1. A Yagi antenna is to operate at 50 MHz. What is the length of the driven element?
   \[
   \text{length} = \left(\frac{1}{2} \cdot 3 \times 10^8 \text{ m/s}\right) / \left(50 \times 10^6 \text{ Hz}\right) = 3 \text{m or 9.82ft}
   \]

2. The signal input to an amplifier is 25uV into 50 ohms. What is the signal power level in dBm?
   \[
   \text{PdB} = 10\log\left(\frac{P}{1\text{mW}}\right) = 10\log\left(\frac{0.000025\times10^{-6}}{50}\right) = -79.03\text{dBm}
   \]

3. An amplifier has an input signal-to-noise power ratio equal to 10dB and the noise figure is 6dB. What is the output signal-to-noise ratio in dB?
   \[
   \text{S/N dB} = 10 - 6 = 4\text{dB}
   \]

4. What is the sensitivity of a receiver if NF equals 8dB, Bandwidth equals 10MHz, S/N desired equals 10dB?
   \[
   \text{S} = -174\text{dBm} + 8\text{dB} + 70\text{dB} + 10\text{dB} = -86\text{dBm}
   \]

5. What is the approximate dynamic range of a receiver if the 3rd order intercept is 25dBm and the sensitivity equals -95dBm?
   \[
   \frac{2}{3} \times (25\text{dBm} - (-95\text{dBm})) = 80\text{dB}
   \]

6. What is the approximate dynamic range of a receiver if the 1-dB compression point is -5dBm and the sensitivity equals -95dBm?
   \[
   (-5\text{dBm} - (-95\text{dBm})) = 90\text{dB}
   \]

7. In an AM transmitter the carrier is 1500kHz and the signal is 3 KHz. What frequencies are present at the output of the modulator?
   1500kHz, 1503kHz, 1497kHz, 3kHz

8. The carrier frequency input to a mixer in a superheterodyne receiver is 1500kHz and the local oscillator frequency is 1800kHz. What is the frequency of the mixer output signal?
   300kHz

9. What is the image frequency in Problem 8?
   2100kHz
10. An AM receiver has a tuned-circuit bandwidth of 10 kHz at 1000 kHz. What is the receiver’s selectivity at 1040 kHz?
10.4 kHz

11. An FM system has a maximum deviation of 60 kHz. The maximum signal frequency is 12 kHz. Calculate the bandwidth required to transmit the FM signal by using the Bessel function table below.

<table>
<thead>
<tr>
<th>$m$</th>
<th>$J_6$</th>
<th>$J_7$</th>
<th>$J_8$</th>
<th>$J_9$</th>
<th>$J_{10}$</th>
<th>$J_{11}$</th>
<th>$J_{12}$</th>
<th>$J_{13}$</th>
<th>$J_{14}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0.25</td>
<td>0.98</td>
<td>0.12</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0.5</td>
<td>0.94</td>
<td>0.24</td>
<td>0.03</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1.0</td>
<td>0.77</td>
<td>0.44</td>
<td>0.11</td>
<td>0.02</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1.5</td>
<td>0.51</td>
<td>0.56</td>
<td>0.23</td>
<td>0.06</td>
<td>0.01</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2.0</td>
<td>0.22</td>
<td>0.38</td>
<td>0.33</td>
<td>0.13</td>
<td>0.03</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2.4</td>
<td>0</td>
<td>0.52</td>
<td>0.43</td>
<td>0.20</td>
<td>0.06</td>
<td>0.02</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2.5</td>
<td>0.05</td>
<td>0.50</td>
<td>0.45</td>
<td>0.22</td>
<td>0.07</td>
<td>0.02</td>
<td>0.01</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3.0</td>
<td>0.26</td>
<td>0.34</td>
<td>0.49</td>
<td>0.31</td>
<td>0.13</td>
<td>0.04</td>
<td>0.01</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4.0</td>
<td>0.40</td>
<td>0.07</td>
<td>0.36</td>
<td>0.43</td>
<td>0.28</td>
<td>0.13</td>
<td>0.03</td>
<td>0.02</td>
<td>—</td>
</tr>
<tr>
<td>5.0</td>
<td>0.18</td>
<td>0.33</td>
<td>0.05</td>
<td>0.36</td>
<td>0.39</td>
<td>0.26</td>
<td>0.13</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>6.0</td>
<td>0.15</td>
<td>0.28</td>
<td>0.24</td>
<td>0.11</td>
<td>0.36</td>
<td>0.36</td>
<td>0.25</td>
<td>0.13</td>
<td>0.06</td>
</tr>
<tr>
<td>7.0</td>
<td>0.30</td>
<td>0.00</td>
<td>0.30</td>
<td>0.17</td>
<td>0.16</td>
<td>0.35</td>
<td>0.34</td>
<td>0.22</td>
<td>0.13</td>
</tr>
<tr>
<td>8.0</td>
<td>0.17</td>
<td>0.23</td>
<td>0.11</td>
<td>0.29</td>
<td>0.10</td>
<td>0.19</td>
<td>0.34</td>
<td>0.32</td>
<td>0.22</td>
</tr>
<tr>
<td>9.0</td>
<td>0.09</td>
<td>0.25</td>
<td>0.14</td>
<td>0.18</td>
<td>0.27</td>
<td>0.06</td>
<td>0.20</td>
<td>0.33</td>
<td>0.31</td>
</tr>
<tr>
<td>10.0</td>
<td>0.25</td>
<td>0.05</td>
<td>0.25</td>
<td>0.06</td>
<td>0.22</td>
<td>0.23</td>
<td>0.01</td>
<td>0.22</td>
<td>0.32</td>
</tr>
</tbody>
</table>

mod index = 5
BW = 2*8*12 = 192 kHz

12. A 10kW FM transmitter has a modulation index of 5. Using the Bessel function table determine the power in the $J_3$ sidebands.

\[ 0.36^2 \times 10kW = 1296W \]

13. In an FM transmitter, the output is changing between 89.003 and 88.997 MHz 1500 times a second. The intelligence signal is 3 volts peak. What is the deviation constant?

Deviation constant = \( \frac{3\text{kHz}}{3\text{V}} = 1\text{kHz/V} \)
14. An FM system is transmitting the signal, \( v = 1000\sin\left(556 \times 10^6 t + 5\sin(94 \times 10^3 t)\right) \) into a 50 ohm antenna. Determine the frequency deviation in kHz.
\[ 5\times 14.96 = 74.8 \text{ kHz} \]

15. The power of an AM carrier is 10kW and the modulation index is 80%. What is the total transmitted power?
\[ P_t = 10kW\left(1 + 0.8^2/2\right) = 13.2kW \]

**Total Score __________**