

**6 SEM TDC PHY M 4 (Op)****2018****( May )****PHYSICS****( Major )**

Course : 604

**( Optional Course )**Full Marks : 60Pass Marks : 24/18

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

**OPTION—A**

Paper : 60410

**( ASTROPHYSICS AND PARTICLE PHYSICS )**

1. Choose the correct answer from the following (any six) : 1×6=6

(a) The largest unit of distance among the following is

(i) light year

(ii) astronomical unit

(iii) parsec

(iv) Mpc

( 2 )

- (b) For the white dwarf end point of a star, it should be of
- (i) 1 solar mass
  - (ii) 1.5 solar mass
  - (iii) 2 solar mass
  - (iv) 2.5 solar mass
- (c) Newtonian telescope used in astronomy is a
- (i) refracting telescope
  - (ii) reflecting telescope
  - (iii) dispersive telescope
  - (iv) None of the above
- (d) Which of the following represents the particle-antiparticle pair?
- (i) Proton-neutron
  - (ii) Electron-proton
  - (iii) Electron-hole
  - (iv) Electron-positron
- (e) Andromeda Galaxy belongs to a galaxy of type
- (i) elliptical
  - (ii) circular
  - (iii) spiral
  - (iv) irregular

( 3 )

- (f) The nature of energy generation in sun is
- (i) mechanical
  - (ii) chemical
  - (iii) thermonuclear
  - (iv) gravitational
- (g) Which combination of quarks represents the internal structure of proton?
- (i) udd
  - (ii) uud
  - (iii) ddd
  - (iv) uuu

2. Answer any *five* of the following :  $2 \times 5 = 10$

- (a) Define spin and isospin of elementary particles.
- (b) Name the force carriers of four fundamental interactions.
- (c) Explain the Hubble's law relating to expansion of universe.
- (d) What are hadrons?
- (e) State the difference between Astronomy and Astrophysics.
- (f) Mention the stages to be completed in the life of a star.

3. (a) Classify elementary particles. What conservation laws are obeyed in the case of production and annihilation of particles?
- (b) Discuss the fundamental interactions of nature with their relative strength.
- (c) Compare the advantages and disadvantages of reflecting telescope and refracting telescope.
4. Explain with diagram the positions of stars in Hertzsprung-Russell diagram on the basis of stellar evolution theory.

Or

What is thermonuclear energy? Discuss CNO cycle reactions of energy formation. Why are neutrons responsible to carry away energy from the stellar interior? What are the end products of CNO cycle and P-P cycle reactions under equilibrium condition?

$$1+3+1+1+1=5$$

5. What is an optical telescope? How does it differ from radio telescope? Write the working principle of a Cassegrain telescope used in astronomical observations.

$$1+1+4=6$$

Or

Describe Hubble's classification of galaxies with the help of tuning fork diagram. What are the principal observable features that form the basis for this classification?

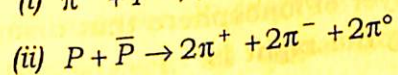
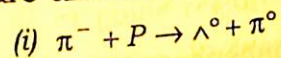
$$3+3=6$$

6. (a) Define luminosity of a star. Derive the relationship between the luminosity and absolute magnitude of a star.

$$2+3=5$$

- (b) What conservation laws are obeyed in the case of annihilation of particles? Check whether the following reactions are allowed or forbidden :

$$1+2+2=5$$



7. Write short notes on any three of the following :

$$3 \times 3 = 9$$

- (a) Variable stars
- (b) Red giant
- (c) Fermions
- (d) Discovery of elementary particles
- (e) Expansion of the Universe
- (f) Gluons

( Turn Over )

OPTION—B

Paper : 60420

**( SPACE AND ATMOSPHERIC PHYSICS )**

1. Choose the correct answer from the following : 1×6=6

(a) Temperature of the \_\_\_\_\_ is highest among all the layers of the sun.

(i) corona

(ii) photosphere

(iii) core

(iv) None of the above

(b) The layer of ionosphere that disappears during the night is

(i) E layer

(ii) D layer

(iii) F<sub>1</sub> layer

(iv) F<sub>2</sub> layer

(c) In a sunspot, the magnetic field is

(i) higher than the surrounding area

(ii) lower than the surrounding area

(iii) same as the surrounding area

(iv) two times of the surrounding area

8P/810

( Continued )

(d) The idea of internal energy of a thermodynamical system comes from

(i) 1st law of thermodynamics

(ii) 2nd law of thermodynamics

(iii) 3rd law of thermodynamics

(iv) None of the above

(e) The ionosphere is formed primarily by

(i) photoionization

(ii) thermionic emission

(iii) photoelectric emission

(iv) photomultiplication

(f) Equatorial ionization anomaly is found

(i) in polar region

(ii) between 20 degree N to 20 degree S

(iii) between 60 degree to 70 degree latitude

(iv) None of the above

2. Answer the following questions : 2×6=12

(a) What do you mean by potential temperature?

(b) What are air parcels?

(c) "The Sun is a G2V type star." Explain.

(d) What do you mean by entropy? Why is entropy of the universe increasing?

( Turn Over )

8P/810

- (e) Why is the Sun's magnetic field always in a variable state?
- (f) What do you mean by loss reactions?

3. Answer the following questions :

- (a) Explain the term 'solar activity'. Describe its variation with time.  $2+3=5$
- (b) Describe how the atmosphere has been divided into different layers on the basis of temperature.
- (c) What do you mean by the F layer of the ionosphere? Discuss various anomalies observed in this layer.  $1+3=4$
- (d) Describe how atmospheric pressure varies with altitude.
- (e) Differentiate between solar flare, solar storms and solar prominences.
- (f) Describe how the ionospheric layers are important for communication.
- (g) What are the thermodynamic parameters? Give their significances.

4. Write short notes on any three of the following :  $4 \times 3 = 12$

- (a) Saturated adiabatic lapse rate
- (b) Chapman theory
- (c) Solar flare
- (d) Water content in the atmosphere

OPTION—C

Paper : 60430

### ( LASER AND ITS APPLICATIONS )

1. Choose the correct answer from the following :  $1 \times 5 = 5$

- (a) Pumping source preferred for gaseous lasers is
- optical pumping
  - electrical pumping
  - chemical pumping
  - X-ray pumping
- (b) Resonant cavity in semi-conductor lasers consists of
- intrinsic region
  - junction
  - two ends of junction
  - polished ends of junction
- (c) What is the need to achieve population inversion?
- To excite most of the atoms
  - To bring most of the atoms to ground state
  - To achieve stable condition
  - To reduce the time of production of laser

(d) The highly directional property of laser beam is due to

(i) temporal coherence

(ii) spatial coherence

(iii) both temporal coherence and spatial coherence

(iv) None of the above

(e) The phenomenon of splitting of a spectral line emitted by a source into a set of lines due to the application of an intense electric field is called

(i) Zeeman effect

(ii) Stark effect

(iii) Faraday effect

(iv) Kerr effect

2. (a) Discuss various pumping methods used in different laser systems for obtaining population inversion.

(b) Differentiate between three- and four-level lasers by taking suitable examples. Why does a three-level laser normally provide pulsed output?

(c) Determine the SI units of (i) energy density  $u(\omega)$  and (ii) Einstein coefficients  $A$  and  $B$ .  $1+1=2$

(d) What are the main components of a laser system? 2

3. (a) Draw the energy-level diagram of He-Ne laser. Mention the advantages of He-Ne laser over Ruby laser. Explain the role of Helium atoms in He-Ne laser.  $2+2+2=6$

(b) Discuss the principle of operation of semiconductor laser. 3

4. (a) Explain the terms spatial coherence and temporal coherence. Show that temporal coherence depends upon the value of coherent length and coherent time.  $2+3=5$

(b) Show that the degree of visibility of fringes is a measure of the degree of coherence between waves of equal intensities. 4

5. (a) What is an optical fibre? Give the basic principle of light guidance through the optical fibre. Derive an expression for numerical aperture of an optical fibre.  $1+2+3=6$

- (b) A step index fibre with refractive index of core 1.458 and numerical aperture 0.3 is to be used at 850 nm. Find the core radius if the normalized frequency is 75 Hz.

6. Write short notes on the following :

5×2=

- (a) Kerr effect  
(b) Second harmonic generation

OPTION—D

Paper : 60440

( MATERIAL SCIENCE AND NANOMATERIALS )

1. Choose the correct answer from the following : 1×6=6

- (a) Which of the following statements is correct?

- (i) All metallic nanoparticles are quantum dots.  
(ii) All composite nanomaterials are quantum dots.  
(iii) Semiconductor nanomaterials of any size are called quantum dots.  
(iv) Semiconductor nanomaterials with its size smaller than EBR (exciton Bohr radius) is called quantum dots.

- (b) Blue shift in the UV-vis absorption spectrum of a nanomaterial is an indication of

- (i) decrease in particle size compared to the bulk material  
(ii) increase in particle size compared to the bulk material  
(iii) indication of crystallinity of the material  
(iv) quantum confinement in the material

- (c) The physical properties of composite materials are generally
- isotropic
  - orthotropic
  - anisotropic
  - homogeneous
- (d) The quantum dots have
- zero dimension
  - one dimension
  - two dimensions
  - None of the above
- (e) Spintronics technology depends on
- mass of electron
  - charge of electron
  - spin of electron
  - parity of electron
- (f) What type of material is diamond?
- Composite
  - Polymer
  - Metal
  - Ceramic

2. Answer any four of the following :  $3 \times 4 = 12$
- What are smart materials?
  - Why do nano-structured materials (NSMs) show significantly different behaviour in comparison to their bulk counterpart?
  - What is particle reinforced composite?
  - What is electrodeposition technique?
  - What are advanced electronic materials?
3. On what basis the material for material science and engineering are classified? What are the two categories in which polymers can be classified?  $6 + 3 = 9$
- Or
- Discuss various classes of material in engineering. Compare between the applications of organic and inorganic materials for engineering purpose.  $3 + 6 = 9$
4. What do you mean by composite materials? Explain the characteristics of nano-materials.  $1 + 4 = 5$
5. Discuss about the fabrication of composite materials. 5

6. Describe how energy of electrons is quantized in quantum dots, quantum wires and quantum wells.
7. What are different physical methods for preparation of nano-structured materials? Compare between chemical vapour deposition and chemical bath deposition techniques for nano-structured material fabrication. 3+5
8. (a) What are nano-machines? Why are there so many applications of nano-structured materials? 1+2
- (b) What is meant by nanomaterial characterization? Discuss about the principle and uses of scanning tunneling microscope (STM). What important inference can be drawn from the STM analysis? 2+4+1

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