PG Odd Semester (CBCS) Exam., December—2016

PHYSICS

(3rd Semester)

Course No. : PH–304 (C)

Full Marks : 75
Pass Marks : 30

Time : 3 hours

The figures in the margin indicate full marks for the questions

Candidates are to answer *either* Option—A *or* Option—B *or* Option—C

OPTION—A

Course No. : PH–304 (A) (C)

(ASTROPHYSICS—II)

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

UNIT—I

1. *(a)* Discuss, in brief, equatorial system of coordinates. 7

(b) Calculate the local sidereal time (LST) of Silchar on December 8, 2016. 4

(c) What are celestial equator and ecliptic? 4

2. *(a)* What are apparent and absolute magnitudes of stars? Derive the relation between them. A star of absolute magnitude 6 is observed to have an apparent magnitude of 12·0. Determine the distance of the star. 3+3+3+3=12

(b) What is color index of a star? 3

UNIT—II

3. Discuss briefly the different configurations of the reflecting telescope with neat diagrams. 15

4. *(a)* What is a charge-coupled detector (CCD)? 5

(b) Discuss in brief : 10

(i) Plate scale of a telescope

(ii) Magnification

(iii) Light gathering power

(iv) Resolving power of a telescope

UNIT—III

5. Discuss HR diagram. How can the spectral class of stars be explained with the help of Saha's ionization theory? 9+6=15

6. Explain briefly Jeans theory of gravitational collapse of a molecular cloud. 15

UNIT—IV

7. What is a binary star? Discuss, in brief, the different classes of binary stars with examples. 2+13=15

8. Write short notes on the following : 5×3=15

(a) Black hole

(b) White dwarf

(c) Neutron star

UNIT—V

9. *(a)* Discuss origin and evolution of solar system. 10

(b) Discuss sunspots and their cycles. 5

10. What is a comet? How are comets designated? Also discuss the classification scheme for comets. How are comets formed? 2+4+3+6=15

OPTION—B

Course No. : PH–304 (B) (C)

(CONDENSED MATTER PHYSICS—I)

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

UNIT—I

1. *(a)* What are the nine elastic stress components along x, y and z directions of a cubic solid? Show that these nine components can be reduced to six components. 5+3=8

(b) What are extensional strain components along x, y and z directions in a cubic solid? Show that they can be represented by

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

where the symbols have their usual meanings. 4+3=7

2. *(a)* What is the work done by tension components and by tangential components when applied to an infinitesimal parallelopiped? 7

(b) Write short notes on the following : 4×2=8

(i) Elastic stiffness constants

(ii) Bulk modulus and compressibility

UNIT—II

3. (a) Derive the expression for lattice specific heat from classical theory. 8

(b) Explain how the discrepancies in classical theory of specific heat were investigated by Einstein using Planck's quantum theory. 7

4. (a) Derive an expression for coefficient of thermal expansion in solid. What is the necessity for consideration of anharmonic terms in the expression for potential? 10

(b) What is the contribution of phonon mean free path in thermal conductivity? 5

UNIT—III

5. (a) What do you mean by free-electron gas model of metals? Give Drude-Lorentz free-electron theory. 8

(b) Give the main assumptions of Sommerfeld model of free-electron gas and obtain the relation between the average KE in ground state and the Fermi energy ($E_0 \quad \frac{1}{3} NE_F$). 7

6. (a) Fermi energy for lithium is 4·72 eV at absolute zero temperature. Calculate the number of conduction electrons per unit volume in lithium, where

$h \quad 6\ 63 \quad 10^{34}$ J-s, $m \quad 9\ 11 \quad 10^{31}$ kg 5

(b) Write short notes on the following : 5×2=10

(i) Density of states

(ii) Fermi energy

UNIT—IV

7. (a) What are the different kinds of imperfections in crystals? What are the applications of defects in solids? 5+2=7

(b) What do you mean by Schottky defect? Find an expression for number of Schottky defects in a crystal at temperature T. 1+7=8

8. *(a)* What are the different types of color centres? How are they produced? Explain how they absorb light. 5+1+1=7

(b) Write short notes on the following : 4×2=8

(i) Slip plane

(ii) Dislocations and crystal growth

UNIT—V

9. *(a)* What do you mean by thermotropic, nematic and semantic phase in liquid crystal? What are their applications? 7

(b) What are top-down approaches in the synthesis of nanomaterials? 8

10. *(a)* What are the applications of nano-technology? Explain how nanotechnology is used in drug delivery system. 3+4=7

(b) Write short notes on the following : 4×2=8

(i) SEM

(ii) Size dependence of nanoparticle properties

OPTION—C

Course No. : PH–304 (C) (C)

(ADVANCED QUANTUM FIELD THEORY—I)

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

UNIT—I

1. *(a)* Construct the Dirac Hamiltonian and hence obtain the Dirac equation. Discuss the properties of the Dirac matrices. 5+5=10

(b) Write the Dirac equation in covariant form. 5

2. *(a)* Discuss the variational principle for fields and obtain the Euler-Lagrange equation from it. 7

(b) State and prove Noether's theorem. 8

UNIT—II

3. Discuss the canonical quantization of scalar field. 15

4. What are the difficulties faced in quantizing the electromagnetic field? Discuss the quantization of the electromagnetic field in the Lorentz gauge. 5+10=15

UNIT—III

5. Show the kinematics of a 2 to 2 scattering process in both the laboratory and the centre of mass frames. 8+7=15

6. Calculate the cross-section of the neutrino-electron scattering process

$$e \qquad\qquad e$$

in the centre of mass frame. 15

UNIT—IV

7. Define parity, charge conjugation and time-reversal transformations. Construct the parity operator for scalar fields and show that it commutes with the Hamiltonian. 5+10=15

8. Show that under charge conjugation the spinors u and v are interchanged. If $\hat{c}$ is the charge conjugation operator for the Dirac field, show that the current density operator j transforms as $\hat{c} j \hat{c}^{1}$ j. 5+10=15

UNIT—V

9. Show that spontaneous symmetry breaking of a continuous symmetry leads to the existence of a massless boson. 15

10. Write a note on Higgs mechanism. 15

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