2018/ODD/08/21/PHY–304
(A/B/D)/225

PG Odd Semester (CBCS) Exam., December—2018

PHYSICS

(3rd Semester)

Course No. : PHYCC–304

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

Candidates have to answer *either* from Option—A *or* Option—B *or* Option—D

OPTION—A

Course No. : PHYCC–304 (A)

(ASTROPHYSICS—I)

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* What is parsec? Draw a schematic diagram showing the definition of 1 parsec. How is it related to light-year and kilometre? Determine the distance of Alpha Centauri A having parallax 0·74 arc-sec from earth. 1+2+1+1=5

(b) Determine the distance of following stars from earth : 2+2=4

(i) Canopus (where m 0 74, M 5 71)

(ii) Deneb (where, m 1 25, M 8 38)

(c) Derive the relation between apparent and absolute magnitudes. 3

(d) What are BVR filters? 2

2. *(a)* What is altitude-azimuth coordinate system? Why this coordinate system was rejected by astronomers? 4+2=6

(b) Find the rising time of the star Sirius in Chennai on December 15, 2020.

(RA = $06^h45^m09^s$, DEC = 16°42 52)

Longitude of Chennai ( ) 80 3° East. 4

(c) The RA and DEC of a star are $05^h30^m30^s$ and 10°15 30 . Determine the hour angle of the star on October 08, 2018 at 12 midnight. The longitude of the place is 75° West. 4

UNIT—II

3. *(a)* Discuss in brief different functions of a refracting telescope. 4

(b) Determine the plate scale of Keck telescopes which have diameter 10 metre and focal ratio $f/1{\cdot}75$. 3

(c) What is a radio telescope? 3

(d) Discuss different types of reflecting telescope with a neat diagram. 4

4. (a) Discuss in brief the working principle of a Charge-Coupled Detector (CCD). 8

(b) Discuss the working principle of a CCD polarimeter. 6

UNIT—III

5. (a) Derive equation of continuity in a fluid flow. Discuss in brief Jeans criteria of gravitational collapse. 3+6=9

(b) What is a protostar? 1

(c) Explain how energy generation of stars takes place through pp and CNO process. 2+2=4

6. (a) What are open and globular clusters? 3+3=6

(b) What is a variable star? Discuss the classification scheme of variable stars with example. 1+7=8

UNIT—IV

7. (a) Based on Saha's ionization equation, explain how stellar spectra of different stars are observed. 3

(b) Draw and explain the HR diagram. 3

(c) Obtain the equation of hydrostatic equilibrium in a star. Solve the hydrostatic equilibrium equation for a general polytropic equation of state and discuss the result. 2+6=8

8. (a) What is Chandrasekhar limit? Explain how a white dwarf maintain an equilibrium state. 1+3=4

(b) Explain how we observe a pulsating radiation from a pulsar. 3

(c) Discuss briefly the evolutionary track of a 15 $M_{\odot}$ star. 7

UNIT—V

9. (a) What are sunspots? Discuss in brief the Babcock model. 3+5=8

(b) Discuss different transient phenomena that take place on solar photosphere. 6

10. (a) What is a comet? How are comets classified? 1+4=5

(b) Discuss a modern hypothesis that describes the origin and formation of sun and other members of the solar system. 9

OPTION—B

Course No. : PHYCC–304 (B)

(CONDENSED MATTER PHYSICS—I)

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* What are the elastic stiffness and compliance constants? What are the sign rules of a deformation of a solid body? 3+3=6

(b) What is dilational strain? Show that dilational strain is given by

$$e_{xx} \quad e_{yy} \quad e_{zz}$$

where the symbols have their usual meanings. 4

(c) Show that the extension strain components in a solid body along three coordinate axes are given by

$$e_{xx} \quad \frac{u}{x}, \; e_{yy} \quad \frac{v}{y}, \; e_{zz} \quad \frac{w}{z}$$

where the symbols have their usual meanings. 4

2. *(a)* Show that the cubic crystals have only three independent elastic constants. 8

(b) Write down the expressions of Young's modulus, Poisson's ratio and shear modulus in terms of elastic constants for cubic crystals. 6

UNIT—II

3. *(a)* Derive the expression for lattice specific heat from classical theory. How far classical theory prediction matches with the experimental results? 6+2=8

(b) Find the expression for lattice thermal conductivity coefficient in a solid. 6

4. *(a)* What are the anharmonic crystal interactions? Show the phenomenon of thermal expansion using anharmonic crystal interaction. 3+3=6

(b) What is thermoluminescence? Explain the method of analysis of thermoluminescence peaks. What information can be drawn from the peaks? 2+4+2=8

UNIT—III

5. *(a)* What is free electron model of metals? Derive the expression for electrical conductivity from Prude-Lorentz free electron theory. 2+6=8 *(b)* Discuss the Sommerfeld theory of electronic specific heat. 6

6. *(a)* What are the Fermi energy and density of states? Find the expression of Fermi energy and density of states in a metal. 3+7=10

(b) What is the effect of temperature on Fermi-Dirac distribution function? 4

UNIT—IV

7. *(a)* What are the various types of imperfections that are found in crystals? Explain a few applications of crystal defects. 4+2=6

(b) What are the Schottky and Frenkel defects? Find the equilibrium concentration of Schottky defects in a crystal at a given temperature *T*. 3+5=8

8. *(a)* What is dislocation? Explain the importance of dislocation in crystal growth. 2+2=4

(b) What are the mechanisms of diffusion in solids? Write the first and second Fick's law of diffusion. Derive the second Fick's law of diffusion. 3+2+5=10

UNIT—V

9. *(a)* Which class of materials are called liquid crystals? What are the different types of liquid crystals? Mention a few important applications of liquid crystals. 2+4+2=8

(b) What are the nematic and smectic phases? What are the properties of the two phases? 4+2=6

10. *(a)* What are nanomaterials? Write some applications of them. 3+3=6

(b) Write a few names of instruments for characterization of nanomaterials. What information can be drawn of a nanomaterial using TEM? Explain it. 3+5=8

OPTION—D

Course No. : PHYCC–304 (D)

(NON-LINEAR OPTICS AND LASER SPECTROSCOPY—I)

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* Define non-linear susceptibility. Discuss its symmetry properties. 2+8=10

(b) Why are second-order effects not observed in centrosymmetric crystals? 4

2. Derive the expression for $^{(2)}_{ijk}$ using Schrödinger equation. How is the condition of intrinsic permutation property of $^{(2)}_{ijk}$ reflected in the expression? 12+2=14

UNIT—II

3. *(a)* What is Difference Frequency Generation (DFG)? Considering undepleted pump approximation, derive the expressions for amplitude of idler and signal waves. 2+8=10

(b) Explain how these waves are amplified. 4

4. *(a)* Derive the wave equation for electromagnetic wave propagation in non-linear dispersive medium. 12

(b) How does the equation change for a dissipative medium? 2

UNIT—III

5. *(a)* Define non-linear refractive index (n_2). Also derive the relation between non-linear refractive index (n_2) and non-linear susceptibility $^{(3)}$. 2+4=6

(b) Discuss the tensor nature of third order susceptibility. 8

6. *(a)* What is self-focussing of light? Derive expressions for self-focussing angle ($_{sf}$) and self-focussing distance (z_{sf}). 2+6=8

(b) How does 'self-trapping' differ from 'self-focussing'? Write the condition for self-trapping of light and hence determine expression for critical power (P_{cr}). 2+4=6

UNIT—IV

7. *(a)* Distinguish between Raman-Nath and Bragg scattering. 4

(b) Give a mathematical analysis of Raman-Nath scattering. Also show that $\frac{l}{\ }$, where the symbols have their usual meanings. 8+2=10

8. *(a)* Distinguish between the types of electro-optic effect. Develop a mathematical formalism to describe linear electro-optic effect. 2+8=10

(b) What is optical rectification? 4

UNIT—V

9. Give the Rabi solution of Schrödinger equation for a two-level atom. Show that for an atom initially at the ground state and exact resonance (0)

$$|c_a|^2 \quad \cos^2 (\tfrac{1}{2} | \quad | t)$$
$$|c_b|^2 \quad \sin^2 (\tfrac{1}{2} | \quad | t)$$

where c_a and c_b represent probability amplitude in level a and b, respectively, and is the Rabi frequency. 7+7=14

10. Deduce the density matrix equation of motion for two-level system in absence of damping. Modify the equations for *(a)* closed and *(b)* open systems in presence of relaxation processes. 8+3+3=14

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