B.Sc. 6th Semester (Honours) Examination, 2024 (CBCS)

Subject : Physics

Course : DSE-4:(8)

(Astronomy and Astrophysics)

Time: 3 Hours **Full Marks: 60**

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as applicable.

Group-A

1. Answer *any ten* of the following questions: 2×10=20

(a) What is a spherical triangle?

(b) Does declination of a star depend on the position of the observer and the time? —Explain.

(c) What do you mean by "mean sun"?

(d) What is the apparent magnitude of a star, that is 40 times brighter than the faintest star, observed by naked eye?

(e) Define Angular Magnification of a Telescope.

(f) Write the name of two space telescopes operating in X-Ray and Infrared region of electromagnetic spectrum respectively.

(g) Using non-relativistic calculation, show that a star of mass M and radius R can trap a photon if $\frac{2GM}{c^2R} > 1$.

(h) What are Solar Prominence and Solar Flare?

(i) What is an exoplanet?

(j) What are the luminosity classes of star? Write in sequence of decreasing luminosity?

(k) Distinguish between globular clusters and open clusters of stars.

(l) Draw the rotation curve of Milky Way galaxy. Can you say something about the dark matter from the rotation curve?

(m) What are lenticular galaxies?

(n) How does the Hubble's law change if we are in some other galaxy? Explain.

(o) State the Virial Theorem for a closed, bounded and stable gravitational system.

Group-B

2. Answer *any four* of the following questions: 5×4=20

(a) Distinguish between solar day and sidereal day. Calculate the length of one sidereal day. 2+3

(b) What do you mean by the effective temperature of a star? Calculate the effective temperature of the Sun. Given radius and luminosity of the Sun are 6,96,340 km and 3.86×10^{26} W. Value of the Stefan Constant is 5.67×10^{-8} Watt-$m^{-2}K^{-4}$. 2+3

(c) What are the functions of Telescope Mounting? Explain the equatorial mount with diagram. 2+3

(d) What are Van Allen Radiation Belts? How did they form? 2+3

(e) Describe Hertzsprung-Russell (HR) diagram. Draw a sketch of the Hertzsprung-Russel (H-R) diagram, labeling the axes. Include in your sketch the approximate positions of the sun, the main sequence, white dwarfs, giants and the supergiants. 2+3

(f) Describe briefly Hubble's morphological classification of galaxies.

Group-C

3. Answer *any two* of the following questions: 10×2=20

(a) Define the astronomical unit, the light year and the parsec. Write 1 (one) parsec in terms of astronomical unit and light year. If parallax of a star is measured to be 0.6 arc second, then calculate the distance of the star in both astronomical unit and light year. (1+1+2)+2+4

(b) Write down the radiative transfer equation, explaining all of its terms. Obtain the general solution of that equation. Define Source function, optical depth, optically thick and optically thin objects. 2+4+1+1+1+1

(c) Starting from the Maxwell Equations and the Ohm's law in conducting fluid, deduce the magnetic induction equation in Solar Plasma. 10

(d) State Hubbles Law on Distance-Velocity Relation. Explain the principle of measurement of line of sight velocity of a galaxy. Galaxy NGC 123 has a velocity 1320 km/sec away from us. How far away is the galaxy? (Hubble Constant = 70km/sec/Mpc) 3+4+3

B.Sc. 6th Semester (Honours) Examination, 2024 (CBCS)

Subject : Physics

Course : DSE-4:(9) (OR)

(Applied Dynamics)

Time: 2 hours **Full Marks: 40**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as applicable.

1. Answer *any five* questions: 2×5=10

(a) Define dynamical system. Give two examples of mechanical system which can be termed as first order dynamical systems.

(b) Define "phase space".

(c) What does the trajectory of a dynamical system in the phase space represent?

(d) What is return map? Mention one way of detecting chaos from return map.

(e) What is a discrete dynamical system?

(f) What is a 'fluid parcel' corresponding to fluid dynamics?

(g) What is computational fluid dynamics? What is its utility?

(h) What is flow-dimensionality?

2. Answer *any two* questions: 5×2=10

(a) Define the viscosity of a fluid. Define the thermal conductivity of a fluid. What is mass-diffusivity? 2+2+1

(b) What is DLA? How is Sierpinski gasket formed? 2+3

(c) What do you mean by a uniform and a non-uniform flow? What is an inviscid flow? Give two examples of inviscid flow. 2+1+2

(d) What is deterministic fractal? What is the use of deterministic fractal? Give two examples of deterministic fractals. 2+1+2

3. Answer *any two* questions: 10×2=20

(a) What is the billiard model of dynamical systems? Describe in detail the Sinai billiard model. Write an example where the billiard is used to model a dynamical system. 3+5+2

(b) (i) What are fixed points?

(ii) What is a stable fixed point? Why are they called attractor? What are unstable fixed points? Why are they called repelles?

(iii) Find all fixed points for $\dot{x} = f(x) = x^2 - 1$ and classify their stability.

2+(1+1+1+1)+4

(c) Consider the logistic equation, $\frac{dp}{dt} = KP(N - P)$, Where P is the population $P \equiv P(t)$, K = constant and N is the carrying capacity of the system. If the initial population was $P(0) = P_0$, show that the solution to the logistic growth equation is—

$$P(t) = \frac{N}{\left(\frac{N-P_0}{P_0}\right)e^{-KNt}+1}$$

(d) (i) Define fluid from the perspective of shear stress.

(ii) State and explain the continuum hypothesis.

(iii) Define 'steady' and 'unsteady' flow. {2+(2+2)+(2+2)}