1. An InGaAsP detector with an active area of 50 µm$^2$ is used to monitor signals at 1.55 µm. The refractive index of the semiconductor is 3.6, the responsivity at 1.55 µm is 0.3 A/W, and the junction depth is 2 µm.
   a. If the detector is used in a low impedance load configuration with a 75 Ω resistor, determine the output voltage when the detector is illuminated with 50 µW of optical power.
   b. Determine the rise time of this receiver.
   c. Determine the signal to noise ratio if the receiver is limited by shot and thermal noise. Assume that the receiver is at room temperature (300°K).
   d. Determine the output voltage and SNR when the same detector is used in a transimpedance amplifier receiver with $A = 15$ and a feedback resistance of 2 kΩ.

2. A receiver is formed with a detector that can be described with the simple detector model and that has a junction capacitance of 1 pF. The responsivity of the detector is 0.3A/W. The receiver operates at room temperature (300°K). 10 µW of optical power is incident on the detector and $R_L = 1$ kΩ. Determine the minimum detectable power that is required to achieve a BER = $10^{-15}$. You can assume that Gaussian statistics apply and that the probability of receiving a 1 and a 0 are equally likely.

3. The threshold current for a semiconductor laser is 20 mA and the differential efficiency of the laser is 0.80 mW/mA. The laser output power becomes saturated when the drive current reaches 45 mA.
   a. Draw a sketch showing the laser output power as a function of drive current when the injection current varies from 0 to 60 mA.
   b. At what operating point should the laser be biased so that the maximum optical power modulation (sinusoidal) can be achieved with saturation or clipping effects?
   c. The RIN factor for the laser is –180 dB/Hz and will be used in a system with an operating bandwidth of 10 GHz with an average output power of 10 mW. What is the fluctuation in optical output power?