Roll No. ....

D–972

M. Sc. (Fourth Semester) (Main/ATKT)

EXAMINATION, May-June, 2020

PHYSICS

Paper Second

(Laser Physics and Applications)

Time : Three Hours]   [*Maximum Marks : 80*

Note : Attempt all Sections as directed.

Section—A   1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. If υ_0 and $\Delta\upsilon$ are respectively the central frequency and frequency spread of a wave, then the coherence time τ of the wave is :

   (a) $\dfrac{\upsilon_0}{\Delta\upsilon}$

   (b) $\dfrac{1}{\Delta\upsilon}$

   (c) $\Delta\upsilon$

   (d) $\dfrac{\Delta\upsilon}{\upsilon_0}$

2. For Q-factor of a resonant cavity, which statement is not true ?

   (a)   Its a dimensionless quantity.

   (b)   Greater is Q-factor smeller is losses in the cavity.

   (c)   Smaller is the line width, higher is Q-factor .

   (d)   Q-switching is not possible.

3. Ratio of coefficient of spontaneous emission (A_{21}) to stimulated emission (B_{21}) is given by :

   (a) $\dfrac{8\pi h \upsilon^3}{c^3}$

   (b) $\dfrac{1}{\exp\left(\dfrac{h\upsilon}{k_B T}\right)}$

   (c) $\dfrac{k_B T}{h}$

   (d) $h\upsilon$

   where h, υ, c , k_B and T have usual meanings.

4. Which scheme of pumping is not feasible (possible) ?

   (a)   4-level

P. T. O.

(b) 3-level

(c) 2-level

(d) None of the above

5. Ruby laser gives, wave output of :

(a) Continuous

(b) Pulsed

(c) Both (a) and (b)

(d) None of (a) and (b)

6. Mode locking in laser means production of pulses :

(a) in the same phase

(b) of the same amplitude

(c) Both (a) and (b)

(d) None of (a) and (b)

7. In He-Ne laser, the lasing takes place in :

(a) He atom

(b) Ne atom

(c) Both He and Ne

(d) None He and Ne

8. CO_2 laser may produce :

(a) a continuous output

(b) a pulsed output

(c) Both continuous and pulsed output

(d) None of (a) and (b)

9. The highest power can be achieved in ..... laser.

(a) He-Ne

(b) Ruby

(c) Semiconductor

(d) Ne : YAG

10. Metastable energy state means life time of atoms at that state is :

(a) $> 10^{-8}$ sec

(b) $< 10^{-8}$ sec

(c) $= 10^{-8}$ sec

(d) $\neq 10^{-8}$ sec

11. Which one is not the outcome of non-linear optics ?

(a) Harmonic generation

(b) Parametric oscillation

(c) Optical mixing

(d) None of (a), (b) and (c)

12. Tunable laser is :

(a) Organic dye laser

(b) Solid state laser

(c) Gas dynamic laser

(d) Plasma laser

P. T. O.

13. In second harmonic generation, superimposition of frequencies υ_1 and υ_2 does not yield the frequency of :

(a) $2\upsilon_1$

(b) $2\upsilon_2$

(c) $2(\upsilon_1 - \upsilon_2)$

(d) $\upsilon_1 + \upsilon_2$

14. Phase matching condition, matches the velocities of two waves of :

(a) different phase

(b) the same phase

(c) different frequency

(d) the same frequency

15. In order to accomplish, the thermonuclear fusion two isotopes of Hydrogen used are :

(a) H and D

(b) D and T

(c) H and T

(d) None of the above

where (H : Hydrogen, D : Deuterium and T : Tritium).

16. The extensively used laser for cutting the steel sheets is :

(a) He-Ne laser

(b) Ruby laser

(c) Semiconductor laser

(d) CO_2 laser

17. Q-switching removes the process of :

(a) Negative temperature

(b) Pumping

(c) Giant pulse production

(d) Spiking

18. Wavelength of He-Ne laser is .... Å.

(a) 5145

(b) 10600

(c) 6328

(d) 6943

19. In optical fibre, the optical phenomenon utlised for propagation of laser is :

(a) Interference

(b) Total internal reflection

(c) Diffraction

(d) Polarization

20. LASIK surgery is related to human organ of :

(a) Eyes

(b) Ears

(c) Chest

(d) Abdomen

Section—B   2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. What is meant by metastable state ? Explain.
2. Define coherence time and give its relation with coherence length.
3. What do you mean by the population inversion ? Why is it required in lasing process ?
4. Why is laser beam more monochromatic than ordinary light ? Explain.
5. Define Roman scattering. Explain the stokes and antistokes lines of spectra.
6. Write the condition of phase-matching for second harmonic generation.
7. Define the term NA (Numerical Aperture) of an optical fibre ? What is its significance ?
8. What do you mean by the thermonuclear fusion ? How is it accomplished through the laser ?

Section—C   3 each

(Short Answer Type Questions)

1. Calculate the frequency separation of the modes in Ruby Laser containing crystal of length 4 cm with refractive index of 1.78. The peak emission wavelength is 0.55 μm.
2. What do you mean by Q-factor ? Why Q switching is needed in some laser ? How is Q switching achieved ?
3. What do you mean by mode-locking ? What are different methods of mode-locking ? Describe very briefly.
4. Explain the phenomenon of self-focussing of laser.
5. Explain multiphoton photoelectric effect briefly.
6. What do you mean by the pulse dispersion in optical fibre ? Derive its expression.
7. What do you mean by Stimulated Raman Scattering (SRS) effect explain briefly.

P. T. O.

8. What does LIDAR stand for ? Describe briefly its working via a diagram.

Section—D   5 each

(Long Answer Type Questions)

Note : Attempt all questions.

1. Describe the basic features in terms of any *one* of the following laser system in terms of its construction, working and applications :
   (a) He-Ne laser
   (b) Ruby laser
   (c) CO_2 laser

2. What are Einstein's coefficients denoting the processes of absorption of emissions ? Discuss the condition for laser emission.

Or

Describe the basic principle of semiconductor laser by a simple diagram.

3. What are the characteristics of laser required for precise measurement of length ? Explain, how precise measurement is made.

Or

What are the components of optical communication ? Describe, why is optical fibre regarded as the best channel for communication.

4. Write short note on any *one* of the following :
   (a) Application of laser in thermonuclear fusion
   (b) Application of laser in Medical Science
   (c) Application of laser in industries

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