Task 1.

(a)…

(b) inhomogeneous

(c) Maximum extraction – operation in saturated high-signal regime:

$$\Gamma(l) = \Gamma_{in} + gl\Gamma_S$$

$$l = \frac{\Gamma_d}{2g\Gamma_S} = \frac{\Gamma_d}{2h\nu(N - N_{tr})} = 0.82mm$$

$$E_{out} = \frac{\Gamma_d}{2Ld} = 175\,pJ$$

Task 2.

(a) 3

(b) rotational

(c) glass.

$B/A \propto 1/n^3$. 2.8 times.

Task 3.

(a) transitional metal. Vibronic coupling.

(b) Frank-Condon principle.

(c) $\frac{\tau(GaAs)}{\tau(GaN)} = \frac{n(GaN)(Eg(GaN))^3}{n(GaAs)(Eg(GaAs))^3} = 11.26$. GaN lifetime 266 ps.

Task 4.

(a) …
(b) V_p=(I_{max}-I_{min})/ (I_{max}+I_{min})
(c) From Eq. 11.3.13: $V_p = \frac{2(\langle I_1\rangle\langle I_2\rangle)^{1/2}}{\langle I_1\rangle+\langle I_2\rangle}\left|\gamma^{(1)}(r_1, r_2, 0\,)\right|$, so $\left|\gamma^{(1)}\right| = V_p\frac{1+r}{\sqrt{r}} \cong 0.8$.

Task 5.

(a) w1, w2, w0's equations are 5.5.8a, 5.5.8b, and 5.5.9. g_1=g_2=1-L/R=0.75, so w0=0.465 mm, and w1=w2=0.497 mm.
(b) g_1=1, and g_2=0.75, so w1=0.532 mm (=w0), and w2=0.614 mm.

(c) $g_1=1-R/(R+\Delta R)>0$ while $g_2=1-R/(R-\Delta R)<0$, so $g_1g_2<0$. The cavity is unstable, and the laser does not work. To move the cavity into a stable configuration, one must have $g_1g_2>0$, i.e., $(1-L/(R+\Delta R))(1-L/(R-\Delta R))>0$. Thus, $L>R+\Delta R$ or $L<R-\Delta R$ should be satisfied. You have to move the mirrors by at least ΔR closer or farther than the confocal position to bring the resonator into the stable region.

Task 6.

(a) ...

(b) $$P_{th} = \left(\frac{\gamma}{\eta_p}\right)\left(\frac{h\nu_p}{\tau}\right)\left[\frac{\pi(w_0^2 + w_p^2)}{2\sigma_e}\right]$$, so 75 mW.

(c) ...

(d) $\eta_s = \eta_p\eta_c\eta_q\eta_t$. $\eta_c = \gamma_2/2\gamma = 83\%$ ($\gamma_2 = 5\times10^{-2}$), $\eta_q = h\nu/h\nu_{mp} = 808/1060 = 76\%$, $\eta_t \sim 1$, so $\eta_s = 51\%$.