NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 4210 MIDTERM EXAM II 3/6/92 Po

- This exam is open book and notes.
- There are three problems; each is equally weighted.
- Partial credit will be given; *be sure to do some work on each problem.*
- Be sure to include units in your answers.
- *Please circle or underline your answers.*
- Show *ALL* work.
- Do not do any work on this exam sheet.

1	
2	
3	
Total	

Name: _____

1. An avalanche photodiode operates into a 50 Ω load cooled to 77K. The APD has a quantum efficiency of 60%, a gain of 100, an excess noise factor that varies as $M^{0.3}$, a negligible surface dark current, and a bulk dark current of 1 pA. It is illuminated with a direct–detection test signal with an unmodulated photon flux of 1×10^{10} photons per second with $m = 1$.

   Calculate the signal–to–noise ratio *(in dB)* if the noise bandwidth is 1 GHz.

2. An IR detector, that is loaded with a 50 Ω load resistor at a noise temperature of 600K, is used with a preamplifier that has a power gain of 35 dB, an input resistance of 50 Ω, and an output resistance of 50 Ω. An rms noise voltage measurement at the preamplifier output is 0.2 mV.

   Calculate the noise figure *(in dB)* of the preamplifier.

3. A photoconductor that measures 1 mm x 1 mm is used with heterodyne detection at a wavelength of 1 μm. The IF frequency is 100 MHz and the noise bandwidth is 10 MHz. The detector has a responsivity of 3 A/W, a dark current of 1 pA, a carrier lifetime of 5 ns, and a transit time of 1 μs. It operates into a 300 Ω load resistor that has a noise temperature of 600K.

   Calculate the ratio of the mean–square generation–recombination noise current to the mean–square thermal noise current when the signal power is 1 nW and the local oscillator power is 20 μW.