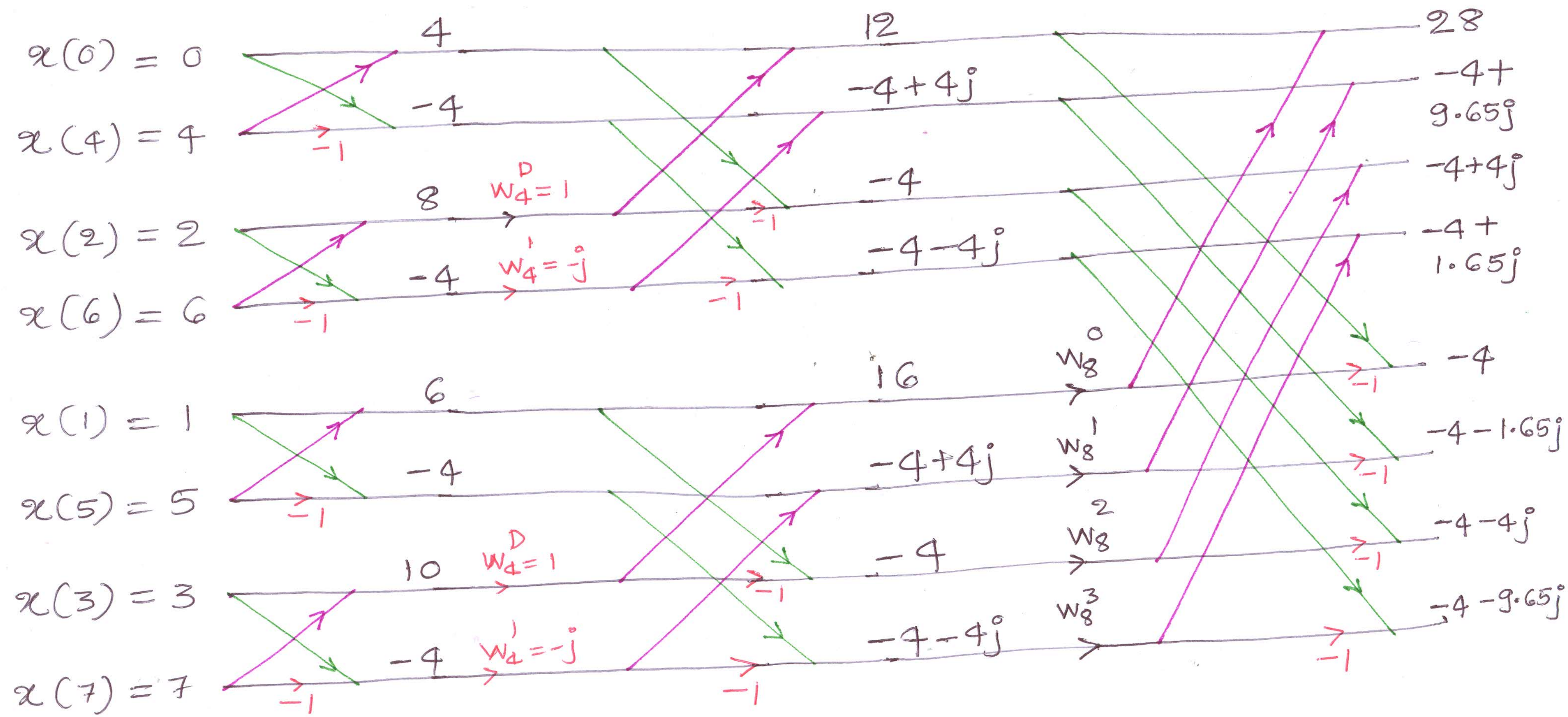
$y(n) = (6,6,-1,-4,2,6,4,-3,-6,-4,-1)$ (2)

5 $$X(k) = \sum_{n=0}^{\frac{N}{2}-1} x(2n) W_{\frac{N}{2}}^{kn} + \sum_{n=0}^{\frac{N}{2}-1} x(2n+1) W_{N/2}^{kn} W_N^{k}.$$ (5)



(5)

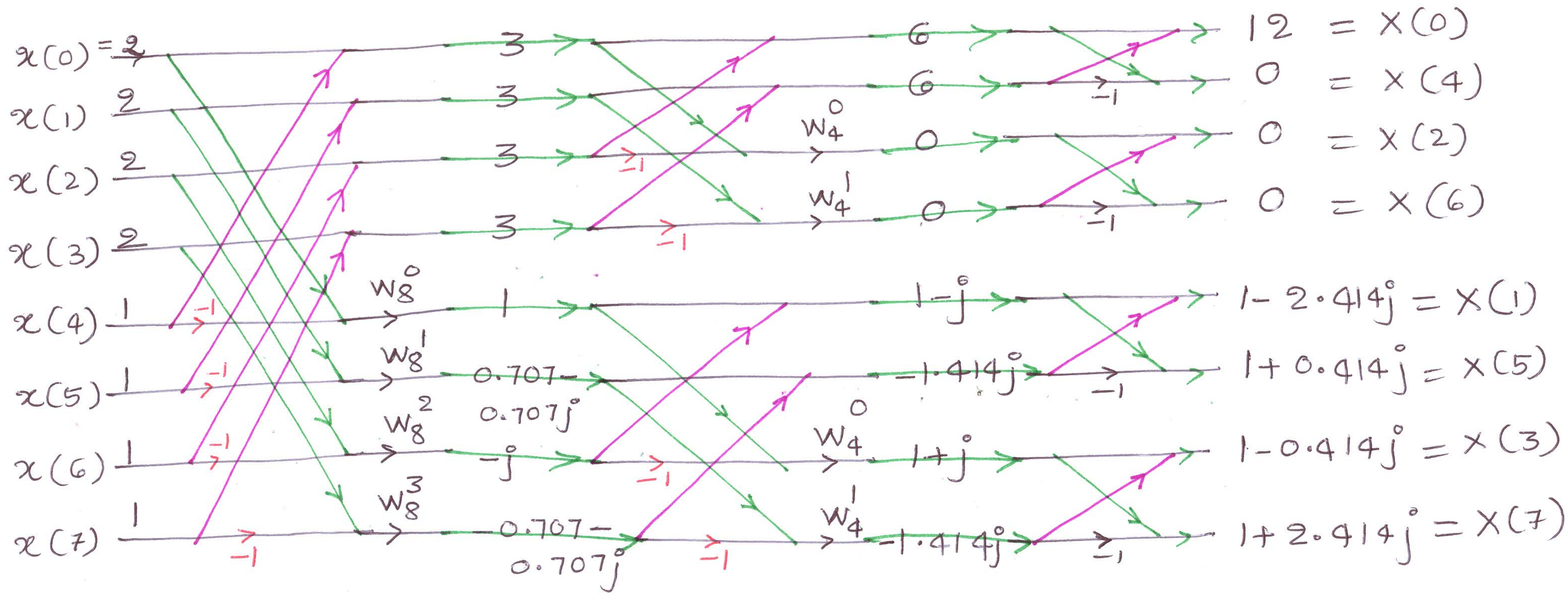
12. Find the DFT of $x(n) = [0, 1, 2, 3, 4, 5, 6, 7]$ using DIT-FFT



$W_8^0 = 1$, $W_8^1 = e^{-j\frac{2\pi}{8}} = e^{-j\pi/4} = 0.707 - j0.707$

$W_8^2 = W_4^1 = e^{-j\frac{2\pi}{4}} = e^{-j\pi/2} = -j$ $\quad W_8^3 = e^{-j\frac{2\pi}{8}\times 3} = e^{-j\frac{3\pi}{4}} = -0.707 - 0.707j$

17. Find the 8-point DFT of $x(n) = [2,2,2,2,1,1,1,1]$ using DIF-FFT.



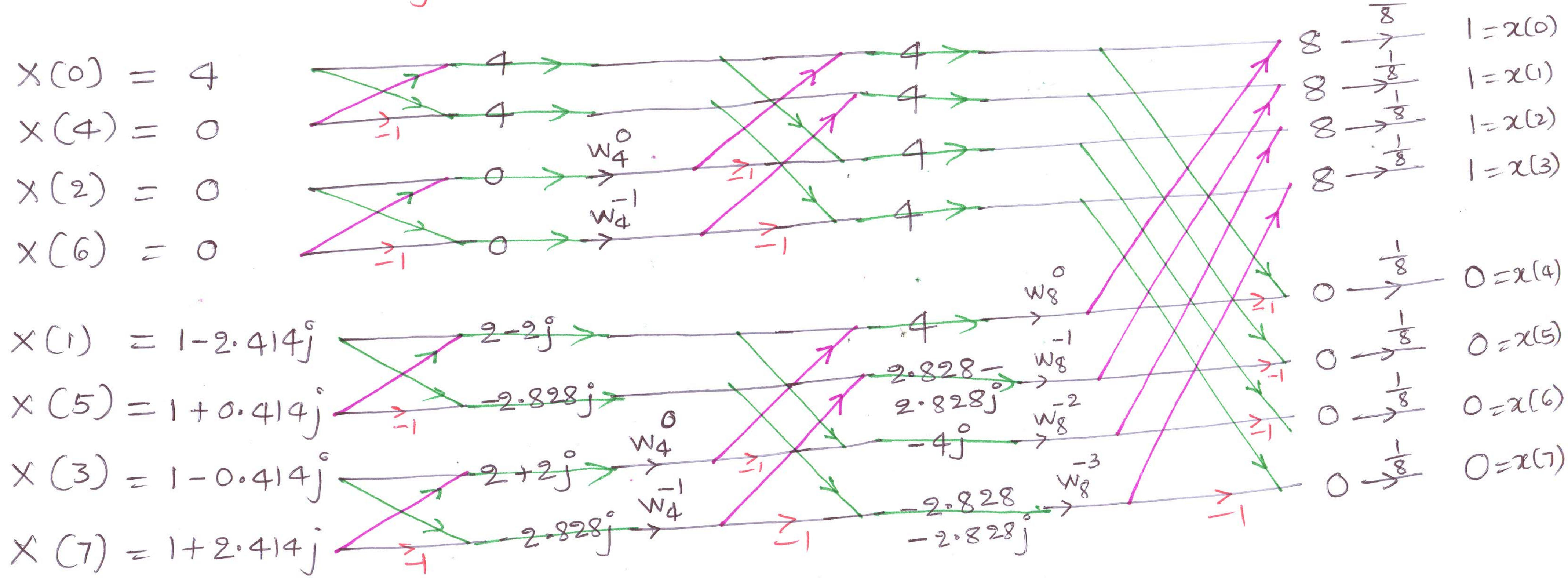
$W_8^1 = 0.707 - 0.707j$, $W_8^2 = W_4^1 = -j$, $W_8^3 = -0.707 - 0.707j$

Arranging the output in natural order, we get,

$X(k) = [12, 1-2.414j, 0, 1-0.414j, 0, 1+0.414j, 0, 1+2.414j]$

20. Find the IDFT using DIF-IFFT :

$x(K) = [4,\ 1-2.414j,\ 0,\ 1-0.414j,\ 0,\ 1+0.414j,\ 0,\ 1+2.414j]$



$W_4^{-1} = W_8^{-2} = j$, $W_8^{-1} = 0.707+0.707j$, $W_8^{-3} = -0.707+0.707j$