Problem 1 Jinsong Liu 20b216

(a) $\delta = \frac{1}{2\tau_2}\frac{W_p}{W_{th}}$ $\quad \frac{d(\Delta n)}{dt} = -\sigma \cdot c \cdot \bar{p} \cdot \Delta n - \Gamma \cdot \Delta n - \frac{\Delta P}{\tau_{ph}}$

The spontaneous emission causes the excited particles to decrease in the active medium. As the photon density is increasing, the derivative of Δn is decreasing.

(b) spontaneous emission

(c) The spiking of lasers is a behavior similar to relaxation oscillations, but nonlinear instead of damped oscillations.

(d) $Q \propto \frac{\text{in cavity stored energy}}{\text{energy loss per round trip}}$

$\therefore$ The quality factor is determined by the photon lifetime in the cavity τ_{ph}

(e) The pump power

(f) The cavity life time

Problem 2 Jinsong Liu 20b216

(a) ① First the resonator is low-Q resonator, high inversion possible without laser oscillation.

② Then the resonator switches to high-Q resonator, the photon density increases fast.

③ Most of energy stored in active medium as inversion extracted

④ Giant pulse