K20P 0121

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree (CBSS-Reg./Suppl./Imp.)
Examination, April 2020
(2014 Admission Onwards)
PHYSICS
PHY4C14 : Optics

Time : 3 Hours

Max. Marks : 60

SECTION – A

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

1. a) i) What is population inversion ? Why a four level laser system is better than 3 level laser system ?

   ii) Explain the rate equation for a three level laser system.

   OR

   b) i) Discuss the electro-optic effect in Lithium Niobate crystals.

   ii) Derive the Einstein coefficients in the theory of laser.

2. a) i) Give an account of Stimulated Raman Gain Spectroscopy.

   ii) Explain the quantum picture of the sum frequency generation.

   OR

   b) i) Describe different signal degradation in optical fibres.

   ii) Briefly discuss pulse broadening in optical fibers. **(2×12=24)**

P.T.O.

SECTION – B

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

3. a) A two level pumping scheme cannot be used for lasing. Explain.
   b) Briefly explain the principle of an optical resonator.
   c) With the help of an energy level diagram, explain the principle and working of a He-Ne laser.

4. a) What is meant by magneto-optic effect ?
   b) Briefly explain principle and operation of a Pockels cell modulator.
   c) Sketch and explain an electro-optic amplitude modulator using KDP crystal.

5. a) What is meant by harmonic generation ?
   b) Write a short note on spatial solitons.
   c) Describe the theory of inverse Raman scattering.

6. a) What is meant by material dispersion ?
   b) The numerical aperture of an optical fibre is 0.24. If the refractive index of the core is 1.48, calculate the refractive index of the cladding.
   c) Explain what is meant by :
      a) Fiber birefringence
      b) Fiber beat length in single mode fibers.

7. a) What are leaky modes in optical fibers ?
   b) Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 6943 Å at 300 K and 500 K.
   c) Briefly discuss the nonlinearity in the polarization of the medium.

8. a) What is meant by phase matching ?
   b) Explain what is meant by self-focusing of light.
   c) With an energy level diagram, explain the working of a Carbon dioxide laser.

(4×9=36)

K20P 0122

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IV Semester M.Sc. Degree (CBSS-Reg./Suppl./Imp.) Examination, April 2020
(2014 Admission Onwards)
PHYSICS
PHY4C15 : 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) Define Binomial distribution and Poisson distribution. Derive Poisson distribution as a limiting case of binomial distribution.

OR

b) What do you mean by Chi-square distribution ? What is its pdf ? How it can be used for the goodness of fit ?

2. a) What do you mean by interpolation ? Derive Newton's forward interpolation formula for equal intervals.

OR

b) Derive formula for Trapezoidal rule for numerical integration of $\int_a^b f(x)\,dx$. Also explain the geometrical interpretation of Trapezoidal rule. **(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) Define probability.

b) Two similar urns A and B contain 2 white and 3 red balls, 4 white and 5 red balls respectively. If a ball is selected at random from one of the urns, find the probability that the urn is B, when the ball is red.

c) State and prove addition theorem on probability.

P.T.O.

4. a) What do you mean by standard normal distribution ?

   b) The marks of 1000 students in a university are found to be normally distributed with mean 70 and standard deviation 5. Estimate the number of students whose marks will be (i) between 60 and 75 (ii) more than 75 and (iii) less than 68.

   c) Fit a binomial distribution to the following data :

x	0	1	2	3	4	5
f	3	6	24	26	4	1

5. a) What is the order of convergence of Newton-Raphson method ?

   b) Explain bisection method to find a root of the equation $f(x) = 0$.

   c) Using Regula-Falsi method, find a real root lying between 1 and 2 of the equation $x^3 - 3x + 1 = 0$ upto 3 places of decimals.

6. a) State Lagrange's interpolation formula.

   b) Find the n^{th} difference of e^x.

   c) Find the second difference of the polynomial $f(x) = x^4 - 12x^3 + 42x^2 - 30x + 9$ with $h = 2$.

7. a) What is the order of error in Simpson's one third rule ?

   b) The velocity v of a particle at distance s from a point on its path is given by the table below :

s in meter	0	10	20	30	40	50	60
v metre per sec	47	58	64	65	61	52	38

   Evaluate the time taken to travel 60 metres by Simpson's three eighth rule.

   c) Evaluate $\int_{-1}^{1} e^{-x^2} \cos x \, dx$ by Gauss two and three point quadrature formula.

8. a) Write Euler's formula to find the value of $y(x_1)$ from the differential equation $\frac{dy}{dx} = f(x, y), y(x_0) = y_0$.

   b) Using Euler's modified method, find the value of y at $x = 0.1$, given that $\frac{dy}{dx} = 1 - y, y(0) = 0$.

   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)

K20P 0123

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IV Semester M.Sc. Degree (CBSS-Reg./Suppl./Imp.) Examination, April 2020
(2014 Admission Onwards)
PHYSICS
PHY 4E06 : Optoelectronics

Time : 3 Hours

Max. Marks : 60

SECTION – A

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

1. a) i) Sketch and explain the reverse biased pn junction with minority carrier profiles and the origin of the reverse current.

   ii) Explain the depletion layer capacitance.

   OR

   b) What is Mode Locking ? Deduce the expressions for the Separation between pulses Δt_{sep} and pulse width Δt_p for a mode locked laser.

2. a) What is Pockels effect ? With a diagram explain the principle and operation of a transverse Pockels cell phase modulator.

   OR

   b) i) Explain the principle and operation of a pn junction photodiode.

   ii) Give an account of PIN photodiode. **(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) In which bands do the movement of electrons and holes takes place ?

   b) Sketch the energy band diagram of an n-type Si-doped with 1 ppm As.

P.T.O.

c) Consider a GaAs LED, the band gap of GaAs at 300K is 1.42eV, which changes (decreases) with temperature as $dE_g/dT = -4.5 \times 10^{-4}$ eVK^{-1}. What is the change in the emitted wavelength if the temperature change is 10°C ?

4. a) What is meant by active mode locking ?

   b) Give an account of LED materials.

   c) Explain the evolution of a giant pulse through Q-switching.

5. a) What is a avalanche photodiode ?

   b) Explain the principle and operation of a phototransistor.

   c) A Si PIN photodiode has an active light receiving area of diameter 0.4mm. When radiation of wavelength 700nm (red light) and intensity 0.1m Wcm^{-2} is incident it generates a photocurrent of 56.6nA. What is the responsivity and quantum efficiency of the photodiode at 700nm.

6. a) What are photovoltaic devices ?

   b) With a sketch explain the principle and operation of a solar cell.

   c) A particular family house in a sunny geographic location over a year consumes a daily average electrical power of 500W. If the annual average Solar intensity incident per day is about 6kWhm^{-2} and a photovoltaic device that converts solar energy to electrical energy has an efficiency of 15%. What is the required device area ?

7. a) What is dichroism ?

   b) Distinguish between quarter wave plate retarder and half wave plate retarder.

   c) With a sketch explain the principle and working of a Kerr cell phase modulator.

8. a) What is meant by second harmonic generation ?

   b) Briefly explain the phase matching.

   c) Give an account of third order nonlinear optical process. **(4×9=36)**

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IV Semester M.Sc. Degree (CBSS – Reg./Suppl./Imp.) Examination, April 2020
(2014 Admission Onwards)
PHYSICS
PHY4E07 : Astrophysics

Time : 3 Hours

Max. Marks : 60

SECTION – A

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

1. a) Define luminosity of a star. Derive the relation between the luminosity and the absolute magnitude of a star. Find the apparent magnitude of the sun if its absolute magnitude is +5.0.

OR

b) Explain the origin of binary stars. Obtain and analyse the mass luminosity relation for common stars.

2. a) Discuss the physical characteristics and kinematics of elliptical and spiral galaxies.

OR

b) Derive the Friedmann equation for the scale factor. Discuss the consequences of the equation.

(2×12=24)

SECTION – B

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

3. a) Define bolometric magnitude.

b) What is bolometric correction ? Why is bolometric correction negative for every star ?

c) Explain color index of a star.

P.T.O.

4. a) What is a thermonuclear reaction ?
   b) Explain Chandrasekhar-mass limit.
   c) Write a note on white dwarfs.
5. a) What are binary stars ?
   b) Give the classification of binary stars.
   c) Distinguish between visual binary and spectroscopic binary.
6. a) What are irregular galaxies ?
   b) Explain Hubble's method of classifying galaxies.
   c) Draw and explain Hubble's tuning fork diagram of galaxy classification.
7. a) What is an active galaxy ?
   b) Distinguish between Seyfert I, Seyfert II and radio galaxies.
   c) Discuss the characteristics of Quasers.
8. a) What is general relativity ?
   b) Illustrate with an example.
   c) Discuss the development of the field theory of gravity.

(4×9=36)
