Chapter 1: Introduction to Communication Systems

MULTIPLE CHOICE

1. The theory of radio waves was originated by:
   a. Marconi               c. Maxwell
   b. Bell                  d. Hertz
   
   ANS: C

2. The person who sent the first radio signal across the Atlantic ocean was:
   a. Marconi               c. Maxwell
   b. Bell                  d. Hertz
   
   ANS: A

3. The transmission of radio waves was first done by:
   a. Marconi               c. Maxwell
   b. Bell                  d. Hertz
   
   ANS: D

4. A complete communication system must include:
   a. a transmitter and receiver
   b. a transmitter, a receiver, and a channel
   c. a transmitter, a receiver, and a spectrum analyzer
   d. a multiplexer, a demultiplexer, and a channel
   
   ANS: B

5. Radians per second is equal to:
   a. $2\pi \times f$
   b. $f \div 2\pi$
   c. the phase angle
   d. none of the above
   
   ANS: A

6. The bandwidth required for a modulated carrier depends on:
   a. the carrier frequency
   b. the signal-to-noise ratio
   c. the signal-plus-noise to noise ratio
   d. the baseband frequency range
   
   ANS: D

7. When two or more signals share a common channel, it is called:
   a. sub-channeling
   b. signal switching
   c. SINAD
   d. multiplexing
   
   ANS: D

8. TDM stands for:
   a. Time-Division Multiplexing
   b. Two-level Digital Modulation
   c. Time Domain Measurement
   d. none of the above
   
   ANS: C
9. FDM stands for:
   a. Fast Digital Modulation     c. Frequency-Division Multiplexing
   b. Frequency Domain Measurement d. none of the above

   ANS: C

10. The wavelength of a radio signal is:
    a. equal to \( f \div c \)
    b. equal to \( c \div \lambda \)
    c. the distance a wave travels in one period
    d. how far the signal can travel without distortion

    ANS: C

11. Distortion is caused by:
    a. creation of harmonics of baseband frequencies
    b. baseband frequencies "mixing" with each other
    c. shift in phase relationships between baseband frequencies
    d. all of the above

    ANS: D

12. The collection of sinusoidal frequencies present in a modulated carrier is called its:
    a. frequency-domain representation
    b. Fourier series
    c. spectrum
    d. all of the above

    ANS: D

13. The baseband bandwidth for a voice-grade (telephone) signal is:
    a. approximately 3 kHz
    b. 20 Hz to 15,000 Hz
    c. at least 5 kHz
    d. none of the above

    ANS: A

14. Noise in a communication system originates in:
    a. the sender
    b. the receiver
    c. the channel
    d. all of the above

    ANS: D

15. "Man-made" noise can come from:
    a. equipment that sparks
    b. temperature
    c. static
    d. all of the above

    ANS: A

16. Thermal noise is generated in:
    a. transistors and diodes
    b. resistors
    c. copper wire
    d. all of the above

    ANS: D
17. Shot noise is generated in:
   a. transistors and diodes  
   b. resistors  
   c. copper wire  
   d. none of the above
   ANS: A

18. The power density of "flicker" noise is:
   a. the same at all frequencies  
   b. greater at high frequencies  
   c. greater at low frequencies  
   d. the same as "white" noise
   ANS: C

19. So called "1/f" noise is also called:
   a. random noise  
   b. pink noise  
   c. white noise  
   d. partition noise
   ANS: B

20. "Pink" noise has:
   a. equal power per Hertz  
   b. equal power per octave  
   c. constant power  
   d. none of the above
   ANS: B

21. When two noise voltages, $V_1$ and $V_2$, are combined, the total voltage $V_T$ is:
   a. $V_T = \sqrt{V_1 \times V_1 + V_2 \times V_2}$  
   b. $V_T = (V_1 + V_2)/2$  
   c. $V_T = \sqrt{V_1 \times V_2}$  
   d. $V_T = V_1 + V_2$
   ANS: A

22. Signal-to-Noise ratio is calculated as:
   a. signal voltage divided by noise voltage  
   b. signal power divided by noise power  
   c. first add the signal power to the noise power, then divide by noise power  
   d. none of the above
   ANS: B

23. SINAD is calculated as:
   a. signal voltage divided by noise voltage  
   b. signal power divided by noise power  
   c. first add the signal power to the noise power, then divide by noise power  
   d. none of the above
   ANS: D

24. Noise Figure is a measure of:
   a. how much noise is in a communications system  
   b. how much noise is in the channel  
   c. how much noise an amplifier adds to a signal  
   d. signal-to-noise ratio in dB
   ANS: C
25. The part, or parts, of a sinusoidal carrier that can be modulated are:
   a. its amplitude
   b. its amplitude and frequency
   c. its amplitude, frequency, and direction
   d. its amplitude, frequency, and phase angle
   ANS: D

COMPLETION

1. The telephone was invented in the year _________________.
   ANS: 1863

2. Radio signals first were sent across the Atlantic in the year _________________.
   ANS: 1901

3. The frequency band used to modulate the carrier is called the ________________ band.
   ANS: base

4. The job of the carrier is to get the information through the _________________.
   ANS: channel

5. The bandwidth of an unmodulated carrier is _________________.
   ANS: zero

6. The 'B' in Hartley's Law stands for _________________.
   ANS: bandwidth

7. The more information per second you send, the ________________ the bandwidth required.
   ANS: greater
   larger
   wider

8. In ________________, you split the bandwidth of a channel into sub-channels to carry multiple signals.
   ANS: FDM

9. In ________________, multiple signal streams take turns using the channel.
   ANS: TDM

10. VHF stands for the ________________ frequency band.
11. The VHF band starts at _______________ MHz.
   ANS: 30

12. The UHF band starts at _______________ MHz.
   ANS: 300

13. A radio signal's _______________ is the distance it travels in one cycle of the carrier.
   ANS: wavelength

14. In free space, radio signals travel at approximately _______________ meters per second.
   ANS: 300 million

15. The equipment used to show signals in the frequency domain is the _______________.
   ANS: spectrum analyzer

16. Mathematically, a spectrum is represented by a _______________ series.
   ANS: Fourier

17. Disabling a receiver during a burst of atmospheric noise is called _______________.
   ANS: noise blanking

18. For satellite communications, _______________ noise can be a serious problem.
   ANS: solar

19. Thermal noise is caused by the random motions of _______________ in a conductor.
   ANS: electrons

**SHORT ANSWER**

1. Name the five elements in a block diagram of a communications system.
   ANS: Source, Transmitter, Channel, Receiver, Destination

2. Name five types of internal noise.
3. Why is thermal noise called "white noise"?

ANS:
White light is composed of equal amounts of light at all visible frequencies. Likewise, thermal noise has equal power density over a wide range of frequencies.

4. What is "pink noise"?

ANS:
Light is pink when it contains more red than it does other colors, and red is at the low end of the visible spectrum. Likewise, pink noise has higher power density at lower frequencies.

5. Suppose there is 30 μV from one noise source that is combined with 40 μV from another noise source. Calculate the total noise voltage.

ANS:
50 μV

6. If you have 100 mV of signal and 10 mV of noise, both across the same 100-ohm load, what is the signal-to-noise ratio in dB?

ANS:
20 dB

7. The input to an amplifier has a signal-to-noise ratio of 100 dB and an output signal-to-noise ratio of 80 dB. Find NF, both in dB and as a ratio.

ANS:
20 dB, NF = 100

8. A microwave receiver has a noise temperature of 145 K. Find its noise figure.

ANS:
1.5

9. Two cascaded amplifiers each have a noise figure of 5 and a gain of 10. Find the total NF for the pair.

ANS:
5.4

10. Explain why you could use a diode as a noise source with a spectrum close to that of pure thermal noise. How would you control the amount of noise generated?

ANS:
When current flows through a diode, it generates shot noise that can be represented as a current source, the output of which is a noise current. The equation for the noise current is very similar to the equation for thermal noise voltage. Since the power in the shot noise is proportional to the diode current, controlling the diode current controls the noise power.