Homework 6

Here are the parameters of semiconductor laser:
Active layer thickness d_a=100 Angstrom
Width W=2μm
Length L=300μm
Reflectivity R=32%
Refractive index n=3.35;
Confinement factor Γ=0.04
Modal loss $\alpha=20cm^{-1}$
Wavelength λ=1550nm
Gain dependence on carrier concentration $\gamma = \gamma_0 \ln\left[\frac{N_e + N_{e,sat}}{N_{tr} + N_{e,sat}}\right]$
Where transparency density is $N_{e,tr}=1.8\times10^{18}cm^{-1}$, saturation density is $N_{e,sat}=-0.4\times10^{18}cm^{-3}$(negative sign is OK) and $\gamma_0=1800cm^{-1}$
The recombination rate is
$\tau_r^{-1}=A+BN_e+CN_e^2$ where $A=10^7\ s^{-1}$ $B=0.8\times10^{-10}\ cm^3/s$ and $C=3.5\times10^{-30}\ cm^6/s$
Assume 100% injection efficiency (no leakage)

1. Plot gain vs carrier density curve
2. Plot differential gain vs carrier density curve
3. Plot gain vs **current** density curve.
4. Determine photon lifetime τ_p, threshold modal gain, and threshold material gain γ_{th} Determine threshold carrier density $N_{e,th}$, threshold current density J_{th} and threshold current I_{th}
5. Determine threshold differential gain a_{th} and recombination rate at threshold.
6. Plot output power versus input current curve.
7. Determine the current at which output power is equal to 1mW.
8. Determine the resonant frequency at this power level
9. Determine the linewidth at this power level (α=4)