

University Electrical Engineering

Name: \_\_\_\_\_ Score: \_\_\_\_\_

1. A square wave's fundamental has amplitude 1.273. What is the amplitude of its 7th harmonic? Give 3 decimal places.

\_\_\_\_\_

2. What happens when the modulation index goes above 1?
- ☐ The carrier disappears
  - ☐ The envelope folds over and an envelope detector distorts the message
  - ☐ The signal gets louder with no side effects
  - ☐ The bandwidth halves

3. An FM signal has  $\Delta f = 50$  kHz and  $f_m = 10$  kHz. What is  $\beta$ ?

\_\_\_\_\_

4. What is the thermal noise floor in a 1 MHz bandwidth, in dBm?

\_\_\_\_\_ dBm

5. What SQNR does a 12-bit quantiser give for a full-scale sine, in dB? Give 1 decimal place.

\_\_\_\_\_ dB

6. How many bits does each symbol of 64-QAM carry?

\_\_\_\_\_

7. What codeword lengths does Huffman give for probabilities  $1/2$ ,  $1/4$ ,  $1/4$ ?

- ☐ 1, 2, 2
- ☐ 1, 2, 3
- ☐ 1, 1, 2
- ☐ 2, 2, 2

8. A licence grants only 3 kHz for that 3 kHz voice signal. What can you do?

- ☐ Send a single sideband
- ☐ Filter the double-sideband signal down to 3 kHz
- ☐ Raise the carrier frequency
- ☐ Nothing; it cannot fit

9. A 1 MHz carrier is modulated by a 2 kHz tone. Where are the sidebands?

- ☐ 999 kHz and 1001 kHz
- ☐ 1 MHz and 2 MHz
- ☐ 2 kHz and 1 MHz
- ☐ 998 kHz and 1002 kHz

10. For narrowband FM ( $\beta$  much less than 1), the bandwidth is about

- ☐  $f_m$
- ☐  $2f_m$ , like AM
- ☐  $2\Delta f$
- ☐ Zero

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1. **0.182**

Odd harmonics fall as  $1/k$ :  $1.273/7 = 0.182$ .

2. **The envelope folds over and an envelope detector distorts the message**

With  $m > 1$  the term  $1 + m \cdot x(t)$  goes negative, so the envelope no longer follows the message.

3. **5**

$$\beta = \Delta f / f_m = 50/10 = 5.$$

4. **-114 dBm**

$$-174 + 10 \log_{10}(10^6) = -174 + 60 = -114 \text{ dBm}.$$

5. **74.0 dB**

$$6.02 \times 12 + 1.76 = 74.0 \text{ dB}.$$

6. **6**

$$\log_2 64 = 6.$$

7. **1, 2, 2**

Merge the two  $1/4$ s into  $1/2$ , then merge with the other  $1/2$ . The average, 1.5 bits, equals  $H$ .

8. **Send a single sideband**

One sideband carries the whole message in  $W$ . Filtering the voice itself below 3 kHz would delete part of it.

9. **998 kHz and 1002 kHz**

The sidebands sit at  $f_c \pm f_m$ .

10.  **$2f_m$ , like AM**

With  $\Delta f \ll f_m$ , Carson gives  $2(\Delta f + f_m) \approx 2f_m$ .