ECGR4124 **FINAL** **SPRING 2002**

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:

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

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

5 Points Each (Circle the best answer)

1. IIR filters are always stable.

   (a) True   (b) False

2. The DTFT of $(1/2)^{(n-1)}u[n-1]$ is

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

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

   (a)True   (b) False

4. A filter with $H(z) = \frac{z-1}{z+2}$, $|z| > 2$ is BIBO stable.

   (a) True   (b) False

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

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

5 Points Each (Circle the best answer)

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

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

7. An analog frequency of 250 Hz after sampling at 1000 samples/second would correspond to a discrete time frequency ω of

(a) $\pi/2$ (b) $\pi/4$ (c) 0.2π (d) None above

8. If $X(z) = z$ then x[1] =

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

9. 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

10. If an analog filter is stable, the impulse invariance method guaranteees that the discrete time filter will be stable.

(a) True (b) False

5 Points Each (Circle the best answer)

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

(a) z (b) $1/(z)$ (c) $\delta[z]$ (d) None above

12. $H(z)$ 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

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

(a) True (b) False

14. If the highest frequency in a signal is 2000 Hz, the sampling rate to prevent aliasing must be greater than

(a) 1000 Sample/s (b) 2000 Sample/s (c) 4000 Sample/s (d) None above

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

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

5 Points Each (Circle the best answer)

16. A causal filter with $H(z) = \frac{z-1}{(z-2j/3)(z+2j/3)}$ is BIBO stable.

(a) True (b) False

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

(a) True (b) False

18. The response $|H(\omega)|, \omega = \pi$ of a filter with $H(z) = \frac{z}{(z+1/2)}$ is

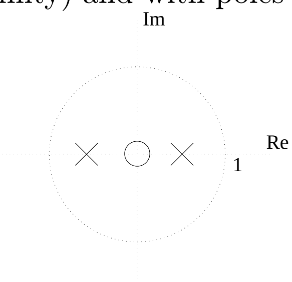
(a) 1 (b) 2 (c) 3 (d) None above

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

(a) 0 (b) 2 (c) 4 (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 at z=0 (and one at infinity) and with poles at $z = +0.5$ and $z = -0.5$.



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

(a)True (b) False

21. Sketch the causal ROC in the above figure.

22. H(z) =

(a) $\frac{z^2}{(z-0.5)(z+0.5)}$ (b) $\frac{1}{(z-0.5)(z+0.5)}$ (c) $\frac{z}{(z-0.5)(z+0.5)}$ (d) None above

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

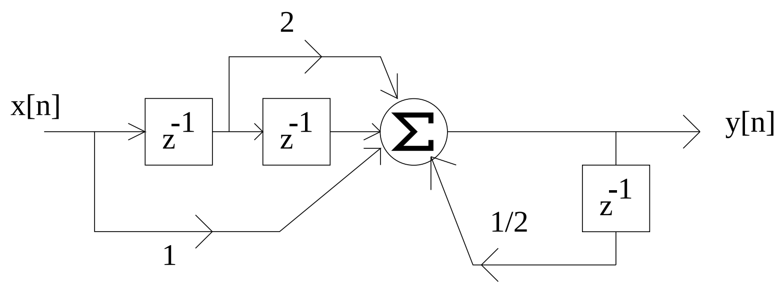
(a) 0 (b) 4/3 (c) 3/2 (d) 9

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

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

5 Points Each (Circle the best answer)

The following questions refer to the system below.



25. The difference equation for the above system is $y[n] = x[n] + 2x[n-1] + x[n-2] + 2y[n]$.

(a)True (b) False

26. H(z) =

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

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

(a) $\{1.5, -0.5\}$ (b) $\{1, 2.5\}$ (c) $\{1, 0\}$ (d) None above

28. The filter is an FIR filter.

(a)True (b) False

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

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

5 points

30. The above continuous time filter is transformed into a digital filter using the impulse invariance method where the sampling rate is$f_s = 2Hz$. The discrete-time impulse response $h[n]$ of the resulting filter, is

(a) $h[n] = 0.5(1/2)^n u[n]$
(b) $h[n] = (1/2)^n u[n]$
(c) $h[n] = 2(1/2)^n u[n]$
(d) None above

5 points

31. The DC response of the resulting digital filter is zero.
(a)True (b) False

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::mult(int zz)
                        { return zz * (*this).a; }

                Green  Green::pull(Green & z)
                        { (*this).a = z.b ; return (*this); }
}

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

        x=x.pull(y);
        zz=z.mult(3); }
```

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

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

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

(a) 0 (b) 2 (c) 6 (d) None above

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

(a) 0 (b) 6 (c) 12 (d) None above

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

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

Exam A