C.U.SHAH UNIVERSITY
Summer Examination-2022

Subject Name: Applied Optics

Subject Code: 4SC04APO1   **Branch : B.Sc. (Chemistry, Mathematics)**

Semester: 4   **Date: 09/05/2022**   **Time: 11:00 To 02:00**   **Marks: 70**

Instructions:
 (1) Use of Programmable calculator & any other electronic instrument is prohibited.
 (2) Instructions written on main answer book are strictly to be obeyed.
 (3) Draw neat diagrams and figures (if necessary) at right places.
 (4) Assume suitable data if needed.

Q-1   **Attempt the following questions:**   **(14)**
 a) *The full form of the term LASER is….*   (01)

 (A) Light And Sound Emitting Radar

 (B) Light Amplification by Sustained Emission of Radiation

 (C) Light Amplification by Stimulated Emission of Radiation

 (D) Light Amplification by Spontaneous Emission of Radiation

 b) *Photon energy E = …….*   (01)

 (A) hf (B) hc/λ (C) $2\pi c/\lambda$ (D) All Options are Correct

 c) *Which of the following is not a solid state laser system?*   (01)

 (A) He-Ne Laser   (B) Nd:YAG Laser

 (C) Semiconductor Laser   (D) Ruby Laser

 d) _____*Lasers are used in CD Players, CD ROM devices, Optical Fiber* (01)
 Communication like optical reading and data storage devices.

 (A) CO_2 Laser (B) Semiconductor Laser

 (C) Nd:YAG Laser   (D) He-Ne Laser

 e) Which of the following is not the gas laser system?   (01)

 (A) Nitrogen (N_2) Laser   (B) Carbon Dioxide (CO_2) Laser

 (C) Nd:YAG Laser   (D) (Helium-Neon) He-Ne Laser

 f) Which pumping scheme does a He-Ne laser system employ? What is the ratio of (01)
 He:Ne is used?

   (A) 4-level electrical pumping is achieved in the 01:10 ratio of He:Ne
   (B) 3-level optical pumping is achieved in the 10:01 ratio of He:Ne
   (C) 3-level electrical pumping is achieved in the 01:10 ratio of He:Ne
   (D) 4-level electrical pumping is achieved in the 10:01 ratio of He:Ne

g) ____is the active medium and ___is the active centers In the Ruby laser system. (01)

(A) Al_2O_3 : 0.05% Cr^{+3} ions   (B) Al_3O_2 : 0.05% Cr^{+3} ions

(C) Al_2O_3 : 0.5% Cr^{+3} ions   (D) Al_2O_3 : 5% Cr^{+3} ions

h) What can you say about the refractive indices of core and cladding in an optical (01)
fibre?

(A) $\eta_{Core} = \eta_{cladding}$ (B) $\eta_{Core} > \eta_{cladding}$

(C) $\eta_{Core} \geq \eta_{cladding}$ (D) $\eta_{Core} < \eta_{cladding}$

i) Snell's law is given by (01)

(A) $\eta_1 \sin\theta_2 = \eta_2 \sin\theta_1$ (B) $\eta_1 \cos\theta_1 = \eta_2 \sin\theta_2$

(C) $\eta_1 \sin\theta_1 = \eta_2 \sin\theta_2$ (D) $\eta_1 \cos\theta_1 = \eta_2 \cos\theta_2$

j) Optical fibers are made up from the ………materials. (01)

(A) Glass Core, Plastic Cladding   (B) Plastic Core, Glass Cladding   (C)
Plastic core, Plastic Cladding   (D) All correct

k) The number of modes an optical fiber supports is roughly calculated by the (01)
formula….

(A) $\dfrac{Core\ Diameter}{Transmitted\ Wavelength}$ (B) $Core\ diameter \times Transmitted\ Wavelength$

(C) $\dfrac{Core\ Radius}{Transmitted\ Wavelength}$ (D) $Core\ Radius \times Transmitted\ Wavelength$

l) The optical fibers which support only a single mode of propagation are called (01)

(A) Graded Mode Optical Fibers   (B) Mono Mode Optical Fibers

(C) Cosine Mode Optical Fibers   (D) Sine Mode Optical Fibers

m) The optical fibers which support many propagation paths or transverse modes (01)
are called

(A) Mono Mode Optical Fibers   (B) Multi Mode Optical Fibers
(C) Cosine Mode Optical Fibers   (D) Sine Mode Optical Fibers

n) The working principle of the optical fibers is… (01)

(A) Partial Internal Refraction of light   (B) Total Internal Refraction of light

(C) Total Internal Reflection of light   (D) Partial Internal Refraction of light

Attempt any four questions from Q-2 to Q-8

Q-2   **Attempt all questions** (14)
(A)   Differentiate : Conventional Light Beam versus Laser Light Beam (07)
(B)   Distinguish with figures: Spontaneous Emission of Radiation *versus* Stimulated (07)
      Emission of Radiation.

Q-3   Name any two solid state laser systems. Discuss any one of them in detail giving (14)
      principle, construction, working, advantages, disadvantages and applications
      with necessary figures of construction and pumping-energy level transition
      diagrams.

Q-4 What are Einstein's Coefficients? Define them. Prove that the ratio of **(14)** spontaneous emission and stimulated emission is proportional to the cube of the frequency by establishing relation between them.

Q-5 What is Holography? Discuss construction and reconstruction of a Hologram. **(14)** What are the applications of Holography?

Q-6 **Attempt all questions** **(14)**
(A) Distinguish: Mono Mode Optical Fiber versus Multi-Mode Optical Fiber. (07)
(B) Distinguish: Step Index Optical Fiber versus Graded Index Optical Fiber. (07)

Q-7 **Attempt all questions** **(14)**
(A) What are the advantages of optical fibre communication system over a conventional communication with the metallic cable system? (07)
(B) Narrate the general construction of optical fibers and their cable in brief. (07)

Q-8 **Attempt all questions** **(14)**
(A) Derive necessary expressions for optical fibreparameters: Acceptance Angle , Numerical Aperture, Propagation angle, Fractional refractive index, V-parameter and No. of modes that the optical fibre supports. (07)
(B) Calculate Propagation angle, Critical angle, Acceptance angle, Acceptance cone angle, Numerical Aperture and Relative refractive index of the given optical fiber, if refractive indices of core and cladding are 1.563 and 1.498 respectively with the core diameter 3μm; operated at the wavelength of 1.32μm. (07)