**Q1) Correct the following questions:**

1- The Boltzmann distribution shows the higher the energy level, the lower the population number and the higher

 the temperature, the lower the population number

2- The probability of transition from higher energy level to a lower one is directly proportional to the lifetime of

 the higher energy level.

3- The axis connecting the centers of resonator mirrors and perpendicular to them is called transverse axis of the

 laser

4-the lower transverse mode TEM00 have the biggest diameter compared to other modes.

5- In a continuous wave laser, increasing pumping cause increase in small signal gain, the saturation gain is

 increased, and remains equal to threshold gain.

6- In a continuous wave laser at steady state lasing, threshold gain is always “1”.

7- The absorption coefficient (α) for any material is function of the amplitude

8- Two waves of the same frequency and phase are moving in opposite directions, which is the condition for

 creating a standing wave.

 9- The advantage of the Concentric Circular Cavity resonator is; minimum focusing of the laser

 radiation inside the optical cavity

10-Energy loss by an excited atom can be performed in radiative decay only.

11- Stimulated emission is a process of transition of atom from a higher state to a lower one without any

 outer effect .

**Q2) Chose the correct answer for the following questions:**

1- In Spontaneous Emission there is ;

 a-no phase relation between photons emitted by different atoms. b- independent of external influence.

 c- no preferred direction for different photons. d- all of them.

2- The photon which is emitted in the stimulated emission process is identical to the;

1. incident electron. b- incident photon c- outgoing photon d- out going electron.

3- Active medium gain - which depends on:

1. Population Inversion and Fluorescence line-shape b- population and amplitude

c- Frequency and phase d- No one of them

 4-The narrower the fluorescence line-shape:

 a-No energy required to achieve population inversion b- Less energy required to achieve population inversion

 c-More energy required to achieve population inversion d-No one of them.

5-Energy loss by an excited atom can be performed in;

1. non-radiative decay b- radiative decay c- both of them d- no one of them.

6-The advantage of the Concentric Circular Cavity resonator is:

1. Limited use of the volume of the active medium b- Medium diffraction losses.

c- Maximum focusing of the laser radiation inside the optical cavity d-Very low sensitivity to misalignment

 7- The line width for Homogeneous broadening distribution can be expressed as :

a- Lorentzian curve and the equation is given as $g\left(v-v\_{o}\right)=\frac{δv}{2π[(v-v\_{o})^{2}+\frac{(δv)^{2}}{2}]}$

b-Lorentzian curve and the equation is given as

c- Gaussian curve and the equation is given as $g\left(v-v\_{o}\right)=\frac{c}{v\_{o}}\sqrt{\frac{M}{2πKT}}e^{\{\frac{-MC^{2}}{2KT}\frac{(v-v\_{o})^{2}}{v\_{o}}\}}$

 d- Gaussian curve and the equation is given as

 8- Losses in the laser, which include:

 a-Reflections from end mirrors. b- Radiation losses inside the active medium

 c- Diffraction losses d- All of them

9- Two waves of the -----are moving in opposite directions, which is the condition for creating a standing wave.

1. same frequency and amplitude b- same frequency and phase

c- same wavelength and phase d- opposed frequency and amplitude

10- The excitation in ruby laser don by:

 a- optical b- chemical c- electrical d- all of them

**Q3)** Prove that the difference in population numbers (N1, N2 )between two energy levels E2 and E1  is given by: N1 –N2 =N1 x [exp(-hν/kT)]. Where ν = ν2-ν1is the frequency which corresponds to the energy difference between the two levels E2 and E1 .

**Q4)** The properties of Nd YAG laser are: Wavelength is 1.06 [µm]. Cavity length is42 [cm].Length of the laser crystal is125 [mm]. Index of refraction of the crystal is 1.823. Width of the fluorescence line is 30 [GHz]. Output coupler transmission = 4%. Losses inside the cavity is 0.5%.

**Calculate:** The wavelength difference between the mode with the maximum frequency, and the mode with the minimum frequency (the range of wavelengths emitted from the laser)

**Q5) Briefly explain the** Electrical excitation ( second kind collision):

 Q6) **Briefly explain the** Step by step Operation of a Laser System as - Interactive Applets.

**Q7) Briefly explain the** Enumerate the Most Properties of Basic Gaussian Transverse Mode.

**Q8) Draw** Active Medium Gain Curve with lasing - Hole Burning

**Q9) Draw** The intensity distribution of 3 lower transverse modes, and their superposition.

Q10) Draw the gain and output power from a pulsed solid state laser.