NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3550 MIDTERM EXAM II 5/98 Prof. Powers

- This exam is open book and notes.
- There is a 50 minute time limit.
- 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.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.

1	
2	
3	
Total	

Name: _____

1. An avalanche photodiode (APD) is to operate with a 5-nW signal at 1300 nm. The signal requires a bandwidth of 500 MHz. The responsivity of the APD is 50 A/W when the gain of the APD is 50. The excess noise factor depends on the gain as $M^{0.5}$. The bulk dark current of the device is 10 nA and the surface dark current is 10 μA. The device operates into a 500-Ω load resistor with a noise temperature of 350K.

   (a) Calculate the optimum gain for this APD with this signal.

   (b) Calculate the value of gain, M, that will make the signal-dependent shot-noise power equal to 20 times the shot-noise power due to the surface current.

---

2. We want to connect two singlemode fibers together. The fibers on each side of the connection are the same. They each have a mode-field diameter (MFD) of 9 μm and a core index of 1.450. The gap between the fiber ends is air.

   Find the expected connector loss (in dB) at an operating wavelength of 1300 nm when the lateral displacement *and* the longitudinal separation are *each* equal to 10% of the MFD. The angular misalignment can be assumed to be zero.

---

3. A surface-emitting laser has a circular active region with a diameter of 6 μm and produces a symmetric beam pattern. It is observed that this laser couples 7% of its power into a singlemode fiber with a core diameter of 8 μm, a core index of 1.460, and a Δ of 0.2%.

   Find the full-angle beam divergence (in degrees) for this laser.