Microwave Circuits Review Quiz #6 solution 2017.1.3

1. Figure 1.1 is a 10dB attenuator at To=290°K and Figure 1.2 is a 10dB amplifier at Te=290°K. Give the parameters, expressions and results in the following table. ($k=1.38\times10^{-23}J/^oK$, $1J/sec=1W=10^3mW$)

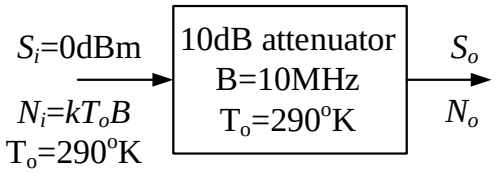

Fig. 1.1

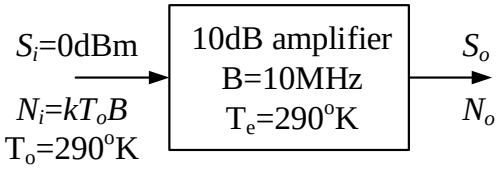

Fig. 1.2

10dB attenuator			*10dB amplifier*	
Parameter	*Expression*	*Result*	*Expression*	*Result*
N_i (W)	kT_oB	$1.38\times10^{-23}\times290\times10^7$ $=4\times10^{-14}W$	kT_oB	$1.38\times10^{-23}\times290\times10^7$ $=4\times10^{-14}W$
N_i (dBm)	$10\log(N_i\times10^3)$	$10\log(4\times10^{-11}\times10^3)$ $=-104dBm$	$10\log(N_i\times10^3)$	$10\log(4\times10^{-11}\times10^3)$ $=-104dBm$
SNR_i (dB)	S_i(dBm)-N_i(dBm)	$0-(-104)=104dB$	S_i(dBm)-N_i(dBm)	$0-(-104)=104dB$
G (power gain)			$10^{\frac{S_o(dB)-S_i(dB)}{10}}$ $=S_o/S_i$	$10dB=10^{\frac{10(dB)}{10}}=10$
L (power loss)	$10^{\frac{S_i(dB)-S_o(dB)}{10}}$ $=S_i/S_o$	$10dB=10^{\frac{10(dB)}{10}}$ $=10$		
S_o (dBm)	S_i(dBm)-L(dB)	$0-10=-10dBm$	S_i(dBm)+G(dB)	$0+10=10dBm$
T_e (°K)	$(L-1)T_o$	$(10-1)\times290=2610^oK$		290°K
N_o (dBm)	N_i(dBm) $(=10\log Gk(T_o+T_e)B$ $=10\log GkT_oBF)$	$-104dBm$ $(=10\log[0.1\times1.38\times10^{-23}$ $\times(290+2610)\times10^7\times10^3]$ $=10\log[0.1\times1.38\times10^{-23}$ $\times290\times10^7\times10\times10^3]$ $=10\log[4\times10^{-11}(mW)]$ $=-104dBm$	$10\log Gk(T_o+T_e)B$	$10\log[10\times1.38\times10^{-23}$ $\times(290+290)\times10^7\times10^3]$ $=10\log[8\times10^{-10}(mW)]$ $=-91dBm$
SNR_o (dB)	S_o(dBm)-N_o(dBm)	$-10-(-104)=94dB$	S_o(dBm)-N_o(dBm)	$10-(-91)=101dB$
F(dB)	SNR_i (dB)- SNR_o (dB)	$104-(94)=10dB$	SNR_i (dB)- SNR_o (dB)	$104-(101)=3dB$
T_e (°K)			$(F\text{-}1)T_o$	$(2-1)\times290=290°K$