NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3550 MIDTERM EXAM II 11/93 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.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.

1	
2	
3	
Total	

Name: ______________________________

1. A silicon APD with the properties found below operates in a fiber link at a wavelength of 850 nm. The load resistor of the APD is 300 Ω and has a noise temperature of 300K. The signal bandwidth is 75 MHz.

   (a) Find the incident optical power required to make the signal–dependent shot noise power equal to fifteen times (15x) the thermal noise power.

   (b) For the power found in part a, find the optimum gain of the APD.

APD parameter	Value
Dark current (bulk)	5 nA
Dark current (surface)	0 nA
Quantum efficiency at 850 nm	90%
Gain	75
Excess noise factor	$M^{0.4}$

2. Consider a representative fiber optic link that uses a pin diode detector and load resistor as a receiver. After 1 year of operation, it is observed that the optical power of the source has dropped to 99% of its original value. Also, it is found that the measured S/N ratio at the receiver is +13 dB after one year of operation. Assuming that the receiver noise is dominated by the thermal noise of the load resistor, find the predicted S/N ratio (in dB) at the receiver due to the decrease of source power at the end of 20 years of operation.

3. An optical source with a symmetric beam pattern and a full–angle beam divergence of 30° (measured at the half-power points) is used in an fiber link operating at 150 Mb/s. The total optical losses of the link are 30 dB and the NA of the step–index fiber is 0.15. The minimum power required at the receiver to achieve the desired bit error rate (BER) is given by

$$P'_R[\mathrm{dBm}] = 10.5 \log(B'_R[\mathrm{Mb/s}]) - 65$$

   where P'_R is the minimum required receiver power *(in units of dBm)* and B'_R is the bit rate *(in units of Mb/s)*.

   Find the minimum source power (in dBm) to achieve the desired BER.