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.