Homework 2

Consider a three-level system shown here. The lasing transition is from the level 3 to level 2. Population of level 3 spontaneously decays to both level 2 and level 1 with rates shown. Total density of atoms is N

1. What are the lifetime of level 3, $\tau_3$ and lifetime of level 2, $\tau_2$ ?
2. Write the rate equations and solve them to determine the steady state value of gain.
3. Is there a transparency pump power density?
4. How does the gain depend on $\tau_2/\tau_3$ assuming fixed $\tau_{32}/\tau_{31}=\kappa$? Plot it
5. How does the gain depend on $\tau_{32}/\tau_{31}$ assuming fixed $\tau_2/\tau_3=m$? Plot it
6. Can you always obtain a steady state gain?
7. Can you always obtain gain in a transient (pulsed) regime? To answer this question think about a very short pump pulse (i.e. $\tau_{\text{pulse}}<<\tau_{\text{mn}}$) of a given energy density $E_{\text{pump}}=S_{\text{pump}}\times\tau_{\text{pulse}}$