EE6320 HW #1: Noise and Noise Figure – due Tuesday 24/03/2026 (11:59pm)

1) The resistive T-attenuator shown in Fig. 1 below is to be designed for a 50 Ohm system. Assume that the load resistor is noiseless. The attenuator must satisfy the following conditions:

   Input impedance = 50 Ohms
   Output impedance = 50 Ohms
   Voltage attenuation of the attenuator itself = 6 dB

   (a) Determine the values of the three resistors R_1, R_2 and R_3 for the network (shown below).
   (b) If the T-match resistors are noiseless, find the output noise power spectral density.
   (c) Find the output noise power spectral density due to R_1, R_2 and R_3.
   (d) Determine the noise factor of the attenuator and the corresponding Noise Figure in dB.

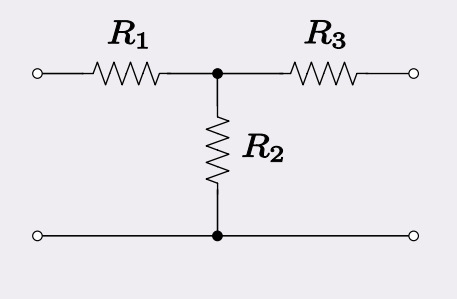

Fig. 1

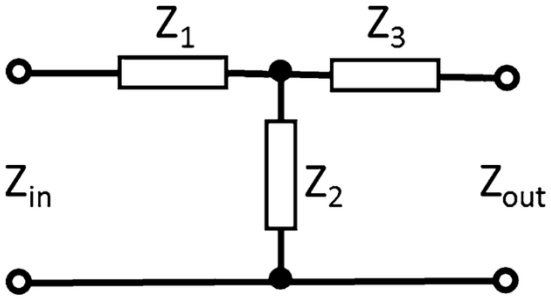

Fig. 2

2) A symmetric T-attenuator is shown in Fig. 2. The load resistor is noiseless. Z_1 and Z_3 are equal resistors of value R and Z_2 is a shunt capacitor of value C at the centre node.

   (a) Choose R and C such that:
   Low frequency voltage attenuation from source to load is 12 dB
   The -3dB bandwidth of the network is 1 GHz
   (b) Using the above values, derive the transfer function of the network
   (c) Find the output noise power spectral density due to R_S only.
   (d) Find the output noise power spectral density due to Z_1.
   (e) Find the output noise power spectral density due to Z_3.
   (f) Determine the noise factor and noise figure of the attenuator.
   (g) Evaluate the noise figure at 500 MHz, 1 GHz and 2 GHz.

3) A series LC network is driven by an input voltage source in series with a source resistance R_S = 50 Ohms. The inductor L has loss in the form of a series resistance R. The output voltage is taken across the capacitor C. The load may be assumed to be infinite.

   (a) Determine L, C and R so that the resonance frequency is 1 GHz, the quality factor of the inductor at resonance is 25 and the magnitude of the voltage transfer function at resonance is 0.5.
   (b) Find the output noise power spectral density due to R_S only.
   (c) Find the output noise power spectral density due to R only.
   (d) Determine the noise factor and noise figure.
   (e) If the quality factor improves from 25 to 50, with L and resonance frequency remaining the same, determine the new values of R, noise factor and noise figure.

4) Calculate the noise figure of the circuit shown in Fig. 3 with respect to the source resistance R_S. Assume R_F is very large and noiseless.

5) Calculate the noise figure of the circuit of Fig. 4 with respect to the source resistance R_S.

6) Calculate the noise figure of the circuit of Fig. 5 with respect to the source resistance R_S.

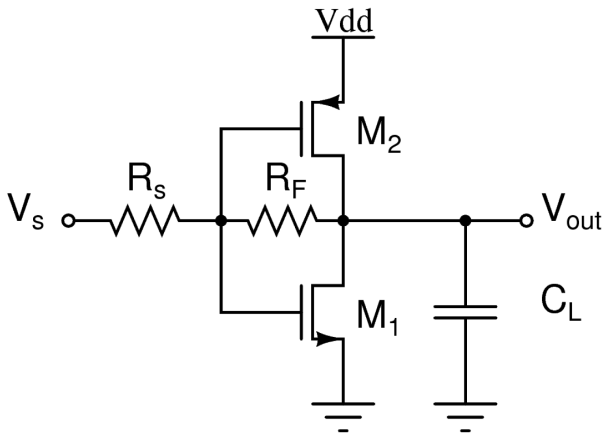

Fig. 3

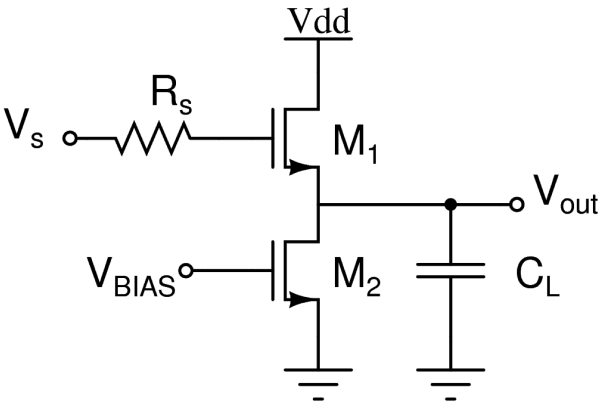

Fig. 4

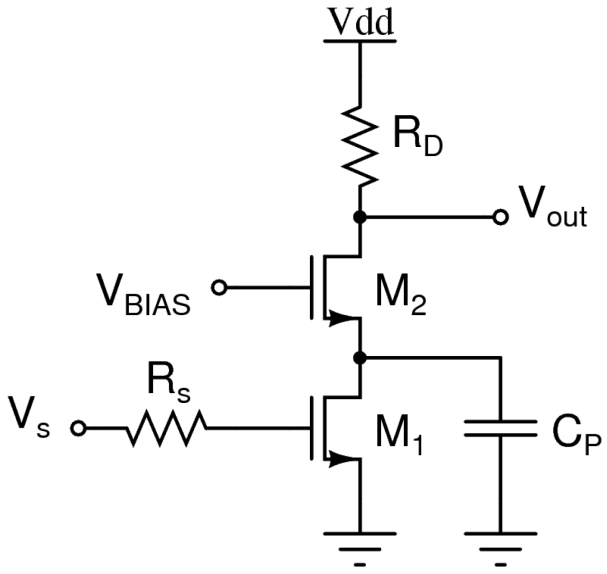

Fig. 5