Design and simulation of a communication link using AM

Expected Outcomes:
To have built communication links using existing AM modulation and demodulation blocks, constructed AM modulators using operational function blocks based on their mathematical expressions, and conducted simulations of the links and modulators, all in Simulink.

Detailed Requirements:

Use Simulink to design a communication link for AM audio broadcasting. The message signal is a mono audio signal although you may not be able to transmit the full audio frequency range that is normally required for high quality sound.

The specification for the link is as follows:

Required signal to noise ratio (SNR) at the demodulated audio output of the receiver: 40 dB for a 1 kHz message signal at 50% modulation (m = 0.5).

- Carrier frequency: 1.35 MHz
- Maximum RF bandwidth available 9 kHz
- Channel noise power spectral density = -150dBm/Hz

Find out the followings for Task-01:

1. What is the highest frequency of the message signal that can be transmitted without exceeding the specified RF bandwidth?
2. For this message frequency, save a time domain plot and a frequency domain plot showing the modulated RF output from the transmitter.
3. How much carrier power is required in order to achieve the required SNR? For this carrier power, how much power is there in each sideband for the m = 0.5?
4. What is the SNR at the demodulated output if the frequency of the message signal is changed to the following frequencies?
    - 200 Hz
    - The highest frequency that can be transmitted without exceeding the specified RF bandwidth.
    - What is the SNR at the demodulated output if the modulation index m is increased to 1?
5. What happens if m > 1, if m = 1.5? Compare the demodulated output from the receiver in the time domain and in the frequency domain for m = 1 and m = 1.5 and explain why a modulation index greater than 1 must be avoided in an AM link.

Prompts:

In order to complete the work required in the above, you will need to

- Generate baseband and carrier sinewave signals and AWGN noise
- Construct a channel model with constant loss and AWGN noise
- Construct an AM modulator with operational function blocks based on time-domain AM expression
- Construct a communications link using the built AM modulator, built channel model, and exiting AM demodulator block in Simulink.

Design and simulation of communication links using PSK

Expected Outcomes:
To have built communication links using existing PSK modulation and demodulation blocks, constructed PSK modulators using operational function blocks based on their mathematical expressions, and conducted simulations of both links and modulators, all in Simulink.

Key Tasks:

- Generate baseband binary signals and carrier sinewave signals and AWGN noise
- Simulate and evaluate a communications link using BPSK with existing mod and de-mod blocks
- Simulate and evaluate a communications link using QPSK with existing mod and de-mod blocks
- Construct a BPSK modulator with operational function blocks based on the time-domain BPSK expression, and simulate and evaluate the BPSK modulator.

Find out the followings for Tasks 02 and 03:

1. You must measure BER against SNR or Eb/No and plot the performance curves according to the data obtained.
2. For the same noise level, in order to achieve a BER of 10^{-5}, what is the signal power ratio of the BPSK and QPSK links?
3. Therefore, comment on BPSK and QPSK in terms of bandwidth efficiency and signal power required.
4. Show waveforms at different points of the link with different SNR (or Eb/No)
5. Show the constellations of the modulators

Report:

For task-01 report must have the followings:
Diagrams of communication links and modulators, simulated/calculated results and performances such as spectra (frequency domain), waveforms (time domain), analysis and discussions of results.

For task-02 and task-03 report must have the followings:
Signals generated, link and modulator diagrams, simulation results including waveforms, evaluation of results, contrasting between BPSK and QPSK.

Lastly, include the references at the end to show the sources used to gather relevant information on the topic.