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

COE-341 – Data and Computer Communication
March 23th, 2010 – 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	30	
3	30	
4	20	
5	40	
Total:	160	

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

1	The network access layer in the IP protocol stack is responsible for routing function across the Internet.	
2	The OSI model networking nodes assumes seven or five layers depending on type of network.	
3	Power spectral density has the units of Watts per Hz.	
4	All periodic signals have a harmonic at the fundamental frequency.	
5	Quality-of-service parameters for network applications include throughput, delay, delay variation, and packet loss.	
6	Synchronization is one communication task where the address info is used by the medium to redirect transmissions.	
7	Inelastic traffic does not adapt to changes in delay and throughput across the network.	
8	The IP protocol stack is less structured compared to the OSI reference model.	
9	HTTP and FTP are examples of transport protocols used over the Internet.	
10	The operation of ATM and frame relay assumes reliable and relatively fast transmission speeds.	
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	For a circuit switching session across a network, a dedicated path between the source and destination is established.	
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	The ATM network uses fixed-sized cells that are equal to 53 bytes.	
18	TV broadcast is an example of half-duplex and not full-duplex communication mode.	
19	The Public Switched Telephone Network (PSTN) is an example of a packet switched network.	
20	Typically the lower layers of the OSI and IP protocol stacks are within the user domain.	

Q.2) (30 points) For each of the following questions select the *most* appropriate answer:

1. 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

2. 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. $N^2/2$ links
    c. $N(N-1)/2$ links
    d. N^3 links

3. 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

4. The typical bandwidth of the TV (video) signal is equal to
    a. 400 KHz
    b. 400 MHz
    c. 1 MHz
    d. 4 MHz

5. Interlacing in video technology means that
    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

6. 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

7. 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

8. The function $s(t)$ in (7) has a DC component equal to
    a. 50 volts.
    b. 100 volts.
    c. 10 volts.
    d. 0.5 volts.

9. 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

10. 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

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

12. 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. 30 W

13. The presentation layer in the OSI protocol stack has the following responsibilities:
    a. The presentation layer is not part of the OSI protocol stack.
    b. Defines format of data to be exchanged by applications.
    c. Controlling dialog between applications at end systems.
    d. Both (b) and (c).

14. Examples of application that utilize elastic traffic include:
    a. FTP and HTTP traffic.
    b. Voice over IP (VOIP) and video streaming.
    c. Real-time plant/measurement data.
    d. All the above.

15. Attenuation of signals has the following general characteristic:
    a. The attenuation is typically flat and equal for all frequencies.
    b. The smaller the signal frequency the greater the attenuation.
    c. The higher the signal frequency the greater the attenuation.
    d. None of the above.

Q3) (30 points) On the subject of protocol architectures:

The services between adjacent layers in the OSI architecture are expressed in terms of primitives. To transfer a packet data unit (PDU) from layer N to its peer layer at the other end system, a specified sequence of service primitives must be executed.

a) (10 points) List these service primitives and explain briefly the purpose of each?

b) (5 points) Assume a confirmed service type – Specify the *sequence execution* order using a diagram similar to that in class notes.

c) (5 points) Assume a non-confirmed service type – Specify the *sequence execution* order using a diagram similar to that in class notes.

d) (10 points) Draw the TCP/IP protocol stack and indicate the layers in your drawing.

For parts (b) and (c) the student must indicate the sequence (i.e. order) of execution of the required primitives.

Q4) (20 points) On the subject of signal impairments:

(a) (8 points) List 4 advantages for digital transmission and *very briefly* (few words) explain each one of these advantages?

(b) (7 points) Explain how delay distortion can occur emphasizing the different between attenuation distortion and delay distortion.

(c) (7 points) For an ADSL system of bandwidth equal to 1MHz and an effective temperature of 1500 Kelvin, calculate the total noise power in Watts and also in dBmW for such system. Assume the Boltzman constant is equal to 1.3803×10^{-23} J/degree Kelvin.

Q.5) (40 points) On the subject of Fourier Series Expansion:

Consider the periodic signal $s(t)$ whose Fourier series expansion is given by:

$$s(t) = \frac{A}{2} + \sum_{n=1,3}^{5} \left(\frac{-4A}{\pi^2 n^2}\right) \cos(2\pi n f_0 t) \text{ , or}$$

$$s(t) = \frac{A}{2} + \left(\frac{-4A}{\pi^2}\right) \cos(2\pi f_0 t) + \left(\frac{-4A}{\pi^2 3^2}\right) \cos(2\pi \times 3 f_0 t) + \left(\frac{-4A}{\pi^2 5^2}\right) \cos(2\pi \times 5 f_0 t)$$

where A = 1 volt, and f_0 = 1Hz.

a) (3 point) What is the period of the function $s(t)$?

b) (2 point) What is the fundamental frequency for $s(t)$?

c) (5 points) What is the DC component of $s(t)$?

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

e) (10 points) Draw the power spectral density function for $s(t)$.

f) (5 points) Determine fmin, fmax, and the bandwidth for $s(t)$.

g) (10 points) A low pass filter (LPF) is a filter that passes all frequency components ranging from 0 Hz till some cut-off frequency $f_{\text{cut-off}}$. The LPF rejects (does not pass) components with frequency higher than $f_{\text{cut-off}}$. Assume our s(t) is passed through an LPF with $f_{\text{cut-off}}$ equal to 2 Hz. The output signal from the filter is denoted by $s_O(t)$. Write an expression for $s_O(t)$ and compute its power.

Appendix: Relations you MAY need

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

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

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

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

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

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

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

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

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

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

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

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

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