B.Sc. 6th Semester (Honours) Examination, 2022 (CBCS)
Subject: Physics
Paper: DSE-4:(8)
(Astronomy and Astrophysics)

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

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

Group-A

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

(a) What is Ecliptic? What are the equinoctial points?

(b) Calculate the time taken by light to travel to the Earth from the star α Centauri with parallax angle 0.75". (Given *1* parsec = *3.262* light year)

(c) Average Flux density of solar radiation over total electromagnetic spectrum on the Earth surface is *1362* wm^{-2}. Calculate the luminosity of the Sun. (Given *1*AU=*1.496×10^{11}*m)

(d) What do you mean by astrometric binary stars?

(e) Electromagnetic radiations coming from the space with wavelength below 300 nm are not observable from the Earth Surface. Why?

(f) Calculate the diffraction limit of resolution of a 20 cm telescope if observations are made at 550 nm?

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

(h) What are coronal holes?

(i) What are the lengths of solar cycle and Hale cycle?

(j) Distinguish between terrestrial planets and outer planets in solar family.

(k) Show the positions of Giant Stars and Dwarf Stars in Hertsprung-Russell Diagram.

(l) What is there at the rotational centre of the Milky Way? What is it's mass?

(m) Why is the young stars are found mainly in the spiral arms of the milky way?

(n) What are the parameters on which spiral galaxies are classified into a, b and c sub-classes?

(o) For expanding the universe state and discuss Hubble's law.

Group-B

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

(a) Apparent magnitude of a star is observed to be +4.2 and its parallax is 0.01". Find the distance of the star in parsec and it's absolute magnitude.   [2+3]

(b) Write down the formula of conversion from the horizontal coordinate system (*A, a*) to the local equatorial coordinate system (*H, δ*). An observer sitting at (45°N, 50°E) measures the altitude (*a*) and the azimuth (*A*) of a star as +45° and 60°E respectively. Find the Declination (*δ*) and the Local Hour Angle (*H*) of that star.   [2+3]

(c) Define quantum efficiency of a detector. What do you mean by the limiting magnitude of a detector? What is its value for a dark adopted naked eye? [2+2+1]

(d) Write down the magnetic induction equation in solar plasma. Define magnetic Raynold number and explain it's significance. [2+1+2]

(e) Write down the spectral classes of stars in Henry Droper Catalogue. Strong lineas of neutral metal lines are found in coolest whereas ionized metal lines are predominant feature of stars like the Sun. Explain reasons. [1+4]

(f) State De Vaucouleur's Law for the luminosity distribution of elliptic galaxies. Show that the total luminosity of a galaxy which satisfies the de Voucouler's law is given by $L \approx 7.2\pi I_e R_e^2$, where you can use $\int_0^\infty dx\, x^7 e^{-x} = 7!$. [2+3]

Group-C

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

(a) Define Local Apparent Solar Time and Local Sidereal Time. Establish a relation between them. What is equation of time? Is it dependent on the position of the observer on the Earth? [(2+2)+3+1+2]

(b) Define specific intensity of a radiation field. Show that the specific intensity is constant along a ray path in empty space. Write down radiative transfer equation in presence of matter, explaining all the terms. [2+4+4]

(c) Deduce the expression of tidal force between two gravitationally bound astronomical bodies as a function of latitude. What is Roche limit? Explain the existence of planetary rings in outer planets using tidal force. [5+2+3]

(d) State the Virial Theorem for a closed, bounded and stable gravitational system. Using Virial Theorem in a galaxy cluster establish the relation $\langle v \rangle^2 \approx \frac{GM}{R}$, Where $<v>$ is the r.m.s. velocity of the galaxies, M is total mass and R is the dimension of the cluster. Estimate the mass of a galaxy cluster having dimension of the order 1 MP_c and r.m.s. velocity *1000* kms^{-1}. Total luminosity of the galaxy cluster is found to be $10^{15} L_\Theta$. How is the existence of dark matter confirmed from those data? (Given G=6.67×10^{-11} Nm^{2}kg^{-2}, M_Θ=2×10^{30}kg, *1*parsec=3×10^{16}m) [2+3+3+2]

B.Sc. 6ᵗʰ Semester (Honours) Examination, 2022 (CBCS)
Subject: Physics
Paper: DSE-4:(9)
(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 word as far as practicable.

Group-A

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

     a. Define chaos.
     b. What is fractal?
     c. How is chaos related to fractals?
     d. Does chaos occur in linear system? justify your answer.
     e. What is a dynamical system?
     f. What is inviscid fluid?
     g. Write the equation of exponential population model, explaining each term.
     h. What is mass diffusivity in fluid dynamics?

Group-B

2. Answer any *two* questions from the following: 5×2=10

     a. What is the use of nonlinear time series analysis? Define Lyapunov exponent.   (3+2)
     b. What is the significance of phase space in dynamical system? What are fixed points?   (2+3)
     c. What do you mean by stability of fixed points? How do you define attractor and repeller based on the stability of fixed points?   (2+3)
     d. Define viscosity of a fluid? Write an expression for viscosity of fluid, explaining each term.   (3+2)

Group-C

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

     a. What is continuum hypothesis in fluid dynamics? What is its significance? How do you define fluid from the shear stress point of view?   (4+2+4)
     b. Influenza flu pandemic spreads through a population rapidly depending on two factors- the more people who have flu, the more rapidly it spreads and also the more the uninfected people there are, the more rapidly it spreads. Consider a community of 1000 people, where initially at t=0, one person has the flu. Researchers find that for this strain of flu, the logistic growth constant is 0.450. Estimate the number of people in this community who will catch the flu in 14 days? How does the logistic growth model differ from exponential growth model?   (7+3)
     c. What is a discrete dynamical system? What is logistic map? Write down the equation for simple logistic map and explain each terms.   (4+4+2)
     d. Consider a system having potential energy $V(x) = -\frac{1}{2}x^2 + \frac{1}{4}x^4$. Find out fixed points and their stability. Hence draw qualitative phase trajectories of the system.   (7+3)