K19P 0112

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY 4C14 : Optics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**).

1. a) Describe He-Ne LASER and explain how population is achieved in this type of laser.

OR

b) i) Explain the rate equation for a four level laser system.

ii) Discuss the waveguide dispersion in optical fibres.

2. a) i) With the help of diagram, describe the sum frequency and difference frequency generation.

ii) Briefly explain Stimulated Raman Gain Spectroscopy.

OR

b) i) Discuss power launching in optical fibres.

ii) Explain parametric generation of light.

(2×12=24)

SECTION – B

Answer **any four** (**1** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**).

3. a) Explain spiking in Ruby laser.

b) Why 4 level laser system is better than 3 level laser system.

c) A laser beam of wavelength 740 nm has coherence time 4×10^{-5}s . Deduce the order of magnitude of its coherence length and spectral half-width.

P.T.O.

4. a) What is linear electro optic effect ?
   b) Briefly explain phase modulation using electro-optic effect.
   c) Sketch and explain an electro optic amplitude modulator using KDP crystals.

5. a) What is meant by optical mixing ?
   b) Write a short note on spatial solitons.
   c) In a material at 300K two energy have a wavelength separation of 1 μm. Determine :
      i) Effective temperature when the levels are equally populate.
      ii) The effective temperature when the upper level is twice as densely populated as the lower level.

6. a) What is meant by signal degradation in optical fibres ?
   b) What is numerical aperture ? Derive an expression for it.
   c) Calculate the V-number and the number of modes possible in a core of radius 50 μm. If the refractive index of the core is 1.53 and that of the cladding is 1.50, for a light of wavelength 1 μm.

7. a) Give an account of bending losses in optical fibres.
   b) Explain pulse broadening in optical fibres.
   c) Explain the generation of third harmonic generation.

8. a) What are semiconductor lasers ?
   b) Explain coherent Antistoke's Raman scattering.
   c) Explain type I and type II phase matching.

(4×9=36)

K19P 0113

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY-4C15 : Numerical Techniques and Probability

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions, either **a)** or **b)**. **Each** question carries **12** marks.

1. a) i) What do you mean by random experiment and random variables. What are the different classifications of random variables ? Explain with examples.

   ii) What do you mean by expected value of a random variable ? Define mean and variance in terms of expectation.

   OR

   b) What do you mean by normal distribution ? What are its constants ? Explain different properties of normal distribution. What are the area properties of normal distribution ?

2. a) i) Discuss the convergence of Newton-Raphson method.

   ii) What do you mean by interpolation ? Derive Newton's backward interpolation formula for equal intervals.

   OR

   b) i) Explain Simpson's $^1/_3$ rule for numerical integration.

   ii) Explain least square method for fitting a second degree parabola $y = ax^2 + bx + c$.

(2×12=24)

SECTION – B

Answer **any four** (**1** mark for Part **'a'**, **3** marks for part **'b'**, **5** marks for **part 'c'**) :

3. a) State addition theorem of probability.

   b) State and prove multiplication theorem of probability.

P.T.O.

c) A factory has 3 production lines I, II and III contributing 20%, 30% and 50% respectively, to its total output. The percentage of substandard items produced by lines I, II and III are respectively 15, 10 and 2. If an item chosen at random from the total output is found to be substandard, what is the probability that the item is from line I ?

4. a) What is the standard deviation of a Poision distribution with parameter λ ?

b) Explain the probability density function of Chi-square distribution.

c) Fit a binomial distribution to the following data :

x	0	1	2	3	4	5	6
f	13	25	52	58	32	16	4

5. a) Write Regula-Falsi method formula :

b) Find the function whose first difference is $x^3 + 3x^2 + 5x + 12$.

c) Use the method of iteration to find the real root lying between 1 and 2 of the equation $x^3 - 3x + 1 = 0$.

6. a) Define backward difference operator.

b) Draw forward difference table for the following data :

x	0	1	2	3	4	5	6
y	176	185	194	203	212	220	229

c) Use Lagrange's formula to find the value of y at x = 6 from the following data y(3) = 168, y(7) = 120, y(9) = 72, y(10) = 63.

7. a) Write trapezoidal rule formula for numerical integration.

b) Explain two point Gaussian quadrature formula for the numerical integration of $\int_a^b f(x)dx$.

c) Using Simpson's $^1/_3{}^{rd}$ rule evaluate $\int_0^{10} \frac{dx}{1+x^2}$ by taking h = 1.

8. a) Write Runge-Kutta second order formula for solving first order ordinary differential equation.

b) Explain Euler's method to solve first order ordinary differential equations. Using Euler's method find the value of y at x = 0.1 given $\frac{dy}{dx} = 1 - y$, y(0) = 0.

c) Compute y (0.1) by Runge-Kutta method of 4^{th} order for the differential equation $\frac{dy}{dx} = xy + y^2$, y(0) = 1. **(4×9=36)**

K19P 0114

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY 4E06 : Optoelectronics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer both questions (either **a** or **b**).

1. a) Explain the semiconductor statistics. Arrive an expression for electron concentration in a conduction band, hole concentration in valence band, Fermi-level in intrinsic crystal.

OR

b) What is mode locking ? Explain the techniques for producing mode-locking.

2. a) i) Explain the principle and operation of the phototransistors.
ii) Briefly explain Avalanche noise in the APD.

OR

b) Briefly explain the following non-linear optical processes.
i) Second harmonic generation
ii) Sum and frequency generation
iii) Optical parametric oscillation. **(2×12=24)**

SECTION – B

Answer **any four**. (**1** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**).

3. a) Write and explain the Fermi-Dirac function.
b) Explain degenerate and non degenerate semiconductors.
c) Consider a GaAs LED. The band gap of GaAs at 300 K is 1.42eV, which changes (decreases) with temperature as $\frac{dE_g}{dT} = -4.5 \times 10^{-4} eVK^{-1}$. What is the change in the emitted wavelength if the temperature change is 10°C ?

P.T.O.

4. a) What is meant by surface emitting LEDs ?

   b) Explain Q-switching with a rotating mirror as a shutter.

   c) Compute the mode-locked pulse width Δt_p and the separation between pulses Δt_{sep} for the Helium-Neon laser operating at 632.8 nm with mirror cavity spacing of d = 0.5 m. For the He-Ne laser we assume that modes will lase over the FWHM emission line width of the 632.8 nm transition of 1.5×10^9 Hz.

5. a) What is a PIN photodiode ?

   b) Briefly explain the acousto-optic effect.

   c) Consider a silicon PIN photo diode with an intrinsic region of width 10 μm. Light from a GaAs laser at energy 1.43 eV impinges up on the diode. The optical power is 1 W/cm^2. Calculate the photocurrent density in the detector. (The absorption coefficient for Si at GaAs wavelength is 700 cm^{-1}).

6. a) What is Pockels effect ?

   b) Briefly explain birefringence of calcite crystals.

   c) Given the following data for a $PbMO_4$ acousto-optic modulator, we may calculate the Bragg angle, the maximum change in refractive index of the material and the maximum width of the optical beam of wavelength 633 nm that may be modulated with a bandwidth of 5 MHz. The modulator length is 50 mm, diffraction efficiency 70%, while the acoustic wavelength is 4.3×10^{-5} m and the acoustic velocity is 3500 m/s.

7. a) What is meant by optical bistability ?

   b) How to achieving phase matching in birefringent optical materials ?

   c) Briefly describe the theory of third-order nonlinear optical processes.

8. a) What is meant by self focusing of light ?

   b) Explain two-photons absorption.

   c) Sketch and explain carrier concentration profiles across the pn junction under forward bias.

(4×9=36)

K19P 0115

Reg. No.: .....

Name: .....

IV Semester M.Sc. Degree (Reg./Suppl./Imp.) Examination, April 2019
(2014 Admission Onwards)
PHYSICS
PHY4E07 – Astrophysics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer both questions (Either **a** or **b**).

1. a) Derive Saha's equation of thermal ionization. Draw the schematic diagram of the different energy states of the neutral atom. **12**

OR

1. b) Describe the mechanism of energy generation and energy transport in stars.

2. a) Give the morphological classification of galaxies. Discuss the physical characteristics of elliptical and spiral galaxies. **12**

OR

2. b) Derive the Friedmann equation for the scale factor.

SECTION – B

Answer **any four**. **1** mark for Part **(a)**, **3** marks for Part **(b)** and **5** marks for Part **(c)**.

3. a) Define luminosity of a star.
   b) Explain colour index of a star.
   c) Define bolometric correction, absolute magnitude and distance modulus.

4. a) What is a pulsar ?
   b) Explain the astrophysical importance of binary pulsars.
   c) Why is Schwarzschild radius called the event horizon ? Find the Schwarzschild radius of (i) the sun (ii) a galactic nucleus of mass 10 billion solar mass.

P.T.O.

5. a) Define Schwarzschild radius.
   b) Explain visual binary system.
   c) Write a note on pulsars.

6. a) Name the theory which explain the aspects of origin of binary stars.
   b) Draw the H-R diagram and give its features.
   c) A star has a luminosity equal to that of the sun. Its surface temperature is 2500K. Compute the radius of the star in terms of the radius of the sun.

7. a) What is the viewpoint of general theory of relativity regarding the interpretation of Hubble's law ?
   b) Write a note on red shift of quasars.
   c) Describe the morphological classification for clusters of galaxies.

8. a) What is a radio galaxy ?
   b) Explain superluminal motion.
   c) Discuss the consequences of the existence of superluminal motion.
