EET368 HOMEWORK #2 KEY

MILLER CHAPTER 1 QUESTIONS 1-5,15-20,22-25

16 POINTS TOTAL (1 PER QUESTION). ALL WORK MUST BE SHOWN OR NO CREDIT IS ASSIGNED.

1. **MODULATION** is the process of placing information onto a carrier for the purpose of transmission.

2. **CARRIER FREQUENCY** is a high-frequency signal which carries the information.

3. MODULATION IS REQUIRED for two reasons. First, it allows **REASONABLE ANTENNA LENGTHS** because of the high-frequency carriers. Second, because each station is assigned a different carrier, INTERFERENCE is eliminated between stations (in other words, it becomes possible to **SEPARATE** stations.)

4. Three three parameters that can be varied are:

   a) VOLTAGE or POWER (Vp)
   b) FREQUENCY (ω, Omega, f)
   c) PHASE ANGLE (Phi, φ).

5. The frequency divisions involved are as follows:

MF	300 KHz - 3 MHz
HF	3 MHz - 30 MHz
VHF	30 MHz - 300 MHz
UHF	300 MHz - 3 GHz
SHF	3 GHz - 30 GHz

15. **ELECTRICAL NOISE** comprises any **undesired voltages or currents** that appear in the signal path of a communications system (especially the RECEIVER). Noise is troublesome because it can mask the intelligence being transmitted.

16. **EXTERNAL NOISE** is created *outside* of the circuitry in the system, while **INTERNAL NOISE** is a consequence of the *circuitry itself*; for example, SHOT and JOHNSON noise are INTERNAL sources.

17. Types of **EXTERNAL NOISE SOURCES** include:

   a) **NATURAL (“QRN”)** sources, such as atmospheric noise (caused by electrical charge build up in the atmosphere), as well as cosmic (caused by radiation from the sun and other stars).
   b) **MAN-MADE (“QRM”)** sources include the power grid; machinery; automotive ignition systems; and other man-made sources of electrical noise.

18. **Johnson noise** is also called **BROWNIAN**, **WHITE**, and **THERMAL** noise.
Given BW=1 MHz, T=27C (300K), R=1MΩ:

$$En = \sqrt{4kT\delta R} = \sqrt{4(1.38E-23)*(300)*(1MHz)(1M\Omega)} = \underline{\underline{128.68\mu V}}$$

19. Given: The noise produced by a resistor is to be amplified by a noiseless amplifier having a voltage gain of 75 V/V and a bandwidth of 100 KHz. The output voltage is 240 μV RMS. Temp = 37C. Find (a) The resistor's value, and (b) The expected meter reading if the bandwidth were reduced to 25 KHz.

$$En(out) = Av * En(input) = Av * En(resistor)$$
$$\therefore En(resistor) = 240\mu V / 75 = 3.2\mu V$$

$$\underline{Finding R:}$$
$$En = \sqrt{4kT\delta R}$$
$$\therefore R = \frac{En^2}{4kT\delta} = \frac{3.2\mu V^2}{4(1.38E-23)(310K)(100KHz)} = \underline{\underline{5.984K\Omega}}$$

$$\underline{Finding New Eout:}$$
$$Since En = \sqrt{4kT\delta R}:$$
$$En' = En\sqrt{\frac{\delta_2}{\delta_1}} = 240\mu V\sqrt{\frac{25KHz}{100KHz}} = \underline{\underline{120\mu V}}$$

20. A **LOW NOISE RESISTOR** is a resistor manufactured especially for operation in low-noise circuitry. It generates less noise than a conventional resistor. Metal-film and wirewound resistors are low-noise devices, though wirewound Resistors are seldom useful at radio frequencies due to their self-Inductance.

22. Given: Noise spectral density of a system is stated as:

$$En^2 / \delta = 4kTR$$

Find: The bandwidth if R=20K, En = 20 μV, T=24C.

By manipulating the above definition of spectral noise density, we get:

$$\delta = \frac{En^2}{4kTR} = \frac{20\mu V^2}{4(1.38E-23)(297K)(20K\Omega)} = \underline{\underline{1.22MHz}}$$

23. The S/N ratio for a receiver output of 4V (signal) and 0.48V (noise) is:

$$SNR = Ps / Pn = Vs^2 / Vn^2 = 4V^2 / 0.48V^2 = \underline{\underline{69.44}}$$

$$SNR(db) = 20\log(\frac{Vs}{Vn}) = 10\log(\frac{Ps}{Pn}) = 20\log(4V / 0.48V) = \underline{\underline{18.42dB}}$$

Caution: Voltage and Power decibels (dB) are only equivalent when measured across the same impedance!

24. *NF = SNR(db - IN) - SNR(dB - OUT)*
= 10 Log (110) - 18.42 dB
= 1.99 dB

NOISE RATIO = SNR(in) / SNR(out) = 110 / 69.44 = 1.584

25. An amplifier with NF = 6 dB and an input SNR of 25 dB will have:

$$SNR(out-dB) = SNR(in) - NF = 25dB - 6dB = \underline{\underline{19dB}}$$

$$SNR(out-ratio) = 10^{(SNR-out/10)} = 10^{1.9} = \underline{\underline{79.43}}$$