ECGR4124 **FINAL** **SPRING 2003**

Do NOT begin until told to do so
Make sure that you have all pages before starting
You may not leave the room during the exam
No calculators, open book, 2 page notes

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.

Name: _____

Student Number: _____

Unless otherwise noted:

Show all work, even for multiple choice
Multiple choice answers should be within 5% of correct value
x[n] is input, and y[n] output of a system
$\mathcal{F}\{\}$ denotes either continuous Fourier transform or DTFT
$\mathcal{F}^{-1}\{\}$ denotes inverse Fourier transform or DTFT
$\mathcal{F}_D\{\}$ denotes DFT
$\mathcal{Z}\{\}$ denotes z-transform
Ω denotes the continuous-time frequency variable
ω denotes the normalized discrete-time frequency variable
$*$ denotes linear convolution
$\otimes$ denotes circular convolution
$x^*(t)$ denotes the conjugate of x(t)
Discrete functions are denoted with square brackets, $x[n]$
Continuous functions are denoted with round brackets, $x(n)$
$\mathcal{L}\{\}$ denotes Laplace transform

Useful constants, etc:

$$\begin{array}{cccc} e \approx 2.72 & \pi \approx 3.14 & 1/e \approx 0.37 & \sqrt{2} \approx 1.41 \\ \sqrt{3} \approx 1.73 & \sqrt{5} \approx 2.22 & \sqrt{7} \approx 2.64 & \sqrt{10} \approx 3.16 \\ log_{10}[2] \approx 0.30 & log_{10}[3] \approx 0.48 & log_{10}[5] \approx 0.70 & log_{10}[10] \approx 1.0 \\ log_{10}[0.1] \approx -1.0 & log_{10}[0.5] \approx -0.3 & log_{10}[e] \approx 0.43 & cos(\pi/4) \approx 0.707 \end{array} \quad (1)$$

$cos(A)cos(B) = \frac{1}{2}cos(A-B) + \frac{1}{2}cos(A+B)$ $\qquad e^{j\theta} = cos(\theta) + jsin(\theta)$
$cos^2(A) = \frac{1}{2} + \frac{1}{2}cos(2A)$ $\qquad \mathcal{L}\{e^{-at}u(t)\} = 1/(s+a)$

5 Points Each (Circle the best answer)

1. If $X(z) = z + z^{-1}$, $0 < |z| < \infty$ then x[0] =

   (a) 0 (b) 1 (c) z (d) None above

2. If $X(z) = z + z^{-1}$, $0 < |z| < \infty$ then x[1] =

   (a) 0 (b) 1 (c) z (d) None above

3. A system initially at rest is described by the difference equation $y[n] = 3\,x[n-1] + 2x[n-2]$. This system is linear.

   (a)True (b) False

4. A filter with $H(z) = \frac{z-1}{1+z^{-1}/3}$, $|z| > 1/3$ is BIBO stable.

   (a) True (b) False

5. IIR filters are always stable.

   (a) True (b) False

5 Points Each (Circle the best answer)

6. A filter with z-transform $H(z) = 2 + 3z^{-1} + 4z^{-2}$ is an IIR filter since $H(z) = \infty$ when z=0.

   (a) True (b) False

7. The DC response of a filter with impulse response $h[n] = 2u[n] - 2u[n-2]$ is

   (a) 0 (b) 2 (c) 4 (d) None above

8. The DFT of the length N sequence h[n] is equal to the values of H(z) at N equally spaced points on the unit circle, including z=1.

   (a) True (b) False

9. A system is described by the difference equation $y[n] = x[n] + 2y[n-3]$. The frequency response $H(\omega)$ is.

   (a) $1/(1 - 2e^{-j3\omega})$ (b) $1/(1 - 3e^{-j2\omega})$ (c) $1 + 2e^{-j3\omega}$ (d) None above

10. An analog frequency of 200 Hz after sampling at 1000 samples/second would correspond to a discrete time frequency ω of

    (a) $\pi/2$ (b) $\pi/4$ (c) 0.4π (d) None above

5 Points Each (Circle the best answer)

11. The DC response of a filter with $\mathcal{Z}\{h[n]\} = H[z] = \frac{1-z^{-1}+2z^{-2}}{1+z^{-2}}$ is

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

12. The magnitude of the frequency response $H(\omega)$ at $\omega = \pi$ of a filter with $\mathcal{Z}\{h[n]\} = H[z] = \frac{2-2z^{-1}}{1+z^{-2}}$ is

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

13. $H(z)$ for a system with impulse response $h[n] = 2^n u[-n-1]$ is

(a) $-2^n\delta(z-n)$ (b) $-z/(z-2)$ (c) $z/(z-0.5)$ (d) None above

14. A Low Pass FIR filter designed with a Hanning window will have lower sidelobes than one designed with a Bartlett window.

(a) True (b) False

15. A Low Pass FIR filter designed with a Hanning window will have wider transition width than one designed with a Bartlett window.

(a) True (b) False

5 Points Each (Circle the best answer)

16. H(z) for a system with impulse response $h[n] = 2\delta[n-3]$ is

(a) $2H(z-3)$ (b) $2/(z^3)$ (c) $2\delta[z-3]$ (d) None above

17. The circular convolution of the N=4 point sequences $x[n] = \{2, 2, 2, 0\}$, and $x[n] = \{1, 0, 1, 0\}$, is

(a) $\{4, 2, 4, 2\}$ (b) $\{2, 2, 2, 4\}$ (c) $\{2, 0, 2, 0\}$ (d) None above

18. In the DFT $X[k]$ of the N=4 point sequence $x[n] = \{2, 0, 0, 0\}$, $X[2] =$

(a) 0 (b) 2 (c) 4 (d) None above

19. A causal filter with $H(z) = \frac{z-1}{z^2-4}$ is BIBO stable.

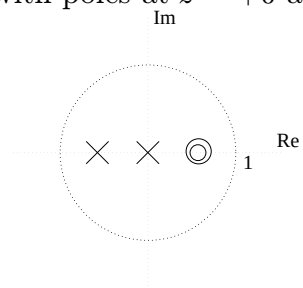
(a) True (b) False

20. The FFT of $x[n]$ equals the DFT of $x[n]$.

(a) True (b) False

5 Points Each (Circle the best answer)

The following questions refer to the pole-zero plot of H(z) below, with a double zero at z=0.5 and with poles at $z = +0$ and $z = -0.5$.



21. Sketch the causal ROC in the above figure.

22. The causal system associated with H(z) is BIBO stable.

(a)True (b) False

23. H(z) =

(a) $\frac{z^2}{(z-0.5)z}$ (b) $\frac{z^2-0.5}{(z+0.5)z}$ (c) $\frac{(z-0.5)^2}{(z+0.5)z}$ (d) None above

24. The magnitude of the frequency response $H(\omega)$ of the system at $\omega = 0$ is

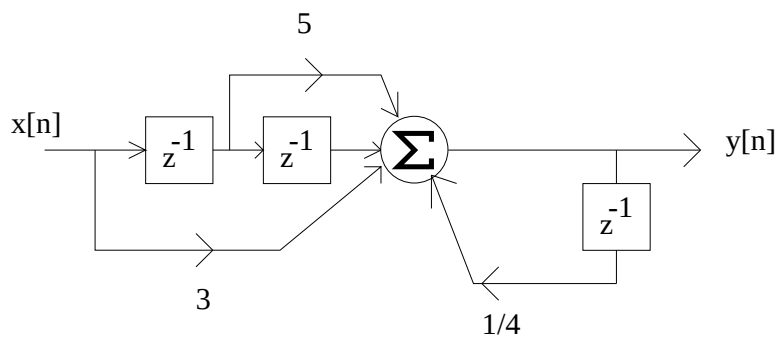
(a) 0 (b) 1/6 (c) 3/2 (d) none above

25. The impulse response h[n] for the causal system at n=0 would be $h[0] =$

(a) 0.5 (b) 1 (c) 2.5 (d) none above

5 Points Each (Circle the best answer)

The following questions refer to the system below.



26. The difference equation for the above system is $y[n] = 3x[n] + 5x[n-1] + x[n-2] + y[n-1]/4$.

    (a)True (b) False

27. H(z) =

    (a) $\frac{3z^2+5z+1}{z^2/4+1}$ (b) $\frac{z/4+1}{3z^2+5z+1}$ (c) $\frac{3z^2+5z+1}{z^2-z/4}$ (d) None above

28. The first 2 points of h[n] =

    (a) $\{3, 23/4\}$ (b) $\{3, 5\}$ (c) $\{3, 5/4\}$ (d) None above

29. The filter is an FIR filter.

    (a)True (b) False

30. The above system is BIBO stable.
    (a)True (b) False

$$h(t) = 2^{-4t}u(t)$$

10 points

31. The above continuous time filter is transformed into a digital filter using the impulse invariance method where the sampling rate is$f_s = 4Hz$. The discrete-time impulse response $h[n]$ of the resulting filter, is

(a) $h[n] = 0.25(1/2)^n u[n]$
(b) $h[n] = (1/8)^n u[n]$
(c) $h[n] = 0.25(2)^{-4n} u[n]$
(d) None above

5 points

32. The resulting digital filter is BIBO stable.
(a)True (b) False

$$H(s) = \frac{1}{s^2+4}$$

10 points

33. The above continuous time filter is transformed into a digital filter using the bilinear transform method where the sampling rate is$f_s = 1Hz$. The z-tranzform $H(z)$ of the resulting filter, is

(a) $H(z) = \frac{(z-1)^2}{4z^2+4}$
(b) $H(z) = \frac{(z+1)^2}{8z^2+8}$
(c) $H(z) = \frac{z^2+4}{(z-1)^2}$
(d) None above

5 points

34. The resulting digital filter is will have the same 3 dB cutoff frequency as the original analog filter.
(a)True (b) False