6 SEM TDC PHY M 4 (Op)

2 0 1 4

(May)

PHYSICS

(Major)

Paper : 604

(Optional Course)

Full Marks : 60
Pass Marks : 24

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 : 1×6=6

   (a) If lenses are used in radio telescope, then they must be

   (i) convex

   (ii) concave

   (iii) Both of the above

   (iv) None of the above

(*Turn Over*)

(b) The branch which is far away from astronomy is

    (i) astrology

    (ii) entomology

    (iii) astrophysics

    (iv) None of the above

(c) The scientist who is closely associated with astrophysics is

    (i) Raman

    (ii) Chandrasekhar

    (iii) Saha

    (iv) Bose

(d) The instrument which is used to measure temperature is

    (i) spectrometer

    (ii) bolometer

    (iii) hygrometer

    (iv) All of the above

(e) Hubble is a

    (i) telescope

    (ii) name of a scientist

    (iii) Both of the above are correct

    (iv) None of the above is related to Hubble

(f) The words which are similar to particle-antiparticle in some sense are

    (i) electron-proton

    (ii) electron hole

    (iii) proton-neutron

    (iv) All of the above

2. (a) What is a radio telescope? How does it differ from optical telescope? Write the working of a Newtonian telescope used in Astronomical observations.   1+1+3=5

(b) Give a brief description of different branches of astronomy on the basis of electromagnetic spectrum.   3

3. (a) Define the absolute magnitude of a star. Derive the relation connecting the absolute magnitude with apparent magnitude and the distance of the star in parsec.   2+3=5

(b) Show how the absolute bolometric magnitude can be used to determine the luminosity of the stars. What is the M_{bol} of a star of luminosity 10^{39} erg.s^{-1}?

    3+3=6

Or

Explain with diagram the positions of stars in Hertzsprung-Russell diagram on the basis of stellar evolution theory.   6

4. *(a)* Discuss various steps in the CNO cycle reactions. Why is it that the neutrinos carry away energy from the stellar interior? What is the end product of CNO cycle reactions under equilibrium conditions?   2+1+2=5

(b) Give the reasons why a protostar is difficult to identify in the HR diagram.   3

Or

Trace the evolution of a massive main sequence star to the ultimate demise as a supernova.

5. *(a)* What are different types of galaxies? Write about the size and shape of the milky way galaxy. Give the differences of spiral and elliptical galaxies.   2+2+2=6

(b) Write the Hubble's law of velocity-distance relationship of galaxies. Give an idea of expanding universe on the basis of this law.   2+2=4

6. *(a)* What are the elementary particles? How are the elementary particles classified? Write a note on the classification of elementary particles.   1+1+4=6

(b) Give an account of intrinsic properties of *(i)* Leptons and *(ii)* μ-mesons.   2+2=4

7. *(a)* Describe the conservation laws obeyed by the elementary particles. Explain how baryons and mesons are related with each other, through decays or production.   3+2=5

Or

Write, in detail, various types of interactions which the elementary particles can undergo. Does the weak interaction obey the conservation law?

4+1=5

(b) Write a short note on any *one* of the following :   2

(i) Antiparticles

(ii) Quarks

(iii) Fermions

OPTION—B

Paper : 60420

(SPACE AND ATMOSPHERIC PHYSICS)

1. Choose the correct answer from the following : $1 \times 6 = 6$

   (a) Hygrometers are used in the measurement of

   (i) pressure

   (ii) humidity

   (iii) rain

   (iv) wind

   (b) A north easterly wind blows

   (i) from the north to the east

   (ii) from the east to the north

   (iii) from the north-east

   (iv) to the north-east

   (c) Under conditions of fair weather, a downwardly directed atmospheric electric field exists whose averaged magnitude on the earth's surface is

   (i) 100 Vm^{-1}

   (ii) 120 Vm^{-1}

   (iii) 220 Vm^{-1}

   (iv) 330 Vm^{-1}

(Continued)

(d) The D-region of the ionosphere is centred approximately at

   (i) 80 km

   (ii) 105 km

   (iii) 175 km

   (iv) 250 km

(e) For a homogeneous atmosphere, the scale height is about (at $T = 273$ K)

   (i) 1·5 km

   (ii) 5·0 km

   (iii) 8·0 km

   (iv) 34·1 km

(f) How much time does solar wind require to reach the earth?

   (i) 2–3 hours

   (ii) 2–3 days

   (iii) 2–3 weeks

   (iv) 2–3 years

2. (a) Find the relative humidity for air at 18 °C, the actual vapour pressure is 10 hPa. The saturation vapour pressure at $T = 18\,°C$ is 20·88 hPa.   2

   (b) Why should one incorporate altitude corrections while reading from a mercury barometer?   2

(c) What are the sources of ionization in the D-region of the ionosphere? 2

(d) What are the basic equations governing the ionized particles in the ionosphere? 2

(e) What are different types of solar activity? 2

(f) Why is a sunspot dark? 2

3. (a) Establish the hydrostatic balance equation. 3

(b) What is adiabatic lapse rate? Derive a relationship between saturated adiabatic lapse rate with dry adiabatic lapse rate. 1+3=4

(c) Describe how wind measurements are made in the atmosphere. What are different types of anemometers? 2+2=4

(d) Derive an expression for the Brunt Väisäla frequency of oscillation for a parcel of air. 4

Or

What are potential and virtual temperatures? 2+2=4

4. (a) Derive an expression for the Chapman production function. 5

(b) Discuss the distinguishing properties of different ionospheric layers.   4

(c) What is equatorial ionization anomaly?   4

5. (a) Derive the dispersion relation for Alfven waves.   4

(b) What are the conditions for the occurrence of solar flares?   5

(c) Obtain expressions for the outward variation of density and pressure in the corona of the sun.   5

Or

Write a short note on coronal heating.

OPTION—C

Paper : 60430

(LASER AND ITS APPLICATION)

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

(a) One of the basic requirements for lasing action is

    (i) stimulated absorption

    (ii) spontaneous emission

    (iii) stimulated emission

    (iv) None of the above

(b) Metastable states are those states which have lifetime

   (i) shorter than those of ordinary states

   (ii) longer than those of ordinary states

   (iii) equal to those of ordinary states

   (iv) of infinite order

(c) The ruby laser is a

   (i) continuous wave ·(CW) laser

   (ii) pulse laser

   (iii) band laser

   (iv) None of the above

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

   (i) temporal coherence

   (ii) spatial coherence

   (iii) Both temporal and spatial coherence

   (iv) None of the above

(e) The propagation of signals through an optical fiber takes place due to the phenomenon of

   (i) reflection

   (ii) refraction

   (iii) defraction

   (iv) total internal reflection

(*Continued*)

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(f) The rotation of the plane of vibration of light under the influence of a strong magnetic field upon an isotropic transparent medium is due to

 (i) Stark effect

 (ii) Kerr effect

 (iii) Zeeman effect

 (iv) Faraday effect

2. *(a)* What are stimulated absorption, spontaneous emission and stimulated emission of radiation? How are these processes related to Einstein's coefficients? 4+5=9

(b) What do you mean by quality factor of a cavity resonator? Derive an expression for the quality factor of a cavity resonator. 2+4=6

Or

Establish threshold condition for laser oscillation in a cavity resonator. 6

(c) Describe briefly about the basic requirements of laser. 3

3. *(a)* Describe with necessary diagram, how ammonia beam maser is produced. 4

(b) Explain how laser is produced either in Ruby laser or in He-Ne laser. What type of pumpings are used in these lasers?

4+1=5

4. *(a)* What are spatial and temporal coherence of laser radiation? How is the purity of spectral line related to coherence?

2+2+2=6

(b) Why there is a vast difference in intensity and directionality between conventional light and laser?

3

5. What is an optical fiber? Explain how signals are propagated through an optical fiber. What are the advantages of optical fibers?

1+5+3=9

6. State Kerr electro-optic effect. Describe the experimental arrangement for the demonstration of this effect. What is a Kerr cell?

2+6+1=9

OPTION—D

Paper : 60440

(MATERIAL SCIENCE AND NANOMATERIALS)

1. Choose the correct answer from the following : $1 \times 6 = 6$

   (a) Nanomaterials can be

   (i) metals

   (ii) ceramics

   (iii) polymers

   (iv) All of the above

   (b) Ceramic materials are

   (i) good conductors of electricity

   (ii) basically crystalline oxides or metals

   (iii) inorganic compounds of metallic and non-metallic elements

   (iv) None of the above

   (c) One nanometer is equal to

   (i) 10^{-11} cm

   (ii) 10^{-9} cm

   (iii) 10^{-8} cm

   (iv) 10^{-7} cm

(d) The choice of material as well as process is made at the early design stage because the type of material affects the detailed aspects of

   (i) atomic weight

   (ii) cost

   (iii) design as well as cost

   (iv) None of the above

(e) The quantum dot has

   (i) zero-dimension

   (ii) one-dimension

   (iii) two-dimension

   (iv) None of the above

(f) The most advanced and promising nano-composites is

   (i) carbon-carbon

   (ii) metal matrix

   (iii) polymer matrix

   (iv) None of the above

2. Answer any *four* of the following :   3×4=12

   (a) What do you understand by electronic structure of a solid?

   (b) What are the two categories in which polymers can be classified?

(Continued)

(c) Explain the differences between macro- and micro-structures.

(d) Define organic, inorganic and biological materials.

(e) What are the smart materials?

3. What do you mean by composite materials? Explain the characteristic of nano-composites. What is particle reinforced composites? 2+4+2=8

4. (a) What is nano-structured material? Mention their properties. 2+2=4

(b) Define quantum dot, quantum wire and quantum well. 2+2+2=6

Or

Explain, in detail, the confined state of nanoparticles in a quantum well. 6

5. Mention four methods of preparation of nanostructured material. Explain the process for preparation of nanomaterials using chemical vapour deposition with a neat diagram. 2+3+3=8

6. What do you mean by material characterisation? Explain about any one method for characterisation of nanomaterials. 2+6=8

7. Write short notes on any *two* of the following : 4×2=8

   (a) Chemical bath deposition

   (b) Applications of nanomaterials

   (c) Sol-gel technique

   (d) Smart materials

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