B.Sc. 6th Semester (Honours) Examination, 2023 (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 the distance of a star from the Earth in light years with parallax angle 0·167 arcseconds?

(b) If the celestial equator and the horizon coincides for an observer, what is the latitude of the position of that observer?

(c) What are declinations of the Sun on the dates: 20th March, 21st June, 23rd September and 21st December?

(d) What is bolometric magnitude?

(e) What do you mean by the colour temperature of a star?

(f) To observe a star at a distance 2 parsec we need a telescope of diameter at least 30 cm. What is the minimum diameter to observe a star of same luminosity at a distance of 4 parsec?

(g) What is the main advantage of space telescopes over ground based telescopes?

(h) Prove the Virial Theorem for a system of a star with a planet in circular orbit.

(i) State the conditions for local thermodynamic equilibrium.

(j) Temperature of solar corona is very high compared with solar photosphere. But photosphere is brighter than corona. Why?

(k) What is the typical value of magnetic field strength at the Sunspots? How can it be measured?

(l) Why are the structures of solar prominence and solar flares appear very similar to the magnetic lines of force?

(m) What are the dark matters?

(n) State Hubble's law and explain.

(o) State the period-luminosity relation of the cepheid variable stars.

Group-B

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

(a) A binary star has a parallax of 0·025 arcseconds and the angular distance between the component stars is 2·5 arcseconds. Calculate the linear separation between two components in AU.

(b) What do you mean by the resolving power of a telescope? Compare the resolving power of an optical telescope operating at 457 nm (1 nm = 10^{-9} m) and a radio telescope operating at 1 cm, both having the same diameter of 200 mm. 2+3

(c) State Newton's theory of Gravitation. Mention two limitations of Newton's theory. In which limit, Einstein's theory of Gravitation reduces to Newton's theory? 2+2+1

(d) How does the sunspot zones migrate along solar latitude? Explain with the butterfly diagram.

(e) Draw a sketch of the Milky Way galaxy showing its bulge, disc, halo and the position of the Sun.

(f) What are cepheid variable stars? Why are they called standard candles? 2+3

Group-C

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

(a) Draw a neat diagram of celestial sphere, showing Zenith, Nadir, the Celestial poles, the celestial equator, the horizon, the ecliptic and the diurnal paths of stars.

(b) Define luminosity and effective temperature of a star. Consider two stars of radii R_1 and R_2, effective temperatures T_1 and T_2 and absolute magnitudes M_1 and M_2, respectively. Using Stefan–Boltzmann law of radiation, show that $\frac{R_2^2 T_2^4}{R_1^2 T_1^4} = 10^{0.4(M_1 - M_2)}$. 2+2+6

(c) Briefly explain the causes of granular structure in solar photosphere. Show the variation of temperature in the surface and atmosphere of the Sun graphically. What is the possible reason(s) of coronal heating? 3+4+3

(d) Explain differential rotation of galaxies. Derive the expressions for Oort's constants. 3+7

B.Sc. 6th Semester (Honours) Examination, 2023 (CBCS)

Subject : Physics

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

Time: **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 fluid.

(b) When sugar or salt is poured from a container it appears to flow? Do you consider these as fluid? Explain your answer from the definition of fluid.

(c) Define shear stress.

(d) What is fixed point of a dynamical system?

(e) What is a dynamical system? Give two examples of dynamical system.

(f) What characteristics should a dynamical system possess in order to be modelled using ordinary differential equation (ODE)? How is the ODE formed for such a one dimensional system?

(g) Define fractal.

(h) What is fractal dimension?

2. Answer *any two* questions: 5×2=10

(a) (i) What is phase space of a dynamical system? What is phase trajectory? Name one software package used for computing and visualizing trajectories of dynamical system on the computer.

(ii) What is a discrete dynamical system? What kind of mathematical equation is used to model a discrete dynamical system? (1+1+1)+(1+1)

(b) (i) State the continuum hypothesis of fluid dynamics. Give two examples where continuum hypothesis is not valid.

(ii) Define viscosity of a fluid. What is the physical origin of viscosity? (2+1)+(1+1)

(c) (i) What is exponential growth model? Why is this model considered unrealistic?

(ii) A bacteria colony is growing in a petridish. The bacteria colony is growing according to the formula $p(t) = 200\, e^{t/40}$, where t is measured in minutes. What will be the population of bacteria in the petridish after 2 hours? How much long will it take for the bacteria population to grow to 80,000? (2+1)+2

(d) What is the predator-prey model? Give a general formulation of this model. Give an example of predator-prey model and explain briefly. (1+2+2)

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

(a) (i) What is diffusion limited aggregation (DLA)? Give two examples where DLA model is used for simulation.

(ii) What is the fractal dimension of a DLA cluster in two-dimensional medium (in the continuous limit)?

(iii) What is logistic map? Write down the logistic map equation explaining each term. Give two examples of use of logistic map. (2+2)+1+(1+2+2)

(b) (i) Explain the Sinai billiard and mention its significance. State one application of chaotic billiard model.

(ii) What is cobweb plot? How to draw a cobweb plot for any recursive formula? (2+2+1)+(3+2)

(c) (i) What do you mean by steady and unsteady flow?

(ii) What is flow dimensionality?

(iii) Define uniform and non-uniform flow. (2+2)+2+(2+2)

(d) (i) When is a fixed point — (I) stable and (II) unstable?

(ii) What is basin of attraction?

(iii) Find the fixed points and classify their stability — (I) $\dot{x} = x^2 - 1$, (II) $\dot{x} = \sin x$. (1+1)+2+(3+3)

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