POSSESSION OF MOBILES IN EXAM IS UFM PRACTICE

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JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY, NOIDA,
TEST 1 EXAMINATION, ODDSEM 2022
B.TECH V SEMESTER

Course Title: Laser Technology and Applications **Maximum Marks: 20**
Course Code: 16B1NPH533 **Maximum Time: 1hr**

18

After pursuing the course, the students will be able to

CO1	Define the coherent properties, high brightness of laser, population inversion and optical feedback to laser technology
CO2	Extend the knowledge of lasers in some applications like LIDAR, laser tracking, barcode scanner, lasers in medicine and lasers in industry
CO3	Apply the optical ray transfer matrix to determine the stability of a laser resonator
CO4	Distinguish the operational principles of CW, Q-switched, mode locked lasers; laser rate equations for three & four level lasers; different types of laser systems

Note: All Questions are compulsory and answer in order. Symbols have their usual meanings

Q.1 [CO1] (a) For the $2P \rightarrow 1S$ transition in the hydrogen atom, the wavelength of the transition is 121.5 nm. The lifetime of the $2P$ state for spontaneous emission is 1.6×10^{-9} s. Calculate the Eistein's A and B coefficients.

(b) Explain line-shape function. Find out the natural line shape function $g(\omega)$ at the center of the line for an atomic transition with a line width of 10^8 Hz.

(c) Write the MKS units of $u(\nu)$, A_{21} and B_{21}. Further, write the expression relating all these three parameters.

(d) Find the coherence length for white light source (400 nm to 700 nm).

[2×4]

Q.2 [CO2] (a) Show that the brightness of a diffraction limited laser beam is given as, $B = (2/\beta\pi\lambda)^2 P$. Symbols used have their usual meanings.

(b) There is a 10% loss per round trip in a ruby laser resonator having a 10 cm long ruby crystal as the active medium. Calculate the cavity lifetime, assuming that the mirrors are coated on the ends of the ruby crystal. The refractive index of ruby at the laser wavelength is 1.78 & reflectivities of mirrors are 96%.

(c) A parallel laser beam with a diameter of 2 mm and a power of 10 W falls on a convex lens of diameter 25 mm and focal length 10 mm. If the wavelength of the laser beam is 500 nm, calculate the intensity and the electric field amplitude at the focused spot.

(d) Write the laser rate equations for two levels laser system and show that steady state population inversion by optical pumping between two levels is not possible.

[3×4]

Constants: $c = 3 \times 10^8$ m/sec; $h = 6.626 \times 10^{-34}$ m^2 kg /s