D 121314 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2025

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

(8 *Short questions answerable within* 7.5 *minutes*)

(Answer **all** *questions, each carries weightage* 1)

1. Explain spontaneous and stimulated emissions.
2. Briefly explain four wave mixing.
3. Bring out the different applications of holography.
4. Define numerical aperture. State the relation between numerical aperture and acceptance angle.
5. What are leaky modes ? Explain the mechanism for their occurrence.
6. Explain briefly optical parametric oscillator.
7. What are the characteristic properties of laser light ?
8. Differentiate between step index and graded index fiber.

(8 × 1 = 8 weightage)

Section B

(4 *Essay questions, each answerable within* 30 *minutes*)

(Answer any **two** *questions, each carries weightage* 5)

9. Explain the theory of Q-switching. Discuss the generation of high-power pulses through Q-switching.
10. With an energy level diagram, explain the construction and working of the Helium-Neon laser.

Turn over

11. What is nonlinear polarization ? Derive an expression to prove the existence of the second and third harmonic generation.

12. Describe the applications of laser in : (a) Industrial application of lasers ; (b) Lasers in medicine ; and (c) Laser induced chemical reactions

(2 × 5 = 10 weightage)

Section C

(7 *problems answerable within* 15 *minutes*)

(Answer any **four** *questions, each carries Weightage* 3)

13. Describe the theory of recording of image and reconstruction of image in a hologram.

14. An Nd:YAG laser emits 1064 nm. with a bandwidth of 0.1 nm. Determine the minimum possible laser pulse duration achievable from this laser without using any special techniques.

15. Derive an expression for Einstein co-efficients.

16. Calculate the gap in frequency between two longitudinal modes in a linear cavity whose optic length, L, = 225 mm.

17. Determine the radiance of a 5 mW helium-neon laser having an output diameter of 2 mm. and a divergence of 1 mrad.

18. Describe Z-scan technique.

19. A step index fibre has a numerical aperture of 0.395, core refractive index of 1.55. Calculate the refractive index of cladding, and the acceptance angle.

(4 × 3 = 12 weightage)

D 101299 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2024

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 *Short questions, each answerable within* 7.5 *minutes.*

Answer **all** *questions, Each question carries weightage* 1.

1. Explain Doppler broadening mechanism in lasers
2. Discuss briefly what unstable resonators are.
3. Explain Z scan technique
4. Explain any two applications of spatial frequency filter
5. What is a fibre laser ? What are the advantages of fibre laser over other lasers ?
6. Mention the medical applications of lasers
7. Give the two requirements for lasing action in a semiconductor diode. Explain how lasing action occurs in it.
8. Compare step index and graded index optical fibre.

(8 × 1 = 8 weightage)

Section B

4 *Essay questions, each answerable within* 30 *minutes.*

Answer any **two** *questions, Each question carries weightage* 5.

9. Explain the technique of mode-locking. How it is used to generate very short optical pulses of high peak power ?
10. Explain the application of lasers in material processing and isotope separation.

Turn over

11. Derive the laser rate equations for a three level laser system and a four level laser system.

12. Explain the working principle of singly resonant oscillator.

(2 × 5 = 10 weightage)

Section C

7 Problem questions, each answerable within 15 minutes.
Answer any **four** *questions, Each question carries weightage 3.*

13. For a cavity with mirrors having reflectivities of 98 %, what would the minimum gain need to be in order for the laser to reach threshold if the amplifier length is 0.2 m. and the mirror separation is 0.4 m ? Assume no losses in the cavity other than the mirror transmission losses.

14. For a ruby laser of 6328 Å wavelength, the spontaneous emission coefficient is $10^7\ s^{-1}$. The active medium of length 20 cm. and refractive index of 1.76 is installed in a two-mirror cavity having mirror reflectivities of 99.9 % and 98 %. Calculate the time in which energy in the cavity is reduced by a factor of 1/e. Also find the threshold population inversion. Given the normalised line shape function as $1.6 \times 10^{-10} s$. Assume no losses in the cavity other than the mirror transmission losses.

15. Explain threshold population inversion.

16. Describe the theory of recording and reconstruction of image in a hologram.

17. Find the phase matching criteria and hence the refractive index criteria for the efficient second harmonic generation

18. A He-Ne laser operating at 632.8 nm. has an output power of 1.0 mW with a 1 mm. beam diameter. Power in the cavity is 99 P since the output mirror has 1% transmission. The beam diameter is also 1 mm inside the laser cavity and the power is uniform over the beam cross section. The laser linewidth is 1.5×10^8 Hz. What is the ratio of stimulated and spontaneous emission rates ? What is the effective blackbody temperature of the laser beam near the output mirror in the cavity ?

19. The core diameter of a single mode optical fiber is 10 μm. the fiber is coupled to semiconductor laser rated to operate at 1.3 μm. The refractive index of the core glass material is 1.55. The maximum numerical aperture is 0.995. Calculate the refractive index of the cladding. Show that all the rays making an angle <5.712° with the axis of fiber will be guided through it.

(4 × 3 = 12 weightage)

C 42054 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2023

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

8 *Short questions answerable within* 7.5 *minutes.*
Answer **all** *questions, each question carries weightage* 1.

1. Derive the rate equation for a four level laser system
2. Discuss briefly what unstable resonators are.
3. What is a line shape function ? What will be the total number of stimulated emissions per unit time per unit volume in terms of line shape function ?
4. Briefly explain the working principle of optical parametric oscillator.
5. What are single mode optical fibres ? What are the advantages and disadvantages of single mode fibres over multimode ones ?
6. Explain Z scan technique.
7. Briefly explain the mechanism in which a step index cylindrical optical fibre can act as a waveguide. Give the equation of motion and mention the different modes.
8. Explain any *two* applications of spatial frequency filter.

(8 × 1 = 8 weightage)

Section B

4 *essay questions, each answerable within* 30 *minutes.*
Answer any **two** *questions, each question carries weightage* 5.

9. Explain any *three* line broadening mechanisms in a laser system.
10. Discuss the theory of Q- switching and how it generates high power pulses.

Turn over

11. Explain the working principle of a semiconductor laser and a fiber laser semiconductor laser.

12. Explain the application of lasers in material processing and isotope separation.

(2 × 5 = 10 weightage)

Section C

7 problem questions, each answerable within 15 minutes
Answer any **four** *questions, each question carries weightage 3.*

13. Derive Einstein's co-efficients in a laser. A He-Ne laser operating at 632.8 nm has an output power of 1.0 mW with a 1 mm beam diameter. Power in the cavity is 99 P since the output mirror has 1 % transmission. The beam diameter is also 1 mm inside the laser cavity and the power is uniform over the beam cross section. The laser linewidth is 1.5×10^8 Hz.

14. For a ruby laser of 6328 A° wavelength, the spontaneous emission co-efficient is 10^7 s^{-1}. The active medium of length 20 cm and refractive index of 1.76 is installed in a two-mirror cavity having mirror reflectivities of 99.9 % and 98 %. Calculate the time in which energy in the cavity is reduced by a factor of 1/e. Also find the threshold population inversion. Given the normalised line shape function as 1.6×10^{-10} s. Assume no losses in the cavity other than the mirror transmission losses.

15. Derive the criteria for a stable laser cavity.

16. Compute the Doppler broadening for the 632.8-nm laser transition in the He-Ne laser, assuming a single isotope of Ne^{20} and that the laser operates at a discharge bore temperature of 100°C.

17. Compare CO_2 laser with He-Ne laser with respect to the energy level diagram, frequency of emission, pumping and efficiency.

18. Compare step index and graded index optical fibre. Calculate the number of modes for a graded index optical fiber if its core diameter d = 62.5 μm, refractive index of core and cladding are 1.48 and 1.46 and its operating wavelength = 1433 nm.

19. The core diameter of a single mode optical fiber is 10 μm. the fiber is coupled to semiconductor laser rated to operate at 1.3 μm. The refractive index of the core glass material is 1.55. The maximum numerical aperture is 0.995. Calculate the refractive index of the cladding. Show that all the rays making an angle < 5.712° with the axis of fiber will be guided through it.

(4 × 3 = 12 weightage)

C 22585 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE [REGULAR/SUPPLEMENTARY] EXAMINATION, APRIL 2022

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions answerable within* 7.5 *minutes*
Answer **all** *questions, each question carries weightage* 1.

1. Briefly explain mode locking
2. Define quality factor of a laser cavity.
3. Explain Multi photon absorption.
4. What is acceptance angle in a fibre ? Show that it does not depend on fibre dimension.
5. What is spatial frequency filtering ? Give one application.
6. How does light propagation take place in an optical fiber ?
7. Briefly explain laser induced fusion.
8. State and explain the threshold condition for laser action.

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each question carries weightage 5.*

9. Explain the basic principle of Laser and derive an expression for Einstein co-efficients.
10. What is Holography ? Discuss about the basic principle of holography.
11. Describe the theory and experimental techniques of third harmonic generation.
12. Derive wave equations a for a step index fiber.

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each question carries weightage 3.*

13. Explain industrial applications of laser.
14. A step index fibre has a numerical aperture of 0.26, core refractive index of 1.5 and a core diameter of 100 μm. Calculate the refractive index of cladding, the acceptance angle and the maximum number of modes with a wavelength of 1 μm that the fibre can carry.
15. A He-Ne laser emitting at 633 nm has a line width of 0.002 nm. Determine its coherence length. Also determine the coherence length if the same laser was frequency stabilized to a frequency uncertainty of 100 kHz.
16. Explain optical parametric oscillator.
17. A laser range finder produces a laser spot of diameter 4 m at a target located at a distance of 8 km from the source. Determine the full angle divergence of the laser beam.
18. A certain laser has a bandwidth of 22 GHz. Determine the theoretically possible shortest mode-locked pulse width it can generate.
19. Differentiate three level lasers from four level laser systems.

(4 × 3 = 12 weightage)

C 2065 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION
MARCH 2021

(CBCSS)

Physics

PHY 4E 13—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions answerable within* 7.5 *minutes.*
Answer **all** *questions, each question carries weightage* 1.

1. What are the characteristic properties of laser light ?
2. Write a note on stable and unstable resonators.
3. Briefly explain industrial applications of laser.
4. How does light propagation takes place in an optical fiber ?
5. Differentiate between step index and graded index fiber.
6. Write a short note on second harmonic generation.
7. Explain any *two* methods to achieve Q-switching.
8. Explain acceptance angle and numerical aperture. How are they related ?

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each question carries weightage 5.*

9. Explain the theory of Q switching and mode locking in lasers.
10. Explain recording and reconstruction of holograms.
11. With an energy level diagram explain the working principle of C02 laser.
12. Explain Z scan technique for measuring nonlinear refractive index and nonlinear absorption

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each question carries weightage 3.*

13. Derive the relation between Einstein's co-efficients.
14. A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm.
15. In a Ruby Laser, the total number of Cr + 3 ions is 2.8×10^{19}. If the Laser emits radiation of wavelength 600 nm, then calculate the energy of one emitted photon and total energy available per pulse.
16. The refractive indices of core and cladding materials of a step index fibre are 1.53 and 1.445, respectively. Calculate : (i) Numerical aperture ; (ii) Acceptance angle ; and (iii) The critical angle at the core-cladding interface.
17. Consider the two-level system with $E_1 = -13.6$ eV and $E_2 = -3.4$ eV. Assume $A_{21} \approx 6 \times 10^8\ s^{-1}$. (a) What is the frequency of light emitted due to transitions from E_2 and E_1 ? (b) Assuming the emission to have only natural broadening, what is the FWHM of the emission ?
18. Calculate the gap in frequency between two longitudinal modes in a linear cavity whose optic length, L, = 250 mm.
19. The spontaneous lifetime of the sodium level leading to a D1 line (λ = 589. 1nm) is 16 ns. Find the natural line width Full width half maximum, $\Delta\lambda$?

(4 × 3 = 12 weightage)

C 80723 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, MARCH 2020

(CUCSS)

Physics

PHY 4E 13—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2017 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*

Each question carries weightage 1.

1. It is not possible to establish steady state population inversion by optical pumping between just two levels. Why ?
2. What are resonators ? Why are they needed in a Laser system ?
3. Distinguish between Q-switching and mode locking.
4. Describe the pumping in Ruby laser. Describe the energy levels of Chromium ions in the Ruby laser.
5. What are the modes of vibrations of carbon dioxide molecule ? Why efficiency of carbon dioxide laser is high ?
6. What is non linear polarization ?
7. Illustrate multiphoton absorption in the context of photoelectric effect.
8. Describe any two applications of laser in chemistry.
9. What are the applications of holography ?
10. Describe photochemical separation of isotopes using lasers.
11. Describe the structure of graded index fibre. Describe one of its advantage.
12. Describe the advantages of communication through the optical fibre.

(12 × 1 = 12 weightage)

Turn over

Section B

Answer any **two** *questions.*
Each question carries weightage 6.

13. Examine Light amplification in Lasers. How does the intensity of radiation changes as it passes through the medium ? Derive the equation for the threshold population inversion. State the conditions for a low threshold value of population inversion.

14. Describe the working principle and energy level diagrams of (a) Nd : YAG laser and (b) He-Ne Laser.

15. Describe the theory of generation of second and third harmonics.

16. Describe in detail the technique of spatial frequency filtering. Discuss its applications.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

17. Compute the natural line width of sodium D_1 line. Given : the spontaneous life time of the relevant sodium level is 16ns. If the actual line width is 10^9 Hz, compute the line shape function.

18. Derive the equation for threshold intensity in the case of parametric oscillations. Show that to achieve parametric amplification, for a given change in propagation constant, there is a minimum value of pump intensity.

19. Discuss Z-scan technique in detail.

20. Describe laser induced fusion.

21. A multimode step index fiber has a core diameter 80μm and a relative index difference of 1.5%. It is operating at a wave length of 0.85μm. If the core refractive index is 1.48. Calculate the normalized frequency of the fiber.

22. Describe the scale wave equation of a fiber. Discuss on the modes in a fiber.

(4 × 3 = 12 weightage)

C 61936 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2019

(CUCSS—PG)

Physics

PHY 4E 13—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions, each question carries weightage* 1.

1. Briefly explain mode locking.
2. Find the ratio between Einstein's co-efficients in red He-Ne laser. Given wavelength of He-Ne laser is 632.8nm.
3. Distinguish between collision broadening and Doppler broadening in laser.
4. Describe the advantages of fibre laser and indicate how they are achieved.
5. Give the setup of flash lamp pumped pulsed ruby laser. Describe laser spiking in ruby laser.
6. What are the requirements for second harmonic generation ?
7. Describe multi quantum photoelectric effect.
8. Describe Z-scan technique.
9. Discuss any *two* applications of spatial frequency filtering.
10. Describe any *one* method of isotope separation using laser.
11. Distinguish between step index fiber and graded index fiber. Which one do you prefer for communication purpose ? Give reason.
12. How is light propagated through optical fibers ? What are the advantages of communication through optical fibers ?

(12 × 1 = 12 weightage)

Turn over

Section B

Answer any **two** *questions, each question carries weightage 6*

13. Explain the theory of Q-switching. Discuss the generation of high power pulses through Q-switching.

14. Illustrate the theory of the parametric amplification in a nonlinear crystal.

15. Describe the theory and experimental techniques of third harmonic generation.

16. Describe the applications of laser in (a) Material processing (b) Laser tracking.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions, each question carries weightage* 3.

17. For a ruby laser, given that the wave length emitted is 6943Å, $t_{sp} = 3 \times 10^{-3}$s, refractive index of the active medium is = 1.76, reflectivity of two mirrors are 0.9, find the threshold value for N_1-N_2 if the average loss per unit length is assumed to be zero. Given the normalized line shape function is equal to 1.1×10^{-12}.

18. Compare the CO_2 laser with He-Ne Laser with respect to energy level diagram, frequency of emission, pumping and efficiency.

19. Find the phase matching criteria and hence the refractive index criteria for the efficient second harmonic generation.

20. Describe the theory of recording of image and reconstruction of image in a hologram.

21. For a step index fiber with $n_1 = 1.48$, $n_2 = 1.46$ show that all the rays making an angle < 9°.47 with the z axis will be guided through the fiber.

22. Consider a step index fiber with $n_1 = 1.461$, n_2=1.458 and a = 5mm. Show that the fiber is single moded for the wavelength > 1.22 μm.

(4 × 3 = 12 weightage)

D 42567 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2018

(CUCSS)

Physics

PHY 4E 13—LASERS AND FIBRE OPTICS

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*

Each question carries 1 *weightage.*

1. Explain about optical power meters.
3. What is population inversion ?
4. What are Einstein coefficients ?
5. What are modes of a wave guide ?
6. Explain the propagation of light through an optical fibre.
7. How absorption losses are caused in an optical fibre ?
8. What is an optical fibre ? What are the different types of optical fibres ?
9. Explain about leaky modes.
9. Explain the techniques for q-switching.
10. What is mode locking ?
11. What is laser spiking ?
12. What are the different attenuation measurement techniques ?

(12 × 1 = 12 weightage)

Turn over

Part B

Answer any **two** *questions*
Each question carries 6 *weightage.*

1. Derive the wave equations for a step index fibre.
2. What is an optical time domain reflectometer ? Explain how fibre attenuation can be measured using an OTDR.
3. What is holography ? Discuss about the basic principle of holography.
4. What is a four level laser system ? With a suitable example explain about a four level solid state laser system.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. How population inversion can be achieved in a three level laser system ?

   Briefly explain the Doppler line broadening mechanism.
2. Describe the absorption losses in an optical fibre.
3. Discuss about modes of a confocal resonator system.
4. What is V-number ? Calculate the v -number for a fibre of core diameter 46 μm with core and cladding refractive indices 1.56 and 1.50 respectively at a wavelength of propagating wave is 1300 nm. Also calculate the number of modes that the fibre can support.
5. Explain the basic properties of a laser. A laser produces 8.5 mW beam of light at a wave length 6328 Å. Find the number of photons emitted by the laser in each second.

(4 × 3 = 12 weightage)

C 3538 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2016

(CUCSS)

Physics

PHY 4E 13—LASERS AND FIBRE OPTICS

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Explain why at optical frequencies the emission from ordinary light is incoherent.
2. What are the conditions to be satisfied to have a low threshold value of population inversion ?
3. What is quality factor of a laser cavity ? Explain Q switching.
4. Distinguish between temporal coherence and spatial coherence.
5. What is spatial frequency filtering ? Give *one* application.
6. What is an optical fibre ? Explain the principle of working of an optical fibre.
7. Distinguish between mono mode and multimode fibre.
8. Explain the principle of working of any *one* type of optical fibre sensor.
9. Bring out the difference between Holography and Photography.
10. What are leaky modes ? What causes this effect ?
11. What are the measurement standards ?
12. Draw and label the block diagram of an optical fibre communication system.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

1. Describe the Confocal resonator system. Obtain the longitudinal mode spectrum of a Confocal resonator.

Turn over

2. Describe the construction and working of the Helium-Neon laser. Find the ration of population of the two states in a He-Ne laser that produces light of wavelength 6328 A° at 27° C.

3. Explain the causes of absorption. Describe the effects of ionizing radiation on optical fibre attenuation. What is Urbach's rule ?

4. Describe the optical time domain reflectometer and explain how fibre attenuation can be measured.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. Derive an expression for the threshold pumping per unit volume required to maintain population inversion in a three level laser system.

2. What is mode locking in lasers ? Describe how mode locking is effected.

3. Define acceptance angle and numerical aperture of optical fibre. Derive an expression for acceptance angle of an optical fibre.

4. What is V number ? A step index fibre is made with a core of refractive index 1.52, a diameter of 295 μm and a fractional difference of 69×10^{-5}. It is operated at a wavelength of 1.3 μm. Find the V number and the number of modes that the fibre will support.

5. Calculate the temporal coherence length for : (a) Mercury vapour lamp emitting in green portion of spectrum at wavelength of 546.1 nm with an emission bandwidth of 6×10^8 Hz ; (b) A helium neon laser operating at wavelength of 632.8 nm.

6. Give an account of Inherent defect losses.

(4 × 3 = 12 weightage)

C 22109 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2017

(CUCSS)

Physics

PHY 4E 13—LASERS AND FIBRE OPTICS

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. What is critical angle of incidence in an optical fibre ?
2. What is the basic principle of an optical fibre ? Explain.
3. Distinguish between step index and graded index optical fibre.
4. What are the different types of line broadening mechanisms ?
5. Define quality factor of a laser cavity.
6. Explain the techniques for mode locking.
7. Bring out the different applications of holography.
8. What is radiation induced losses in an optical fibre ?
9. What are the different attenuation measurement techniques?
10. Explain about leaky modes.
11. What are core and cladding losses ?
12. What are the measurement standards exist for fibre optics ?

(12 × 1 = 12 weightage)

Part B

Answer any **two** *question.*
Each question carries 6 *weightages.*

1. Derive an expression for Einstein coefficients.
2. What are the different signal attenuation mechanisms in an optical fibre ? Explain.
3. Discuss about different type of fibres and their properties.
4. What is a line broadening mechanism ? Discuss about the different line broadening mechanisms.

(2 × 6 = 12 weightage)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. Differentiate three level lasers from four level laser systems.
2. Explain about spatial frequency filtering and its applications.
3. What is mean by numerical aperture of an optical fibre ? Derive an expression for it.
4. Explain how refractive index can be measured by reflection method and transmitted near field method.
5. What are the different attenuation measurement techniques ? Describe about the insertion loss method.
6. What is V-number ? What should be the core size and cladding refractive index of an optical fibre with $v = 63$ and a numerical aperture 0.30 to be used at 820 nm. if $n_1 = 1.458$.
7. Explain the basic properties of a laser. A laser produces 8.5 mW beam of light at a wave length 6328 Å. Find the number of photons emitted by the laser in each second.

(4 × 3 = 12 weightage)

82505 (Pages : 2)

Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2015

(CUCSS)

Physics

PHY 4E 13—LASERS AND FIBRE OPTICS

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. What are Einstein's coefficient ?
2. What are the conditions to be satisfied to have a low threshold value of population inversion ?
3. What is Laser spiking ?
4. Distinguish between Temporal coherence and Spatial coherence.
5. Explain directionality of a laser beam. What is its application ?
6. What is an optical fiber ? Explain the principle of working of an optical fibre.
7. Distinguish between Step index and Graded index optical fibre.
8. Explain the principle of working of any one type of optical fibre sensor.
9. Bring out the difference between Holography and Photography.
10. Define attenuation of optical signal. Show that in an ideal fibre, attenuation is zero.
11. What are the measurement standards ?
12. What are the functions of an optical power meter ?

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

1. Discuss the quantum theory for the evaluation of Transition rates and hence derive the equations.
2. Describe the construction and working of the Helium-Neon laser. Find the ration of population of the two states in a He-Ne laser that produces light of wavelength 6328 Å at 27°C.
3. Derive the wave equations for step index fibres.
4. Describe the optical time domain reflectometer and explain how fibre attenuation can be measured.

(2 × 6 = 12 weightage)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. What is the importance of the study of line broadening mechanism ? Derive an equation for the frequency distribution of the radiation causing the transition.
2. What is mode locking in lasers ? Describe how mode locking is effected.
3. What is laser induced fusion ? Discuss the laser energy requirements of a fusion reaction.
4. What is V number ? A step index fibre is made with a core of refractive index 1.52, a diameter of 295 μm and a fractional difference of 69×10^{-5}. It is operated at a wavelength of 1.3 μm. Find the V number and the number of modes that the fibre will support.
5. Derive an expression for the numerical aperture of a step index fibre in terms of Δ. Calculate the numerical aperture of an optical fibre cable with a clad index of 1.378 and a core index of 1.546.
6. Describe the insertion loss technique for measuring attenuation.

(4 × 3 = 12 weightage)