

B. Sc. Semester VI (Honours) Examination, 2021 (CBCS)
Subject: Physics
Paper: DSE-4
(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

Answer any *three* questions from the following: $10 \times 3 = 30$

1. What are the circumpolar stars? What is the condition on the astronomical coordinates of a star and the geographical coordinates of the observer in northern hemisphere such that the star is circumpolar? What is the respective condition if the observer is at southern hemisphere? At what latitude(s) on Earth will the Sun never set when it is at the summer solstice? Is there any latitude on Earth where the Sun will never set when it is at the vernal equinox? If so, where?
2. What do you mean by binary star system? If M_1 and M_2 are masses of two stars in a binary system measured in units of solar mass (M_{\odot}), T is the time period of revolution measured in years and a is the length of the semi major axis measured in astronomical units (AU) then show that $T^2 = a^3/(M_1 + M_2)$. A binary star system are at a distance 10 parsec from the Earth. Largest and smallest angular separations of the stars are 8 and 2 arcseconds respectively and period of revolution is 250 years. If the larger star is three times massive than the smaller star, then calculate the masses of the stars in units of solar mass.
3. Draw schematic diagrams of Newtonian and Cassegrain types of reflecting telescopes. Mention difference(s) between two. Define quantum efficiency of a detector.
4. Briefly explain the cause of granular structure in solar photosphere. Show the variation of temperature in the surface and atmosphere of the Sun graphically. What is/are the possible reason(s) of coronal heating?
5. Draw the rotation curve of Milky Way galaxy and compare it with the Keplerian motion. What do you mean by dark matter? What is the missing matter problem? How is the concept of dark matter relevant in missing matter problem?

Group-B

Answer any *six* questions from the following:

$5 \times 6 = 30$

6. Write down the cosine formula for spherical triangle. Find the shortest distance between Kolkata (23°N , 88°E) and New York (41°N , 74°W) along the surface of the Earth. Radius of the Earth is 6400 km .

7. What do you mean by effective temperature of a star? Flux density and angular diameter of a star are $2.9 \times 10^{-8}\text{ W m}^{-2}$ and 0.01 arcsecond as measured from the Earth surface. What is its effective temperature? Given $\sigma = 5.67 \times 10^{-9}\text{ W m}^{-2}\text{ K}^{-4}$.

8. B_I and B_{II} are brightness of two stars having magnitudes n_I and n_{II} respectively. Starting from the Pogson's Law show that

$$n_I - n_{II} = 2.5 \log_{10} \frac{B_{II}}{B_I} .$$

9. What are optically thick and optically thin objects? How do you identify an astronomical object as optically thick or optically thin from its spectrum?

10. The Sun, bearing almost entire mass of the solar system, contributes only 1% to the total momentum of the solar system. Explain with nebular model.

11. Give reasons for the following: (a) Balmer lines of hydrogen are weak both in the hottest and the coolest stars. (b) Lines of ionized helium are found only in O stars.

12. What are the major classes of galaxies in Hubble's classification scheme? Mention the observational features of those classes.

13. State Hubble's law on distant-velocity relation. From the present value of Hubble constant (70 km/sec/Mpc), estimate the age of the universe.

OR

B. Sc. Semester VI (Honours) Examination, 2021 (CBCS)
Subject: Physics
Paper: DSE-4
(APPLIED DYNAMICS)

Time: 2 Hours

Full Marks: 40

Answer any eight questions.

$5 \times 8 = 40$

1. a) Explain the exponential population growth model employed in biology.
b) Consider a population of bacteria where the population grows according to the formula $f(t) = 300 \cdot \exp(t/50)$, where t is measured in minutes. How many bacteria are present after 240 minutes? How much longer will it take for the bacteria population to grow to 100,000?
2. Identify and classify the fixed points of the logistic equation $f(N) = rN(1-N/K)$, where the symbols have their usual meaning.
3. a) What is basin of attraction?
b) State the nature of stability for the fixed point $x^* = 0$ for the following system –
i) $\dot{x} = -x^3$ and ii) $\dot{x} = x^3$
4. a) Define a dynamical system. Define phase space.
b) Give a general formulation of the predator-prey model.
5. a) What is a Sinai billiard? What is its significance? Name one other billiard model.
b) State one application of chaotic billiard model.
6. a) what is fractal dimension? Name two practical applications of fractal dimension.
b) Define chaos.
7. a) What is self similarity? Give an example of self similar object.
b) How does self similarity lead to the computation of fractal dimension?
8. Define a fluid? What is viscosity of a fluid? What is the dimension of viscosity? What is its unit?

9. a) Discuss inviscid flow of fluids?
- b) What is the difference between rotational and irrotational flow.
10. The population of a country in 1800 and 1850 was 5.3 and 23.1 million people respectively. Predict its population in 1900 and in 1950 using the exponential model of population growth. Then considering that the population of the country in 1900 was actually 76 million people correct your prediction for 1950 using the logistic model of population growth (help: with this data $k = 0.031476$ in the logistic model). What is the carrying capacity of the country according to this model? (1 million = 1000,000)