Show terms used in calculations and show intermediate answers in order to get partial credit in case your final answers are wrong.

1. Antenna design
   a. If an antenna has a gain of 6 dBi, what is the gain relative to that of a dipole antenna.

   \[ 6 - 2.15 = 3.85 \]

   b. An antenna for a commercial AM radio station is to operate at 1130 KHz. What kind of antenna is practical and what are it’s dimensions.

   Vertical
   \[ v = 3 (10^8) \text{ m/s or } 2.07 (10^8) \text{ m/s} \]
   \[ \lambda = \frac{186000 \times 5280}{1130000} = 869.1 \text{ ft} \]

   height = \( \frac{\lambda}{4} \) = 217.3 ft

   c. A Yagi antenna is to operate at 146 MHz. Roughly, what are the lengths of the elements?

   \[ \lambda = \frac{186000 \times 5280}{146000000} = 2.05 \text{ meters} \]

   = \( \frac{\lambda}{2} \) = 1 meter
2. System analysis

a. If the amplitude of an AM carrier is 1200 volts and the modulation index is 80% what is the amplitude of the signal waveform?

\[ V_s = 0.8 \times 1200 = 960 \text{ volts} \]

b. The noise figure of system is 6 dB. If the signal-to-noise ratio at the output is 10 dB, what is the signal-to-noise ratio at the input.

\[ N_f = S_{NidB} - S_{nodB} \]
\[ 6 = S_{NidB} - 10 \]

\[ S_{NidB} = 16 \text{ dB} \text{ or } 39.8 \]

c. The modulated carrier is displayed on an oscilloscope. Draw what you would see and draw arrows to points on the waveform to indicate values needed to calculate the modulation index.
3. AM system

a. Describe the function (short phrases will do) of these sections of an AM system:
   1) modulator - multiplies intelligence signal times carrier

   2) 1st filter – attenuates signals at frequencies above and below the resonant frequency

   3) rectifier – demodulates the input signal

   4) 2nd filter – attenuates signals above the filter cutoff frequency which is slightly higher than the highest frequency component of the signal

b. The carrier is 455 KHz and the signal is 1 KHz. Sketch the waveforms of signals at the output of these sections:
   1) modulator

   2) 2\textsuperscript{nd} filter

c. Give the values of the primary (non-harmonic) frequencies present at the output of these sections:
   1) modulator – 455KHz, 456KHz, 454KHz

   2) 2\textsuperscript{nd} filter – 1KHz
4. The inputs to a superheterodyne receiver are a 1200 KHz carrier and a 2 KHz signal.

a) Give the values of the primary (non-harmonic) frequencies present at the output of the first modulator?

1202 KHz
1200 KHz
1198 KHz

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2 KHz also, but not counted for exam

b) Give the values of the primary (non-harmonic) frequencies present at the output of the second modulator?

1655 KHz
1202 KHz
1200 KHz
1198 KHz
2857 KHz
2855 KHz
2853 KHz
457 KHz
455 KHz
453 KHz

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2, 1657, 1653

c) Give the values of the primary (non-harmonic) frequencies present at the output of the first filter?

457 KHz
455 KHz
453 KHz

Scores
1. _____
2. _____
3. _____
4. _____