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6 SEM TDC PHY M 4 (Op)

2016

(May)

PHYSICS

(Major)

Course : 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) The Nadir is a point in a celestial coordinate system which is

(i) directly overhead

(ii) directly underneath

(iii) on a great circle

(iv) None of the above

(b) The apparent brightness of a star is the
  (i) total amount of power it radiates into space
  (ii) total amount of light it radiates into space per unit time
  (iii) amount of light reaching us per unit area from the star
  (iv) None of the above

(c) The apparent magnitude of a faint star in comparison to a bright star is
  (i) positive and high
  (ii) negative and high
  (iii) negative and low
  (iv) imaginary

(d) The source of energy of a star is
  (i) chemical in nature
  (ii) mechanical in nature
  (iii) thermonuclear in nature
  (iv) gravitational in nature

(e) Our Milky Way galaxy is a/an
  (i) elliptical galaxy
  (ii) circular galaxy
  (iii) irregular galaxy
  (iv) spiral galaxy

(Continued

(f) Which of the following particles is not a fermion?
  (i) Electron
  (ii) Pi-meson
  (iii) Proton
  (iv) Neutron

2. (a) What do you understand by the terms astronomy and astrophysics? What is celestial sphere? Discuss briefly about the spherical coordinates of such sphere. 2+1+2=5

(b) Mention the basic differences among optical, radio, X-ray and gamma-ray astronomies. 2

3. (a) Show that the apparent magnitude (m), absolute magnitude (M) and the distance (d) of a star are related by a relation

$$m - M = 5 \log d - 5$$

What are the units of m, M and d? 3+1=4

(b) If the measured parallax angle of a star is 0·379″, how far is the star in light year and in km? 3

(Turn Over)

(c) What is H-R diagram? Draw this diagram and discuss the basic features of it. 1+3=4

4. (a) Describe how a star remains in equilibrium in its configuration. Show that its equilibrium configuration is governed by the fundamental equation

$$\frac{1}{r^2}\frac{d}{dr}\left(\frac{r^2}{\rho}\frac{dP}{dr}\right) = -4\pi G\rho$$

where symbols have their usual meanings. 2+3=5

(b) Explain the *p-p* chain and CNO cycle as a source of nuclear energy in a star. 4

5. (a) What do you mean by a galaxy? Classify galaxies on the basis of Hubble's classification and briefly mention their properties. 1+4=5

(b) State Hubble's law. On the basis of this law, explain the phenomenon of expanding Universe. 1+3=4

6. (a) Define spin and isospin of elementary particles. Classify particles on the basis of spin. Write down the isospin multiplets of nucleons, pions and kaons. 2+1+3=6

(Continued)

(b) What is the name of the anti-particle of electron? How was it discovered? 1+2=3

7. (a) What are fundamental interactions? Give a brief idea about all fundamental interactions. 1+4=5

(b) What are quarks and gluons? Write down the quark structures of proton and neutron and show that charges of proton and neutron are sum of the charges of their respective quark constituents. 2+2=4

Or

Write short notes on any *two* from the following : 2×2=4

(i) Variable stars

(ii) Newtonian cosmology

(iii) Hypercharge

(Turn Over)

OPTION—B

Paper : 60420

(SPACE AND ATMOSPHERIC PHYSICS)

1. *(a)* State True or False : 1

An adiathermal process is one in which heat is neither gained nor lost.

(b) Choose the correct answer : 1

Numerical value of solar constant is

(i) $F_s = 1730\ Wm^{-2}$

(ii) $F_s = 1370\ Wm^{-2}$

(iii) $F_s = 1{\cdot}370\ Wm^{-2}$

(iv) None of the above

(c) Choose the correct answer : 1

Which of the following is the least important layer in regard to high-frequency propagation?

(i) *D*-layer

(ii) *E*-layer

(iii) F_1-layer

(iv) F_2-layer

(Continued)

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(d) Choose the correct answer : 1

The ionosphere plays a significant role in radio wave propagation at

(i) high frequency (HF)

(ii) ultra high frequency (UHF)

(iii) microwave frequency (MF)

(iv) optical frequency (OF)

(e) State True or False : 1

High-frequency waves are not affected by solar cycle.

(f) Fill in the blank : 1

The gaseous envelope surrounding the earth is called ____.

2. Answer any *six* questions : 2×6=12

(a) What is internal energy? State the first law of thermodynamics. 1+1=2

(b) How does pressure change with altitude? 2

(c) What is atmospheric boundary layer? 2

(d) What do you mean by inversion layer? 2

(e) Which layers disappear at night in Earth's atmosphere? Why? 2

(Turn Over)

(f) What is anemometer? Mention different types of anemometer.

(g) What is saturated adiabatic lapse rate?

3. (a) Show that if there is a uniform lapse rate Γ, the pressure in the atmosphere is given by

$$p(z) = p_0\left(1-\frac{\Gamma_z}{T_0}\right)^{g/(\Gamma R_g)}$$

where p_0 is the pressure and T_0 is the temperature at the ground $z=0$, and R_g is the gas constant per unit mass of air.

(b) What do you mean by potential temperature? How is it related to entropy? 1+6=7

(c) What is the temperature as a function of pressure in an atmosphere for which the lapse rate equals the dry adiabatic lapse rate?

(d) Discuss the Chapman theory of atmospheric layer formation.

Or

How is ionization lost in the atmosphere? Explain briefly.

(e) What are solar flares? How do they appear? 1+3=4

(f) How do density and pressure vary in the corona of sun? Explain. 6

4. Write short notes on the following : 4×2=8

(a) Photoionization

(b) Solar wind

OPTION—C

Paper : 60430

(LASER AND ITS APPLICATION)

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

(a) The ratio of probability of spontaneous emission to probability of stimulated emission is proportional to

(i) ν

(ii) ν^2

(iii) ν^3

(iv) ν^4

(b) What is the necessary and sufficient condition for a laser to start oscillating?

(i) Population inversion should be large

(ii) Losses should be zero

(iii) Threshold condition should be satisfied

(iv) Pumping should be strong

(c) The wavelength 6328 Å of He-Ne laser is due to transition from

(i) 3s-2p level

(ii) 3s-3p level

(iii) 2s-2p level

(Continued

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(d) In case of fringes produced by coherent beams of equal amplitude, fringe visibility is equal to

(i) 1

(ii) 0

(iii) 0·5

(iv) 2

(e) If n_1 and n_2 be the indices of core and cladding respectively of an optical fibre, then

(i) $n_2 > n_1$

(ii) $n_2 \geq n_1$

(iii) $n_1 \geq n_2$

(iv) $n_1 > n_2$

(f) If the same beam of light is reflected back and forth through a medium, then its magnetic rotation

(i) increases

(ii) decreases

(iii) remains same

2. *(a)* What is population inversion? Discuss optical pumping as a method of achieving population inversion. Why is it necessary for stimulated emission? 2+2+2=6

(Turn Over)

(b) Discuss the basic principle of laser action. What are the main components of a basic laser system? 3+3

(c) What are the essential conditions for laser oscillation? Derive an expression for longitudinal modes in a laser cavity. 2+4

Or

Discuss the threshold condition for laser oscillation. Show that gain per unit length at threshold

$$g = \alpha + \frac{1}{2L} \log_e \left(\frac{1}{R_1 R_2} \right)$$

where α is the total loss coefficient and the second term represents the transmission loss through the mirrors. 2+4

3. (a) Describe with suitable diagram the principle, construction and working of a ruby laser.

(b) Discuss the working of an ammonia-beam maser.

4. (a) What are spatial coherence and temporal coherence? The coherence length of sodium D line ($\lambda = 5890$ Å) is 2·5 m. Calculate the coherence time and spectral width of the line. 2+2+2=6

(b) Define visibility of fringes. Interference fringes of intensity 0·3 are formed by two light beams having intensities in the ratio 1 : 9. Show that the degree of coherence is only 50%. 1+2=3

5. What are different classes of optical fibre? What is graded index fibre? What are the advantages of a graded index fibre over a step index fibre? Find the numerical aperture of a step index fibre when the refractive index of the core is 1·51 and that of the cladding is 1·47. 2+2+2+3=9

Or

Describe the structure of a typical optical fibre. What do you mean by core and cladding of an optical fibre? 5+2+2=9

6. What is Kerr effect? What is Kerr constant? Describe a Kerr cell and explain how it can be used as an electro-optic shutter. 2+1+3+3=9

(Turn Over)

OPTION—D

Paper : 60440

(MATERIAL SCIENCE AND NANOMATERIALS)

1. What is the basis of classification of materials for material science and engineering? Discuss with examples.

Or

Compare between the applications of organic and inorganic materials for engineering purposes.

2. What are semiconductors? Mention their typical resistivity range. Discuss few important applications of semiconductors. 1+1+4

3. What are engineering materials? Discuss how materials are selected for engineering purposes. 2+2

4. What is the basis of spintronics? How is the impact of spintronics on technology? 1+3

Or

What are biomaterials? How are they different from organic and inorganic materials? Give an example of a potential biomaterial. 1+2+1

5. Define composite material with an example. What are their technological advantages? Discuss their applications. 2+2+2=6

6. What are nanostructured materials (NSMs)? Why and how are they different from bulk counterparts? 1+4=5

Or

Define quantum dots, wires and wells. Discuss the applications of quantum dots. 3+2=5

7. Describe how energy of electrons is quantized in quantum dots, wires and wells structures. 5

8. What are top-down and bottom-up approaches of preparation of nanostructured materials? What are different physical methods for preparation of nanostructured materials? 3+3=6

9. What is sol-gel technique? Why is it so called? Mention the important advantages and disadvantages of sol-gel method. 1+1+4=6

Or

Compare between chemical vapour deposition and chemical bath deposition techniques for nanostructured material fabrication. 6

(Turn Over)

10. What are the parameters measured in an X-ray diffraction technique? How is the technique used for characterization of nanostructured materials? 2+3=5

Or

What is the use of transmission electron microscopy technique? Describe its working principle. 1+4=5

11. Why there are so many applications of nanostructured materials in modern technology? Explain why nanostructured materials are better catalysts in comparison to bulk materials. 2+2=4

12. What are nanomachines? Discuss with examples. 1+2=3

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