EEGR4124 **FINAL EXAM** **SPRING 1998**

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 (1997-99 Catalog page 336). 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:

$$\begin{array}{cccc} e \approx 2.72 & \pi \approx 3.14 & 1/e \approx 0.37 & \sqrt{2} \approx 1.41 \\ \sqrt{3} \approx 1.73 & \sqrt{5} \approx 2.22 & \sqrt{7} \approx 2.64 & \sqrt{10} \approx 3.16 \\ log_{10}[2] \approx 0.30 & log_{10}[3] \approx 0.48 & log_{10}[5] \approx 0.70 & log_{10}[10] \approx 1.0 \\ log_{10}[0.1] \approx -1.0 & log_{10}[0.5] \approx -0.3 & log_{10}[e] \approx 0.43 & cos(\pi/4) \approx 0.79 \end{array} \tag{1}$$

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

5 Points Each (Circle the best answer)

1. If $x[n] = \delta[n-1] + 2\delta[n-2] + 2^n u[n]$ then x[0] =

   (a) 1 (b) 2 (c) 4 (d) None above

2. If $x[n] = \delta[n-1] + 2\delta[n-2] + 2^n u[n]$ then x[1] =

   (a) 1 (b) 2 (c) 4 (d) None above

3. A system transformation is $y[n] = (x[n])^2$. This system is linear.

   (a)True (b) False

4. If the sampling rate in a system is 1000 Hz, the highest frequency component in the signal must be less than

   (a) 500 Hz (b) 1000 Hz (c) 2000 Hz (d) None above

5. Two systems with impulse responses $h1[n] = \delta[n]$ and $h2[n] = \delta[n]$ are cascaded. The overal impulse response is

   (a) $\delta[n]$ (b) $\delta[n-1]$ (c) $2\delta[n]$ (d) None above

5 Points Each (Circle the best answer)

6. The form of the homogeneous solution of a difference equation is Az^{-n}, where z is in general complex.

   (a)True (b) False

7. An analog frequency of 1000 Hz after sampling at 8000 samples/second would correspond to a discrete time frequency ω of

   (a) $\pi/16$ (b) $\pi/4$ (c) π (d) None above

8. The DTFT of $2\delta(n+2)$ is

   (a) $2e^{j2\omega}$ (b) $2e^{j2\omega}$ (c) $2e^{-j2\omega}$ (d) None above

9. The DTFT of $n\delta(n-2)$ is

   (a) $2e^{j2\omega}$ (b) $ne^{j2\omega}$ (c) $2e^{-j2\omega}$ (d) None above

10. IIR filters are always stable.

    (a) True (b) False

5 Points Each (Circle the best answer)

11. The bilinear transform is generally used to design FIR filters.

(a) True

(b) False

12. The length 4 sequence $\{1, 2, 3, 4\}$ undergoes a circular shift of 3. $x[((n-3))_4] =$:

(a) $\{1, 2, 3, 4\}$

(b) $\{2, 3, 4, 1\}$

(c) $\{4, 2, 3, 1\}$

(d) None above

13. A causal filter with $H(z) = \frac{z-1}{(z-.5)(z+.5)}$ is BIBO stable.

(a) True

(b) False

14. The DC response $H(\omega), \omega = 0$ of a filter with $H(z) = \frac{z}{(z-.5)(z+1)}$ is

(a) 0

(b) 1/2

(c) 1

(d) None above

15. The response $H(\omega), \omega = \pi$ of a filter with $H(z) = \frac{z}{(z-.5)(z+1)}$ is

(a) 0

(b) 1/2

(c) 1

(d) None above

5 Points Each (Circle the best answer)

16. If the impulse response of a system is $h[n] = \delta[n] + 2^n u[n]$ then the system is BIBO stable

(a)True (b) False

17. If the sampling period in a system is 0.01 seconds, the highest frequency component in the signal must be less than

(a) 50 Hz (b) 100 π Hz (c) 2000 Hz (d) None above

18. H(z) for a system with impulse response $h[n] = \delta[n-1] + 3\delta[n-2]$ is

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

19. The DC response of a discrete time filter with impulse response $h[n] = \delta[n-1] + 3\delta[n-2]$ is

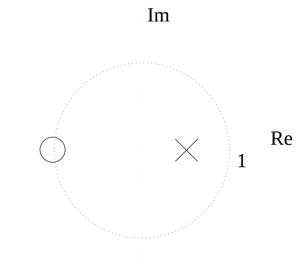
(a) 0 (b) 1/4 (c) 4 (d) None above

20. $H(z)$ 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

5 Points Each (Circle the best answer)

The following questions refer to the pole-zero plot of H(z) below, with a zero az z=-1 and pole at z=1/2.



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

(a)True (b) False

22. H(z) =

(a) $(z-.5)/(z+1)$ (b) $(z-1)/(z-.5)$ (c) $(z+1)/(z+.5)$ (d) None above

23. The causal ROC is

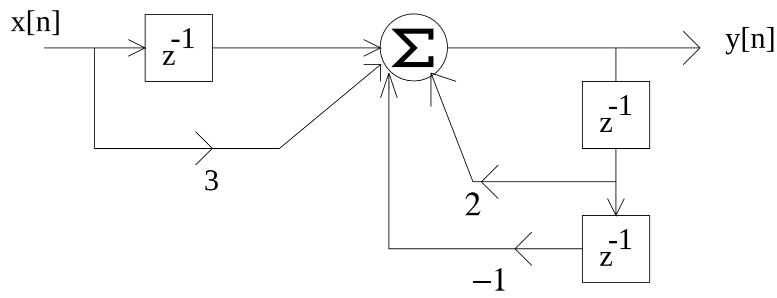
(a) $|z|>1$ (b) $|z|>1/2$ (c) $|z|<1/2$ (d) None above

24. The DC frequency response $H(\omega), \omega = 0$ is

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

25. A valid difference equation for the system would be $y[n] = y[n-0.5] + x[n+1]$

(a)True (b) False



15 points

26. Find H(z) for the above filter.

15 points

27. Find the first 5 points of the impulse response $h[n]$ for the above filter from $n = 0$ to $n = 4$.

15 points

28. Find the discrete-time version $H(z)$ of the continuous time filter:

$$H(s) = \frac{8}{(s+2)(s+4)}$$

using the bilinear transform method when the sampling rate is $f_s = 1Hz$. Express the result in the form of the ratio of two polynomials in z.

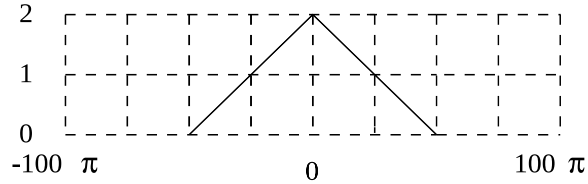
10 points

29. Find the discrete-time impulse response $h[n]$ for a continuous time filter with impulse response:

$$h(t) = e^{-40t}$$

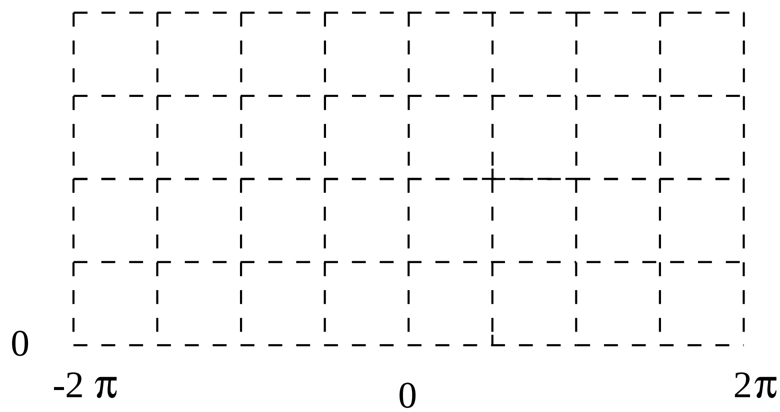
using the impulse invariance method when the sampling rate is $f_s = 10Hz$.

The frequency spectrum $|X(\Omega)|$ of continuous time signal x(t) is given below.



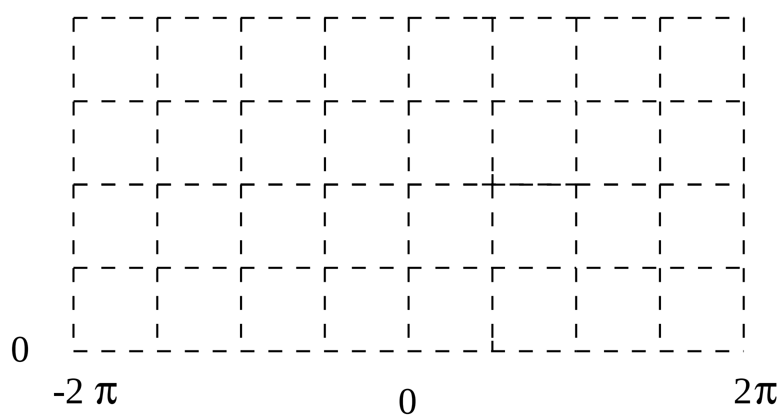
15 points

30. If the continuous time signal is sampled at at 100 samples per second, sketch the discrete-time frequency spectrum $|X(\omega)|$ below. Include labels on the amplitude axis.



10 points

31. If the above discrete-time signal is now downsampled by a factor M=2, sketch the resulting discrete-time frequency spectrum $|X(\omega)|$ below. Include labels on the amplitude axis.



15 points

32. Find the discrete-time version $H(z)$ of the continuous time filter:

$$H(s) = \frac{8}{(s+100)}$$

using the impulse invariance method when the sampling rate is $f_s = 10Hz$. You need not reduce terms of the form e^{α}.

10 points

33. Sketch the block diagram of the filter below, using z^{-1} delay blocks, weights, and adders. You need not reduce terms of the form e^{α}.

5 Points Each (Circle the best answer)

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

```
class Green{
        private:
                int a;
                int b;
        public:
                Green(int aa, int bb)
                        { a=aa; b=bb; }

                Green& Green::operator=(Green & c)
                        { a= c.a; b=c.b; return (*this); }

                int  Green::add()
                        { return (*this).a + (*this).b; }

                Green  Green::add(Green & c)
                        { a=a + c.a; b=b+c.b; return (*this); }
}

main(){
        Green x(1,2), y(2,3), z(3,4);
        int xx=5,yy=6,zz=7;

        x=x.add(y);
        zz=z.add(); }
```

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

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

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

(a) 5 (b) 6 (c) 7 (d) None above

36. At the end of the main program, zz=

(a) 5 (b) 6 (c) 7 (d) None above

37. At the end of the main program, y.a=

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