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FINAL ANSWER

ECGR4124 Digital Signal Processing Exam1 Spring 2017

Name: _____

***LAST 4** DIGITS* of Student Number: _____

Do NOT begin until told to do so
Make sure that you have all pages before starting
NO TEXTBOOK, NO CALCULATOR, NO CELL PHONES/WIRELESS DEVICES
Open handouts, 1 sheet front/back notes, NO exams, NO quizzes
DO ***ALL WORK*** IN THE SPACE GIVEN
Do **NOT** use the back of the pages, do **NOT** turn in extra sheets of work/paper
Multiple-choice answers should be within 5% of correct value
Show ALL work, even for multiple choice.

ACADEMIC INTEGRITY:
Students have the responsibility to know and observe the requirements of The UNCC Code of Student Academic Integrity. This code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials, and complicity in academic dishonesty.

Unless otherwise noted:
$F\{\}$ denotes Discrete timeFourier transform *{DTFT, DFT, or Continuous, as implied in problem}*
$F^{-1}\{\}$ denotes inverse Fourier transform
ω denotes frequency in rad/sample, Ω denotes frequency in rad/second
$*$ denotes linear convolution, $\textcircled{N}$ denotes circular convolution
$x^*(t)$ denotes the conjugate of $x(t)$

Useful constants, etc:

$e \approx 2.72$
$1/e \approx 0.37$
$\sqrt{3} \approx 1.73$
$\sqrt{7} \approx 2.64$
$\ln(2) \approx 0.69$
$\log_{10}(2) \approx 0.30$
$\log_{10}(10) \approx 1.0$
$\log_{10}(e) \approx 0.43$

$\pi \approx 3.14$
$\sqrt{2} \approx 1.41$
$\sqrt{5} \approx 2.22$
$\sqrt{10} \approx 3.16$
$\ln(4) \approx 1.38$
$\log_{10}(3) \approx 0.48$
$\log_{10}(0.1) \approx -1$
$\cos(\pi / 4) \approx 0.71$

$\cos(A)\cos(B) = 0.5\cos(A - B) + 0.5\cos(A + B)$

5 Points Each (Circle the best answer)

1. The first three points of x[n] (at n=0,1,2) in sampling $x(t)= (-2)^{-2t}\, u(t)$ at 2 sample/second are:

$T_0 = 1/2$

a) {-2, 4, 8} b) {1, -1/2, 1/4} c) {1, -1/4, 1/16} d) none above

$x[n] = (-2)^{-2nT_0} = \left(\frac{1}{-2}\right)^{2n/2} = \left(\frac{-1}{2}\right)^{n} = \{1, -\frac{1}{2}, \frac{1}{4} \ldots\}$

2. $((-4))_8 =$

a) 3 b) 4 c) 5 d) none above

011	3	
010	2	
001	1	
000	0	
111	-1	⇒ 7
110	-2	⇒ 6
101	-3	⇒ 5
100	-4	⇒ 4

Some EXAMS

3. $\sum_{n=0}^{3} a^n =$

a) $(1-a^4)/(1-a)$ b) a^4 c) $(1-a^5)/(1-a)$ d) none above

$\sum_{0}^{3} a^n = \frac{1-a^4}{1-a}$ $\quad \sum_{0}^{4} = \frac{1-a^5}{1-a}$ Some EXAMS

4. The system with input x[n] and output y[n] = x[n] + 2 is linear and time invariant.

a) True b) False

$y_1[n] = x_1[n] + 2$

$y_2[n] = x_2[n] + 2$

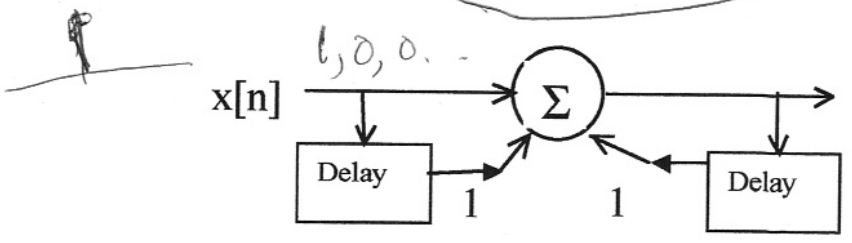
$a y_1[n] + b y_2[n] \neq a x_1[n] + b x_2[n] + 2$

EASY WAY $1 V_{DC} \Rightarrow 1+2=3$ DIDN'T DOUBLE

$2 V_{DC} \Rightarrow 2+2=4$

5. The impulse response of the system below is h[n] =

a) $\delta[n]+2u[n]$ b) $\delta[n-1]+u[n]$ c) $u[n] + u[n-1]$ d) none above



5 Points Each (Circle the best answer)

6. Given the four point sequence x[n] = {1,2,3,4}, then x[((n + 1))$_4$] =

a) {4,3,2,1} b) {4,1,2,3} c) {2,3,4,1} d) none above

7. A 1024-point FFT produces the same result as the DFT, and is more than 10 times faster.

a) True b) False

$$\frac{N^2}{N\log_2 N} = \frac{1024^2}{1024\log_2(2^{10})} = \frac{1024}{1024\cdot 10} \approx 100$$

8. If x[n] = $(0.5)^n$u[n-2], h[n] = δ[n-1], and y[n] = x[n] ∗ h[n], where ∗ denotes convolution, then, y[n] equals

a) $(0.5)^n$δ[n-3] b) $(0.5)^{n-3}$u[n-3] c) $(0.5)^{n-1}$u[n-3] d) none above

$(0.5)^{n-1}u[n-3]$

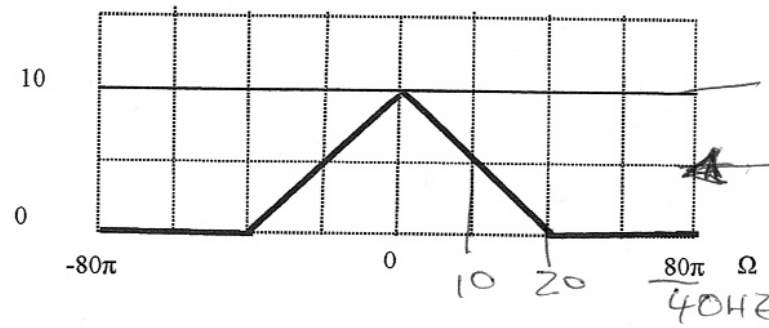
9. The difference equation for a LTI system is y[n] = x[n] - x[n-1] + y[n-1]. The impulse response of the system is h[n] =

a) u[n] - u[n-1] b) δ[n] c) δ[n] + 2 u[n-1] d) none above

$y[0] = \delta[0] - \delta[-1] + y[-1] = 1 - 0 + 0 = 1$
$y[1] = \delta[1] - \delta[0] + y[0] = 0 - 1 + 1 = 0$
$y[2] = \delta[2] - \delta[1] + y[1] = 0 - 0 + 0 = 0$

10. For $|X(\Omega)|^2$ given below, the 3 dB bandwidth of X(Ω) is

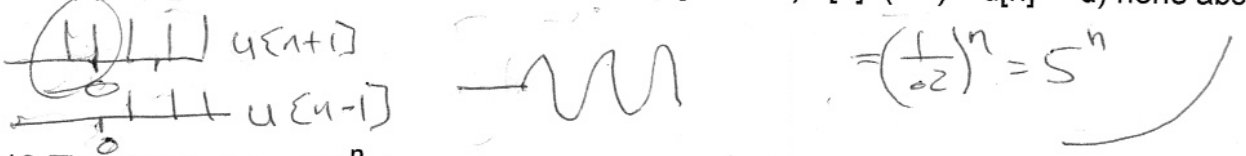
a) 5 Hz b) 10 Hz c) 15 Hz d) 20 Hz e) none above



5 Points Each (Circle the best answer)

11. Circle the BIBO stable impulse response below. $\sum |h[n]| < \infty$

a) h[n]= u[n+1] - u[n-1] b) h[n]= cos(n) u[n] c) h[n]=$(0.2)^{-n}$ u[n] d) none above



12. The signal x[n] = $(j)^n$ has a discrete-time frequency ω =

a) 1 rad/sample b) j rad/sample c) $\pi/2$ rad/sample d) none above

$(j)^n = (e^{j\pi/2})^n = e^{j\frac{n\pi}{2}} = e^{j\omega n}$

13. If a linear time invariant system has impulse response h[n] = 2^{-n}u[n-1], the output response to an input signal of $\delta[n] - \delta[n-1]$ is

a) $2^{-n}u[n-1] - 2^{-(n-1)}u[n-2]$ b) $\{2^{-n} - 2^{-n-1}\}u[n-2]$ c) $2^{-2n-2}u[n-2]$ d) none above

$2^{-n}u[n-1] - 2^{-(n-1)}u[n-2]$

14. If a Backward Difference System is cascaded with another Backward Difference System, the overall impulse response of the cascade is:

a) h[n]=u[n-1] b) h[n]= $\delta[n]-2\delta[n-2]+\delta[n-2]$ c) h[n]= $2\delta[n]-2\delta[n-2]$ d) none above

$y[n]=x[n]-x[n-1]$

$h[n]=\delta[n]-\delta[n-1] \Rightarrow$  ADD $\Rightarrow$

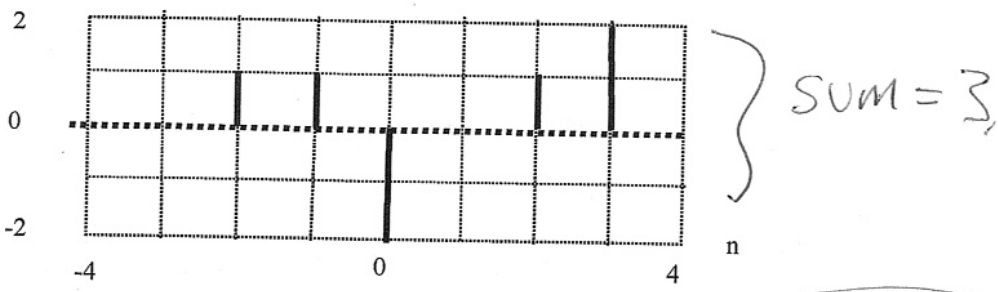
15. The dc response of a system with impulse response h[n] as shown below, is $H(\omega)|_{\omega=0}$ =

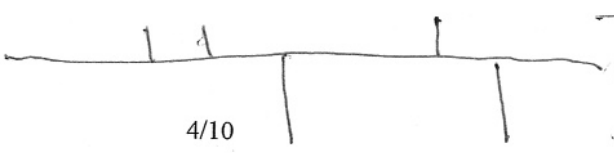
a) -1 b) 2 c) 3 d) none above

$H(\omega)=\sum x[n]e^{-j\omega n}$

$=\sum x[n]e^{0}$

$=\sum x[n]$ h[n]





other EXAMS SUM = -1

5 Points Each (Circle the best answer)

$\mathcal{F}\{\delta[n]\} = 1$

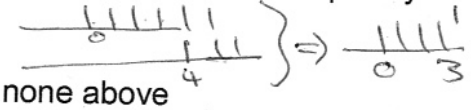
$x[n-n_0]$ Shift Property $\Rightarrow X(\omega)e^{-j\omega n_0}$

16. The DTFT of $x[n] = \delta[n+1] - \delta[n]$ is $X(\omega) =$

a) $e^{-j\omega} - e^{-j\omega}$ b) $e^{j\omega} - e^{-j\omega}$ c) $e^{j\omega k} - 1$ d) none above

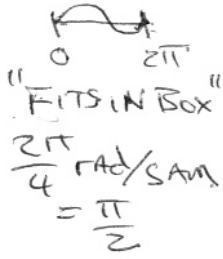
$e^{j\omega} - 1$

17. A system has an impulse response $h[n] = u[n] - u[n-4]$. The magnitude of the frequency response of the system $|H(\omega)|$ at $\omega=\pi/2$, is $|H(\pi/2)|=$



a) 0 b) 1 c) 2 d) none above

$$\sum x[n]e^{-j\omega n} = \sum_0^3 1\cdot e^{-j\frac{\pi}{2}n} = \sum_0^3 1\cdot(-j)^n = 1-j-1+j = 0$$



18. The DFT of the four point sequence $x[n] = \{-1,1,-1,1\}$ is $X[k] =$

a) {1, +4j, -j, 4j } b) {0, 0,-4, 0 } c) {0, -2j, 4, 2j } d) none above

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix}\begin{bmatrix} -1 \\ 1 \\ -1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -4 \\ 0 \end{bmatrix}$$

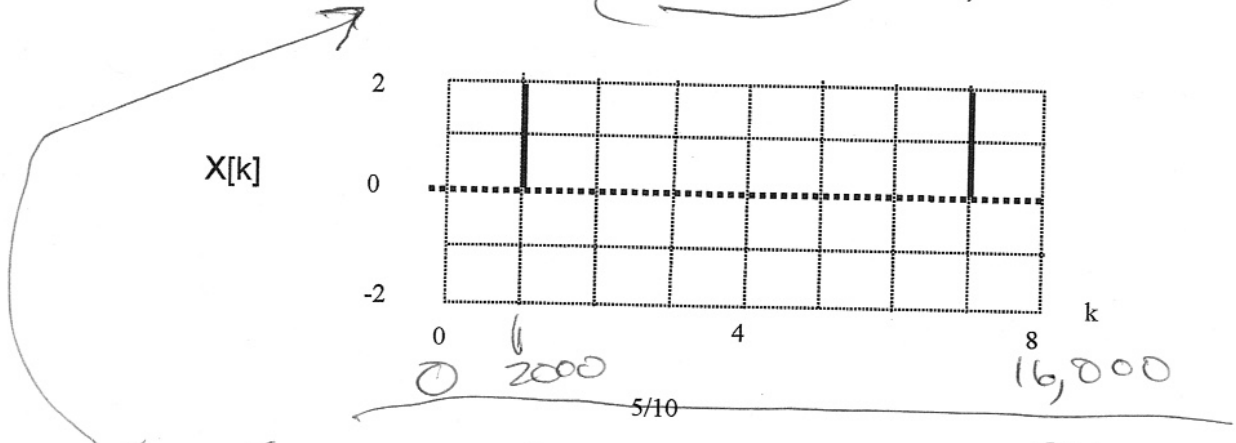
19. The dc response of an LTI system with impulse response $h[n]= (0.25)^n u[n]$ is $H(\omega)|_{\omega=0} =$

a) 0.25 b) 3/4 c) 4/3 d) none above

$$H(\omega) = \sum x[n]e^{-j\omega n}\Big|_{\omega=0} = \sum\left(\frac{1}{4}\right)^n = \frac{1-(1/4)^\infty}{1-1/4} = \frac{1}{3/4} = \frac{4}{3}$$

20. The frequency of the discrete-time sinusoid having the 8-point DFT X[k] shown below (sampled at 16,000 samples/second) has a corresponding continuous-time frequency f =

a) 500 Hz b) 1000 Hz c) 2000 Hz d) 7000 Hz



5 Points Each (Circle the best answer)

21. If $(12)^{0.5} \approx 3.5$, then the rms quantization noise of a 8-bit ADC with 0.14 volt step size is

a) 0.01 V rms b) 0.04 V rms c) 0.07 V rms d) none above

$\frac{\Delta}{\sqrt{12}} = \frac{0.14}{3.5} = \frac{14}{3.5} \cdot \frac{1}{100} = \frac{4}{100}$

22. The 2-point Fourier matrix $\overline{\overline{W_2}}$ is

a) $\begin{bmatrix} 1 & 1 \\ 1 & -j \end{bmatrix}$ b) $\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ c) $\begin{bmatrix} 1 & 1 \\ 1 & j \end{bmatrix}$ b) none above

$W_2 = e^{-j\frac{2\pi}{2}} = e^{-j\pi}$

23. The circular convolution of the two 8-point sequences x[n] = {1,-1,1,-1, 1,0,0,0} and y[n] = {1,1,0,0, 0,0,0,0} is

a) {1,2,2,2, 1,0,0,0} b) {1,0,0,0, 0,1,0,0} c) {1,-1,1,-1, 1,1,0,0} d) none above

{0 1, -1, 1 -1, 1 0 0}
1 0 0 0 0 1 0 0

24. A discrete-time sinusoid with $\omega = \pi/2$ rad/sample (sampled at 1000 samples/second) has a corresponding continuous-time frequency of f =

a) 250 Hz b) 500 Hz c) 750 Hz d) none above

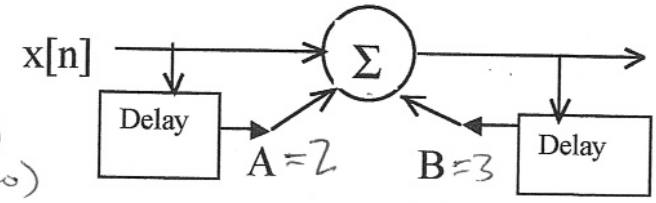
$\omega = \Omega T_s \Rightarrow \Omega = 2\pi f = \frac{\omega}{T_s} = \frac{\pi}{2} \cdot 1000$

$\Rightarrow f = 250$

0 π 2π
500 1000

25. T o obtain a frequency response of $(1+2e^{-j\omega})/(1-3e^{-j\omega})$, the required values for coefficients A and B system below is {A, B} =

a) {1/2, -1/3} b) { -3, 2} c) {2, 3} d) none above



$\frac{1+2e^{-j\omega}}{1-3e^{-j\omega}} = H(\omega) = \frac{Y(\omega)}{X(\omega)}$

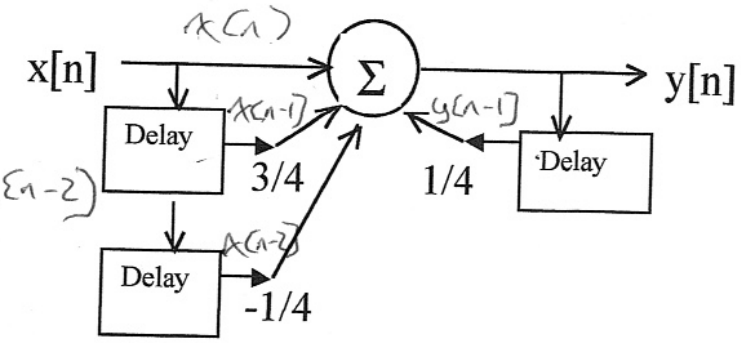
$\Rightarrow Y(\omega)(1-3e^{-j\omega}) = X(\omega)(1+2e^{j\omega})$

$\Rightarrow y[n] - 3y[n-1] = x[n] + 2x[n-1]$

5 Points Each (Circle the best answer)

The system to the right is represented by difference equation:

y[n]= A y[n-1] +B x[n] + C x[n-1] +D x[n-2]



26. In the difference equation for the block diagram above, the weight A is A=

a) – 1/4 b) 1/4 c) 3/4 d) -4 e) none above

27. In the difference equation for the block diagram above, the weight C is C=

a) -4/3 b) – 1/4 c) 3/4 d) 4/3 e) none above

28. Where h[n] is the impulse response, then the *THIRD POINT* is h[2] =

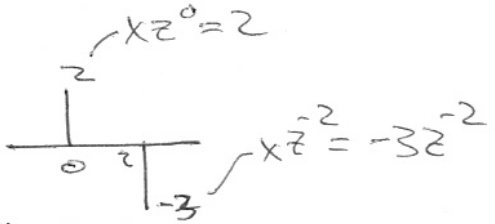
a) 0 b) 1.25 c) 1.75 d) 2.0 e) none above

29. The frequency response of the system above is H(ω) =

a) $\frac{1+0.75e^{-j\omega}-0.25e^{-j2\omega}}{1-0.25e^{-j\omega}}$ b) $\frac{1+0.25e^{-j\omega}}{1-0.75e^{-j\omega}+e^{-j2\omega}}$ c) $\frac{1-0.75e^{-j\omega}+0.25e^{-j2\omega}}{1-0.25e^{-j\omega}}$ d)none above

30. The system above is BIBO stable.

a) True b) False



5 Points Each, Circle the Best Answer

31. Ignoring ROC (which has not yet been discussed in class), the signal $h[n] = 2\delta[n] - 3\delta[n-2]$ has a z-transform H(z)=

a) -1 b) $2z - 3z$ c) $2z - 3z^{-1}$ d) $2 - 3z^{-2}$ e) none above

32. Ignoring ROC (which has not yet been discussed in class), a signal having a z-transform $H(z) = z^{-1} - z^{-2}$ has a DTFT $H(\omega)$=

a) $e^{-j\omega} - e^{-j2\omega}$ b) $1 - 2e^{-j\omega}$ c) $e^{j\omega} - e^{j2\omega}$ d) none above

$$H(\omega) = H(z)\Big|_{z=e^{j\omega}} = (e^{j\omega})^{-1} - (e^{j\omega})^{-2}$$

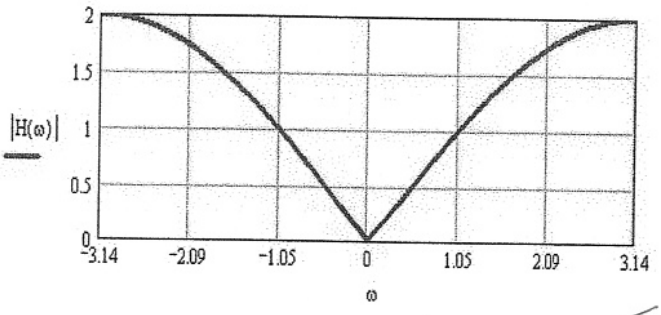
33. The DFT of the 4-point sequence $(-1)^n x[n]$ is $\Rightarrow$ Freq Shift by $N/2$

a) X[k-2] b) $(-j)^k X[k-1]$ c) -X[k-2] d) none above

34. For a discrete-time filter with impulse response $h[n] = \delta[n-1] - \delta[n]$, $|H(\omega)|$ is plotted below.

a) True b) False

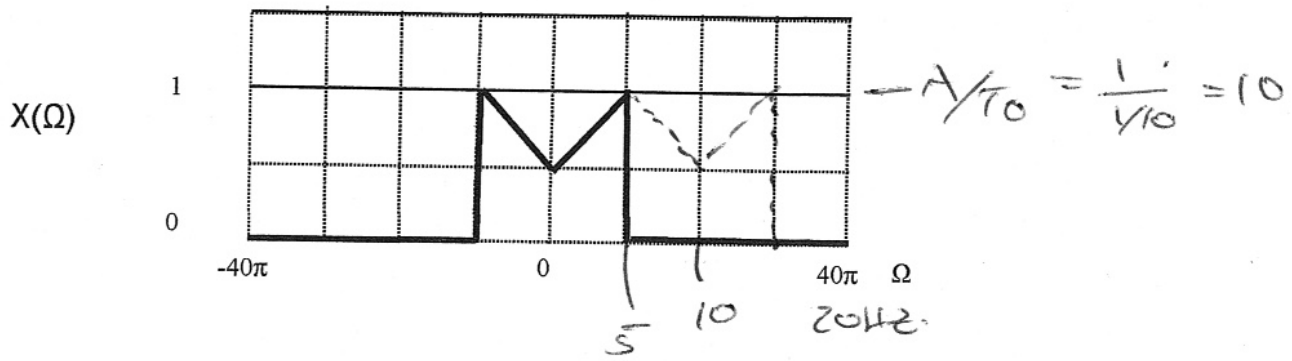
$H(0) = 1 - 1 = 0$ ✓
$H(\pi) = 1 - 1 + (-1)(-1) = 2$ ✓



some exams $h[n] = \delta[n-1] + \delta[n]$
$H(0) = 2$
$H(\pi) = 0$

5 Points Each (Circle the best answer)

For the following questions, the frequency spectrum X(Ω) for a continuous time signal x(t) is given below.

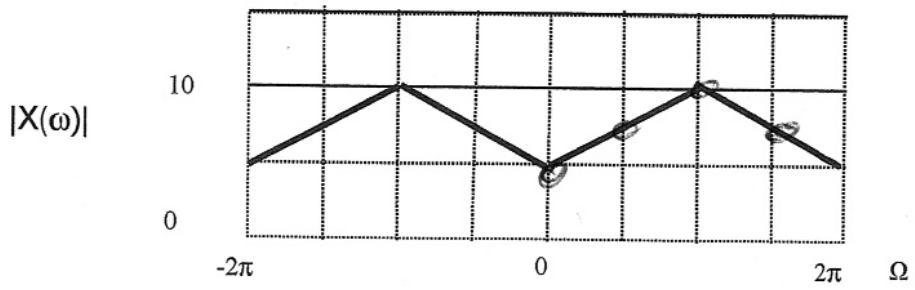


35. To avoid aliasing, the signal x(t) must be sampled at a rate greater than

a) 5 Hz b) 5π Hz c) 10 Hz d) 25 Hz e) none above

36. If the signal x(t) is sampled at 10 Hz, the DTFT results in |X(ω)| as shown below

a) True b) False



37. The magnitude of the 4-point DFT of the signal x(t) sampled at 10 Hz is |X[k]| =

a) {10,5,0,5} b) {10,5,0,10} c) {5,7.5,10,5} d) none above

{5, 7.5, 10, 7.5}

JAVA Not used Any More.

5 Points Each (Circle the best answer)

The following questions refer to the Java class below and the program main().

```
public class Green {
  private int a;  private int b;

  public Green(int aa, int bb)
        { a=aa; b=bb; }
  public void equals(Green  c)
        { this.a= c.a;  this.b=c.b; }
  public void fn(Green c)
        { this.a = 2*c.a – 3*this.a;
          this.b = c.a – 2*this.b; }
  public void gg()
        { this.a =  this.b – this.a;
          this.b =  this.a ; }

  public static void main(String[] args) {
          Green x = new Green (2,1);
          Green y = new Green (3,1);
          Green z = new Green (1,4);
          int xx=1,yy=2,zz=3;
          x.fn(y);
          z.gg();
  }
}
```

38. At the end of the main program, x.a=

a) 0 b) 1 c) 2 d) 3 e) None above

39. At the end of the main program, x.b=

a) 0 b) 1 c) 2 d) 3 d) None above

40. At the end of the main program, z.b=

a) 0 b) 1 c) 2 d) 3 d) None above