1. Prove Moyal’s formula.

2. For \( s(t) = A_1 e^{j\omega_1 t} + A_2 e^{j\omega_2 t} \),
   a) Find the instantaneous frequency.
   b) Find condition on \( A_1, A_2, \omega_1, \omega_2 \) such that the instantaneous frequency lies in between the frequencies of the complex exponentials.

3. Prove that the spectrogram can be written as convolution of Wigner distribution of the signal with Wigner distribution of the window.

4. For the linear chirp signal presented in class, compute the spectrogram using a gaussian shaped window function at 4 different lengths. Choose an appropriate window length and for that window length get the time and frequency marginals from the spectrogram. Compare these marginals with the instantaneous power and the energy density spectrum. Include plots and discuss your results.
   Hint: You can generate a linear chirp signal using the ‘chirp’ command in MATLAB. Use ’specgram’ command in MATLAB to compute Short-time Fourier Transform and then compute the spectrogram.

5. Consider the pseudo Wigner distribution, \( W_{PS}(t, \omega) = \int h(\tau) s(t+\frac{\tau}{2}) s^*(t-\frac{\tau}{2}) e^{-j\omega \tau} d\tau \),
   a) Find the condition on the window function such that the time marginal is satisfied.
   b) Find the condition on the window function such that the frequency marginal is satisfied.
   c) Is there a window function that will satisfy both of the conditions found in part a and b? If yes, give an example.