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

**COE-341 – Data and Computer Communication**
**May 31st, 2009 – Major Exam #2**

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

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- 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 | 80 | |
| 2 | 40 | |
| 3 | 30 | |
| 4 | 20 | |
| Total: | 170 | |

**Q.1) (80 points) Choose the most appropriate answer for each of the following:**

1. A geostationary satellite has
    a. The same speed in kilometers per hours as any point on Earth's surface.
    b. The same angular speed in radians per second as any point on Earth's surface.
    c. Higher angular speed compared to a point on Earth's surface.
    d. Can have any arbitrary speed and elevation.

2. The following applications ordered from low frequency to high frequency should be:
    a. Satellite communication, laser-based communication, AM radio, and TV broadcast
    b. AM radio, TV broadcast, satellite communication, and laser-based communication
    c. Laser-based communication, satellite communication, TV broadcast, and AM radio
    d. None of the above

3. For the free-space path loss model, the pass loss increases by 6 dB for every:
    a. If the carrier frequency is reduced to half.
    b. If the carrier frequency is reduced to one fourth.
    c. If the distance is doubled.
    d. If the distance is increased to four times.

4. Infrared communications use part of the spectrum which is
    a. Lower in frequency than visible light, but higher then microwave
    b. Lower in frequency than microwave but higher than AM/FM radio
    c. Higher in frequency than visible light but lower than x-ray
    d. Lower in frequency than AM/FM radio

5. One of the following statements is not correct regarding the separation between poles used for RF links:
    a. The separation depends on the path loss between the two ends.
    b. The separation can be made as large as desired provided the transmitted power can be arbitrarily increased.
    c. The separation depends on the height of the poles.
    d. The separation between the poles is function of the nature of the terrain.

6. The antenna gain defined as the power output, in a particular direction, compared to that produced in any direction by a perfect omni-directional antenna is a measure of antenna directionality. The antenna gain
    a. Increases with the increase in both the effective area and the carrier frequency.
    b. Increases with the increase of the effective area but decreases as the carrier frequency increase.
    c. Decreases as both the effective area and the carrier frequency increase.
    d. Depends on the effective area but is not related to the carrier frequency.

7. Considering wireless propagation for signals with frequency above 30 MHz
    a. The propagation mode is called ground-wave propagation.
    b. The propagation mode is called sky-wave propagation where the Ionosphere acts as a reflector.
    c. Communication in this frequency range requires line of sight setting.
    d. Communication in this frequency range requires non-line of sight setting.

8. The connector used for connecting the twisted-pair medium to devices is the
    a. BNC connector
    b. RS-232 connector
    c. RJ-45 connector
    d. Three-pin AC connector

9. Comparing a multilevel FSK (MFSK) signal to a multilevel PSK (MPSK) signal:
    a. The MFSK signal uses approximately M times the bandwidth of the MPSK signal but both has the same power.
    b. The MPSK signal has less power but same bandwidth compared to the MFSK signal.
    c. The error performance of the MPSK signal is always better than MFSK signal.
    d. These two signals can not be compared.

10. Comparing the efficiency of the encoding schemes: the NRZ (biphase) and the pseudoternary
    a. The pseudoternary encoding is more efficient compared to NRZ for the same power level.
    b. The NRZ is more efficient compared to the pseudoternary encoding for the same power level.
    c. The NRZ attempts to eliminate the DC component of the encoded signal.
    d. The pseudoternary has a DC component that makes it more vulnerable to channel errors.

11. Considering the two widely used types of optical signal generators
    a. LED is more expensive and more efficient compared to ILD
    b. LED is less expensive but more efficient compared to ILD
    c. LED is less expensive and less efficient compared to ILD
    d. LED is more expensive and less efficient compared to ILD

12. Considering the sigma-delta modulation, the slope-overload noise refers to
    a. The signal $s(t)$ is too fast compared to approximate staircase function.
    b. The signal $s(t)$ has regions where the slope is almost zero and thus large relative quantization error is produced.
    c. The number of quantization levels used is not sufficient.
    d. The signal $s(t)$ requires “companding” prior to encoding to improve SNR.

13. To increase the optical fiber utilization, the following widely applied technique is used
    a. Time division multiplexing
    b. Space division multiplexing
    c. Wavelength division multiplexing
    d. Code division multiplexing

14. Considering unguided media transmissions, the system must have
    a. An antenna.
    b. A repeater.
    c. An ILD.
    d. All the above.

15. Considering the pulse code modulation (PCM) scheme, the sampling refers to
    a. Quantizing the *y*-axis (the signal *s*(*t*)) at predetermined levels.
    b. Sampling the time axis at a sufficiently high frequency to capture signal details.
    c. Encoding each of the quantized levels into an *n*-bit word.
    d. Assigning *n*-bit words for every sample of the signal *s*(*t*).
    e. None of the above.

16. The quality of an PCM encoded signal depends on
    a. The sampling rate.
    b. The number of quantization level.
    c. The SNR figure.
    d. The sampling rate and the SNR figure.
    e. None of the above.

17. Consider an audio signal with spectral components in the range of 300 to 3000 Hz. Assuming a sampling rate of 7000 samples per second will be used to generate the PCM signal. Then for an SNR level of 30 dB, the number of uniform quantization levels is equal to
    a. 2^30 levels.
    b. 16 levels.
    c. 32 levels.
    d. 2^n levels.
    e. Can not be determined from problem statement.

18. The minimum required data bit rate to transmit the PCM signal in the previous question is equal to
    a. 7 kb/s.
    b. 35 kb/s.
    c. 175 kb/s.
    d. 2n kb/s.
    e. n kb/s.

19. Comparing the sampling rate parameter for PCM and sigma-delta modulation (SDM):
    a. The sample rate for PCM is typically higher than that for SDM.
    b. The sampling rate for the PCM is typically lower than that for SDM.
    c. The sampling rates for two schemes can not be related to one another.
    d. The sampling rate for PCM is at least twice the sampling rate for SDM.
    e. None of the above.

20. Ranking these unguided media applications from low to high frequency
    a. Infrared, terrestrial microwave, and broadcast radio.
    b. Broadcast radio, terrestrial microwave, and infrared.
    c. Terrestrial microwave, broadcast radio, and infrared.
    d. Infrared, broadcast radio, and terrestrial microwave.

**Q.2) (40 points)** Consider the line encoding techniques covered in textbook and in class notes. These techniques are summarized in Figure P4.1 and Figure P4.2.

a) **(10 points)** List four criteria (out of the five points discussed in class) that are used to evaluate the encoding techniques?

b) **(10 points)** The number of signal level changes per bit time is an indication of the bandwidth occupied by the encoded signal. Complete the table in Figure P4.3 by specifying the *number* of signal level changes and the *sequence* of 1s and 0s that would result in such changes for each of the minimum and maximum columns. The entries for the first two line encoding techniques (NRZ-L and NRZI) are filled for you as examples.

c) **(10 points)** In addition to line encoding techniques, we have covered two scrambling techniques that may be used: B8ZS and HDB3. What is the purpose of these scrambling techniques?

d) **(10 points)** What is the string eliminated by the B8ZS technique? What is the string eliminated by the HDB3 technique?

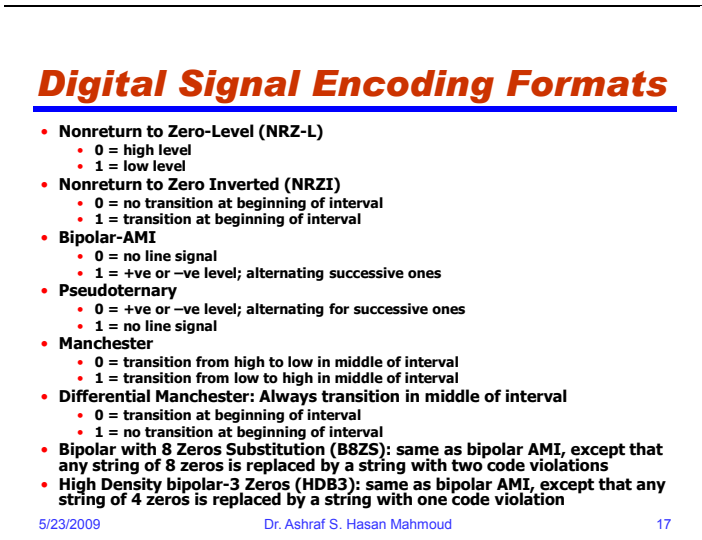


Figure P4.1: Digital signal encoding techniques.

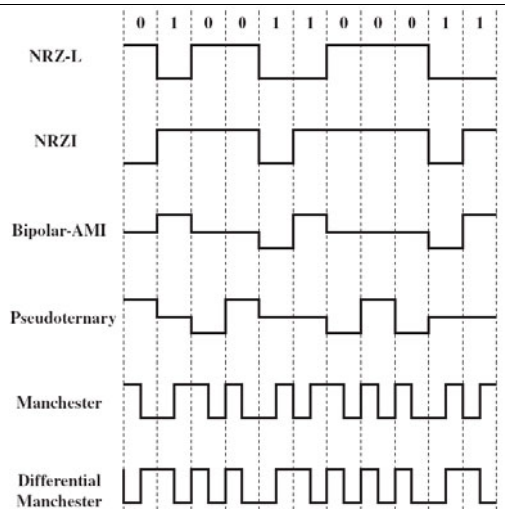


Figure P4.2: Line encoding examples.

| Encoding | Minimum | | Maximum | |
|---|---|---|---|---|
| | No of signal level changes | Sequence | No of signal level changes | Sequence |
| NRZ-L | 0 | all 0s or 1s | 1.0 | 10101… |
| NRZI | 0 | all 0s | 1.0 | all 1s |
| Bipolar-AMI | | | | |
| Pseudoternary | | | | |
| Manchester | | | | |
| Differential Manchester | | | | |

Figure P4.3: Number of signal level changes and the corresponding sequence.

**Q.3) (30 points) On the subject of modulation and encoding.**

(1) Consider the signal specified by $s(t) = 10\cos(10^8\pi t + 5\sin(2\pi(10^3)t)]$

a) **(10 points)** Specify the power of the carrier signal (in Watts) and the carrier frequency in Hz?

b) **(10 points)** If the $s(t)$ signal is a PM signal, determine the information signal $m(t)$. What is maximum phase deviation relative to the carrier phase? Assume $n_p = 0.5$.

c) **(10 points)** If the $s(t)$ signal is an FM signal, determine the information signal $m(t)$. What is maximum frequency deviation relative to the carrier frequency? Assume $n_f = 1000$.

**Q.4) (20 points)** One the subject of communications media
a) There are three types of fiber: step-index multimode, graded-index multimode, and single-index fiber. Complete the table to specify the characteristic of each in terms of signal propagation, output distortion, and maximum possible bit rate.

Use extra text/figures if needed.

| | Signal propagation | Output distortion | Bit rate (Capacity) | Cost |
|---|---|---|---|---|
| Step-index multimode | | | | |
| Graded-index multimode | | | | |
| Single mode | | | | |