	Final Exam	Term	**Code**	P432	**Percentage %**	60
	Term No.	1	**Faculty**	Science	**No. of Papers**	5
	Year	2018/2019	**Department**	Physics	**Date of Exam**	2/1/2019
	Course	Laser and Maser	**Total Marks**	120	**Allowed Time**	2 hours

لاجابة بآخر صفحة من أوراق الأسئلة فى الجداول بوضع دائرة صغيرة مظللة [●] أمام رمز الأجابة الصحيحة، وتسلم جميع أوراق الأسئلة مع ورقة الاجابة.

Q-1: Choose the correct answer in the following sentences: **(2 Marks for each point)**

1. Laser light is intense because (a) it has very less number of photons that in phase (b) it has very large number of Photons that are in phase (c) none of them
2. The population inversion in preparing laser beam can be achieved (a) when one of the excited states is more populated than the ground state (b) when one of the excited state is less populated than the ground state (c) none of them
3. In lasing action. the light amplification is done due to
   (a) stimulated emission (b) spontaneous emission (c) absorption
4. Laser beam is composed of waves at same wavelength. with very small ..... and start at the same time.
   (a) intensity (b) divergence (c) coherence
5. Once the active medium is excited. the first photons of light are produced by a physical process which is called (a) spontaneous absorption (b) stimulated emission (c) None of them
6. The population inversion process is observed due to the existence of
   (a) excited state (b) metastable state (c) ground state
7. The power density of laser sources is (a) higher than (b) lower than (c) equal to that of conventional light sources.
8. Maser is (a) not amplified electromagnetic waves at microwave and radio frequencies (b) not coherent electromagnetic waves (c) coherent electromagnetic waves produced through amplification by stimulated emission at non-visible wavelengths.
9. A LASER is a MASER with higher frequency photons in the ultraviolet or visible light spectrum
   (a) true (b) false
10. When the transition probability from higher energy level to a lower one is low. then the lifetime of the higher energy level is (a) high (b) low (c) constant.
11. In reality, every spectral line of laser has a finite (a) wavelength (b) intensity (c) emission width around its central wavelength (λ_0).
12. When a light wave enters into a medium of different optical density.
    (a) its speed and frequency change (b) its speed and wavelength change
    (c) its frequency and wavelength change (d) its speed. frequency. and wavelength change.

occurs only at wavelengths in which the materials have a ..... emission.

stimulated (b) phosphorescence (c) None of them

cording to Boltzmann equation, for atoms in thermodynamic equilibrium with their surrounding, the higher the temperature, the.....the population number. (a) medium (b) higher (c) lower

15. For fixed thickness of a material with ..... incident wavelengths, the transmission changes with the absorption coefficient (α). (a) constant (b) different (c) none of them

16. A Helium-Neon laser of power 1 mW and the laser beam diameter at the laser output is 2 mm. The power density at a distance of 2 m is 8 mw/cm^2. Then its divergence is ..... mrad. (a) 1 (b) 10 (c) 0.1

17. In a phosphorescent material, after the excitation stops, the photons are emitted by
(a) spontaneous emission (b) stimulated emission (c) fluorescence process.

18. The (a) stimulated emission (b) spontaneous emission (c) phosphorescence is independent of external influence.

19. For laser production, after the first photons of light are produced, which process is responsible for amplification of the light? (a) spontaneous emission (b) stimulated absorption (c) None of them

20. The lower laser energy level (E_2) in the four level lasers has low population and ..... life time.
(a) short (b) long (c) medium

21. Because of the feedback mechanism, only photons which move between the mirrors remain in the active medium, which give the ..... of the output beam.
(a) directionality (b) monochromaticity (c) coherence

22. In (a) fluorescence (b) stimulated emission (c) spontaneous emission process, the emission stops the moment the excitation stops.

23. For new laser materials, the energy levels are examined spectroscopically to find
(a) fluorescence (b) stimulated emission (c) phosphorescence.

24. The ballast resistor is used to limit the current through the tube when the tube gas resistance
(a) remains constant (b) increases (c) decreases

25. Pumping mechanism in diode laser is (a) electric resistance (b) electric current (c) chemical reaction.

26. A low pressure is commonly used in gas laser to obtain ..... spectral width.
(a) narrow (b) broad (c) wavelength

27. The role of the Helium gas in He-Ne laser is to (a) increase (b) decrease (c) limit the efficiency of the lasing process.

28. Electromagnetic radiation has, in addition to its wave nature, some aspects of "particle like behavior" which is called phonons. (a) true (b) false

29. The light from a laser source is monochromatic because all the photons .....
(a) are in phase (b) have same amplitude (c) have same energy (d) are in the same direction

30. Optical pumping is not generally an efficient method for gas lasers. because gas atoms absorb a ..... portion of the light in the excitation process. (a) small (b) large (c) medium

31. To find the beam divergence angle. when the measurement is done ..... the laser source. it is accurate enough to measure the spot diameter and divide it by the distance of the illuminated spot from the laser source. (a) at (b) near (c) very far from

32. Gas lasers use (a) electrical discharge (b) electrical resistance (c) chemical reaction through the gas medium as excitation or pumping mechanism.

33. The laser (a) intensity (b) energy (c) power measured over a defined unit area is called power density.

34. The visible spectrum wavelength difference $\Delta\lambda$ is given by $\Delta\lambda = 0.7\text{-}0.4 = 0.3$ μm. then the frequency width $\Delta\nu$ is given by $\Delta\nu =$ (a) $c/0.4 - c/0.7$ (b) $c/0.3$ (c) $c/0.7$

35. When the lifetime of the metastable state is high. the population of atoms at this level increases and hence the probability is ..... that an incoming photon will stimulate an excited atom to return to a lower state. (a) high (b) low (c) none of them.

36. The relative population (N_2/N_1) depends on (a) the difference between (b) the values of (c) none of the energy levels E_1 and E_2.

37. Monochromaticity means (a) two wavelengths (b) one wavelength (c) three wavelengths

38. This angular spreading of a laser beam is .....compared to other sources of electromagnetic radiation (a) very small (b) very large (c) none of them

39. Pumping source preferred for gaseous lasers is (a) optical (b) electrical (c) X-Ray pumping.

40. A phosphorescence process is a process in which absorption is ..... the emission process.
(a) equal to (b) longer than (c) shorter than

41. Every material is transparent differently to different wavelengths. so the absorption coefficient (α) of a material depends on
(a) the material type only (b) the material type and wavelength (c) wavelength only.

42. Coherence depends on (a) monochromaticity (b) directionality (c) none of them

43. In fluorescence process. the absorbed wavelengths by the atom are ..... the emitted wavelengths.
(a) equal to (b) shorter than (c) longer than

44. In case of the four level lasers, the population inversion can be created with pumping .....of the atoms to the upper laser level. (a) 1 % (b) ≥ 50 % (c) a. b

45. The negative sign in the rate equation of spontaneous emission means that the rate at which the excited atom population $N_2(t)$ decays from the higher energy level (E_2) to the lower energy level (E_1) increases with increasing (a) $N_2(t)$ (b) $N_1(t)$ (c) dN_2/dt

46. The absorption rate equation depends on the number of atoms in the lower energy level and the energy density of radiation n (t) is not included. (a) true (b) false

...e process of stimulated emission is a result of resonance response of the atom to the forcing signal, so they oscillate at the same frequency and are coherent in space and time. (a) true (b) false

48. The angular spreading of conventional sources of electromagnetic radiation is ..... compared to a laser beam. (a) very small (b) very large (c) medium

49. If a material is in a thermal equilibrium, only absorption can occur, and no amplification. To produce amplification, the material must be in a population inversion. (a) true (b) false

50. In non radiative decay - the energy is transferred to mechanical vibrations of neighboring atoms which appears in the form of (a) light (b) laser (c) heat

51. In the process of absorption in the laser medium, the absorption coefficient (α) depends on the material type, and on ..... between the energy levels E_1 and E_2

(a) $\Delta N = N_1 - N_2$ (b) $\Delta N = N_2 - N_1$ (c) none of them

52. If the condition of "Population Inversion" does not exist, the probability of stimulated emission will.....

(a) remain constant (b) decrease (c) increase

53. The ..... determines the possible wavelengths that can be emitted from the laser.

(a) pumping source (b) active medium (c) a or b

54. In the "population inversion" situation, α is positive, and the intensity at the output (I) is bigger than the intensity at the input (I_0), thus amplification occurs. (a) true (b) false

55. Helium is particularly valuable in He-Ne laser because the direct excitation of Neon gas is..... but the direct excitation of He gas atoms is .....

(a) inefficient, efficient (b) efficient, inefficient (c) None of them

56. In He-Ne laser, an excited state of the He atom (labeled E5) has an energy level which has the ..... energy of an excited state of the Neon atom (also labeled E5). (a) same (b) higher (c) lower

57. A problem with creating the red light in He-Ne laser is that a Neon atom in state E5 may also emit 3.3913 μm. This emission ..... the population of the E5 level, without producing visible radiation.

(a) increases (b) does not affect (c) decreases

58. The solution to the above problem *"in sentence 57"* is to use a special coating on the laser mirrors which selectively ..... only the red light. (a) absorb (b) reflect (c) none of them

59. The ratio of the population numbers (N_1/N_2) for the two energy levels E_2 and E_1 when the material is at room temperature (300^0K) is ....., and the difference between the energy levels is 0.5 eV, so the wavelength (λ) of a photon which will be emitted in the transition from E_2 to E_1 is ..... Knowing $h = 6.625 * 10^{-34}$ J.s, $K = 1.38 * 10^{-23}$ J/K, $e = 1.6 * 10^{-19}$ C

(a) $4 * 10^{-9}$, 2.48 μm (b) $10^9/4$, 2.48 μm (c) $10^9/4$, 5.5 μm

60. Light has wavelength 400 nm in a vacuum. It passes into glass, which has an index of refraction of 1.5. What is the frequency of the light inside the glass?

a) 3.3×10^{14} Hz b) 5.0×10^{14} Hz c) 3.3×10^{5} Hz d) None of them

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