KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

COE-341 – Data and Computer Communication
April 14th, 2009 – Major Exam #1

Student Name:
Student Number: **ModelA**
Exam Time: 90 mins

- Do not open the exam book until instructed
- The use of programmable calculators and cell phone calculators is not allowed – only basic calculators are permitted
- Answer all questions
- All steps must be shown
- Any assumptions made must be clearly stated

Question No.	Max Points	
1	40	
2	40	
3	20	
4	20	
5	40	
Total:	160	

Q.1) (40 points) Mark the following statements with either TRUE (T) or FALSE (F)

1	All periodic signals have a harmonic at the fundamental frequency	
2	Intermodulation noise is caused by linearity in the transmitter/receiver system	
3	Noise power spectral density has the units of Watts per Hz.	
4	The NTSC video screen is effectively refreshed once every 1/30 of the second	
5	Equalization is used to reduce the problem of attenuation distortion.	
6	Synchronization is one communication task where the address info is used by the medium to redirect transmissions.	
7	Spectral efficiency is a measure of number of bits per second the system can deliver per unit of the bandwidth	
8	The IP protocol stack is less structured compared to the OSI reference model.	
9	Impulse noise is a major concern for digital data	
10	Multi-level signaling can increase the capacity of a channel.	
11	All periodic signals have a DC component at zero frequency.	
12	The vertical retrace in a video signal refers to the refreshing rate of the image	
13	Network access layer in the IP stack is responsible for addressing and routing of data packets	
14	Fourier Series Expansion covered in class can be used for periodic and non periodic signals	
15	The NTSC video signal has a total of 525 horizontal lines.	
16	The network layer in the OSI protocol stack is responsible for controlling the dialogue between applications at the end systems.	
17	Cross talk noise results from media resistance.	
18	TV broadcast is an example of half-duplex communication.	
19	Delay distortion is the result that different frequency components are attenuated differently.	
20	Typically the lower layers of the OSI and IP protocol stacks are within the user domain.	

Q.2) (40 points) For each of the following questions select the *most* appropriate answer:

1. A Telephone line system has a bandwidth equal to 4kHz. The minimum required signal-to-noise power ratio to achieve an error free capacity of 56 kb/s is equal to
    a. The given bandwidth can not support 56 kb/s
    b. 32 dB
    c. 42 dB
    d. -32 dB

2. If it is desired to achieve the capacity of 56 kb/s for the telephone line system in the above question through multi-level signaling, then the number of signal levels must be at least equal to
    a. 512
    b. 2048
    c. 16384
    d. 32768

3. Image resolution refers to
    a. The number of image pixels in the x and y directions
    b. The number of frames per second used for refreshing
    c. The number of colors assigned to each pixel
    d. None of the above

4. To achieve full connectivity between N nodes using direct point-to-point links, assuming full duplex links, the required number of links is equal to
    a. N links
    b. N^2 links
    c. Nx(N-1)/2 links
    d. N^3 links

5. For a system of Bandwidth B Hz, Nyquist capacity (in bits/sec) limit is given by
    a. Infinite since noise is not a factor
    b. Limited only by the symbol set size
    c. 2 symbols per Hz
    d. All the above

6. The size of an uncompressed digital video image of size 1600 x 1200 pixel with 65,536 colors per pixel is equal to
    a. 3.7 MB
    b. 234.3 KB
    c. 14.6 GB
    d. Need more information to calculate the size

7. A TV signal with 400 horizontal lines with 500 pixels per line and 50 μsec to scan these pixels has a bandwidth equal to
    a. 200 cycles per second
    b. 400 MHz
    c. 500 cycles per second
    d. 5 MHz

8. Interlacing, in video technology, means
    a. The number of frames per second is high
    b. The picture is scanned twice every cycle
    c. The odd lines of picture are scanned first and then the even lines
    d. Odd pixels of picture are scanned first and then the even pixels

9. The vertical retrace time is
    a. The time required to refresh the picture
    b. The time to move the electron beam from left to right of screen
    c. The time to move the electron beam from bottom to top of screen
    d. The time to send the picture

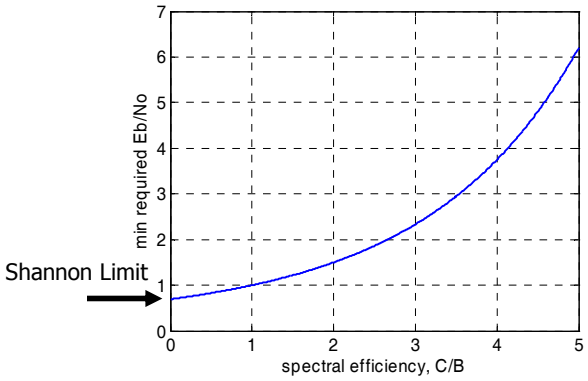
10. The period for the function $s(t) = [10\cos(t)]^2$ is equal to (where t in seconds)
    a. T seconds
    b. π seconds
    c. 1 second
    d. 1 msec

11. The function $s(t)$ in (10) has a DC component equal to
    a. 50 volts.
    b. 100 volts.
    c. 10 volts.
    d. 0.5 volts.

12. If the received signal level for a particular digital system is -151 dBW and the receiver system effective noise temperature is 1500 degrees Kelvin., the noise spectral density, N_0, is equal to (Boltzman constant, $k = 1.3803 \times 10^{-23}$ J/degree Kelvin)
    a. 196.8 dB
    b. -196.8 dBW
    c. -196.8 dBmW
    d. -196.8 dB

13. If the data rate is 2400 bit/sec, the Eb/N0 ratio for the signal in (12) is equal to
    a. -12 dBW
    b. 12 dBmW
    c. 12 dB
    d. 10 dB

14. Consider the graph showing the Shannon limit of 0.6965 or -1.6 dB. This means
    a. All practical communication systems can achieve error-free capacity with Eb/No equal or less than -1.6 dB.
    b. All practical system can not achieve error-free capacity with Eb/N0 equal or less than -1.6 dB.
    c. Any practical implementation may achieve error-free capacity with Eb/N0 equal to -1.6 dB.
    d. None of the above.



15. Frame relay technology is based on the assumption
    a. No need for error control in intermediate switching nodes
    b. There is no requirement for large overhead in switched frames
    c. The connecting links have great capacity with low error rates
    d. All the above

16. For all periodic signals, the following applies:
    a. The theoretical bandwidth is infinite, but most of the power occurs at the lower frequencies.
    b. The theoretical bandwidth can be finite or infinite, but most of the power occurs at the lower frequencies.
    c. The theoretical bandwidth can not be determined, but most of the power occurs at the lower frequencies.
    d. The theoretical bandwidth can not be determined, but most of the power occurs at the higher frequencies.

17. A 1 watt power level is equal to
    a. 30 dBW
    b. 0 dB
    c. 30 dBmW
    d. 1 dB

18. For a 1 mW input signal, your audio/video amplifier whose gain is 30 dB will produce an output power equal to
    a. 30 dBmW
    b. 30 mW
    c. 30 dB
    d. 1 W

19. The human ear acts like a receiver whose typical bandwidth is
    a. 20 Hz to 4kHz
    b. 40 Hz to 20kHz
    c. 40 Hz to 40kHz
    d. 0 Hz to 3.5kHz

20. The public telephony switching network (PTSN) is a classical example of a networking deploying
    a. Message switching technology
    b. Circuit switching technology
    c. Packet switching technology
    d. ATM and frame-relay technology

Q3) (20 points) Consider the spectrum for speech (shown in solid line) and music (shown in dashed line) signals shown in Fig 1. Answer the following questions:

a) What is the typical bandwidth for the speech signal?

b) What is the typical bandwidth for the music signal?

c) What is the significance of the y-axis? What are the units of the y-axis? Why?

d) Which of the two signals (speech or music) has wider variation in power associated with its frequency components? Why? Note this is not regarding the bandwidth for each of the two signals!!

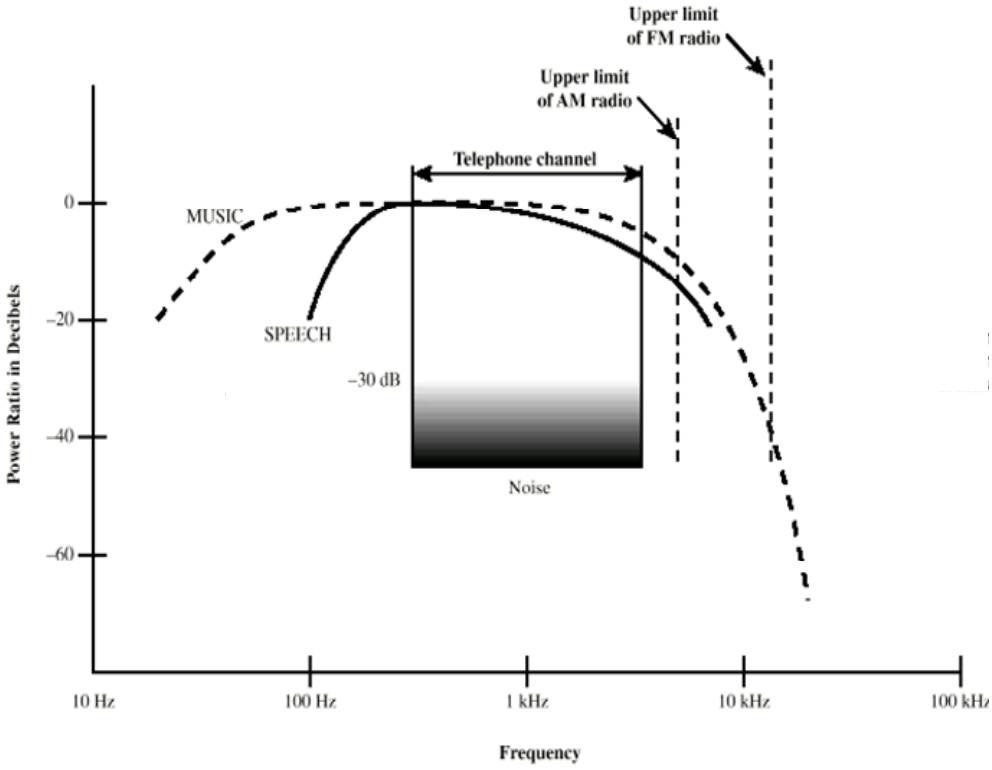


Fig.1: Spectrum for typical voice and music signals.

Q4) (20 points) On the subject of attenuation: (a) Explain what is attenuation and how does cause signal distortion? (b) Is it a major concern for digital signals? Why?

Q.5) (40 points) Consider the function shown in the figure (T = 1 sec, A = 1 volt).

a) (5 points) write an expression for $s(t)$?

b) (5 points) Compute the total power of $s(t)$?

c) (10 points) Find the Fourier series expansion of $s(t)$

d) (6 points) Specify the PSD function for s(t)?

e) (7 points) find n* such that power of s_e(n=n*) is 95% or more of the power contained in $s(t)$?

f) (7 points) An ideal LOW pass filter is a circuit that allows low frequency components to pass unaffected while it suppresses high frequency components. If the signal $s(t)$ is passed through this LOW pass filter which passes all frequencies in [0, $2f_0$] (i.e. including $2f_0$), but suppresses all frequencies in the interval ($2f_0$, ∞) – Write an expression for the output signal, $s_o(t)$, and find its total power?

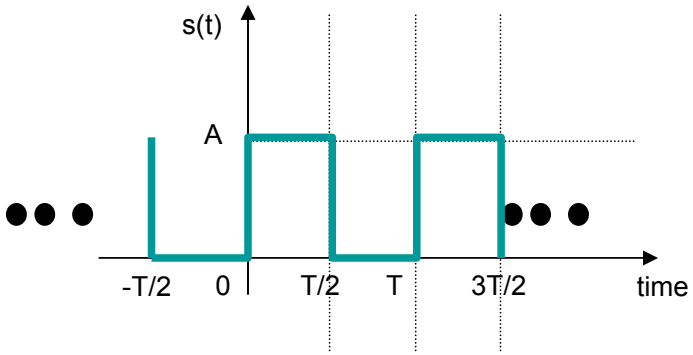


Figure: Question 5

Appendix: Relations you MAY need

$$\cos(a) = \cos(-a) \qquad \sin(a) = -\sin(a)$$

$$\cos(a +/- b) = \cos(a)\cos(b) -/+ \sin(a)\sin(b)$$

$$\sin(a +/- b) = \sin(a)\cos(b) +/- \cos(a)\sin(b)$$

$$\sin(2a) = 2\sin(a)\cos(b)$$

$$\cos(2a) = \cos^2(a) - \sin^2(b) = 2\cos^2(a) - 1 = 1 - 2\sin^2(a)$$

$$\cos(ax)^2 = \frac{1}{2} + \frac{1}{2}\cos(2ax)$$

$$\sin(ax)^2 = \frac{1}{2} - \frac{1}{2}\cos(2ax)$$

$$\int \cos(ax)dx = \frac{1}{a}\sin(ax) + C$$

$$\int \sin(ax)dx = \frac{-1}{a}\cos(ax) + C$$

$$\int \cos(ax)^2 dx = \frac{x}{2} + \frac{1}{4a}\sin(2ax) + C$$

$$\int \sin(ax)^2 dx = \frac{x}{2} - \frac{1}{4a}\sin(2ax) + C$$

$$\int x\cos(ax)dx = \frac{\cos(ax)}{a^2} + \frac{x\sin(ax)}{a}C$$

$$\int x\sin(ax)dx = \frac{\sin(ax)}{a^2} - \frac{x\cos(ax)}{a}C$$