B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING FOURTH YEAR
SECOND SEMESTER - 2024

Subject : INSTRUMENTATION IN SPACE TECHNOLOGY **Time : 3hr** **Full Marks : 100**

Ensure that you clearly designate the questions you're answering by using the format: Q1.a), Q1.b), Q1.c), etc. for Question 1, Q2.a), Q2.b), etc. for Question 2, and so forth. This designation should be explicit and located directly beside each question you choose to address.		
	Conceptual Questions	
Q1	a) Discuss in detail the optical telescope assembly in Hubble Space telescope	5x5
Any five	b) Define "Directivity of antenna" with its mathematical expression? How does antenna radiate?	
	c) What is the purpose of Fractal Analysis? How could you explain the randomness of a time series data using Fractal Dimension?	
	d) What is transponder? Explain microwave frequency band for communication satellite.	
	e) What is the significance of a star's luminosity and magnitude in stellar evaluation?	
	f) How are sunspots formed, and what do they indicate about solar activity?What is the solar cycle, and how does it influence solar phenomena?	
	g) What instruments and methods are used to observe and measure solar flares, CMEs, and solar radio bursts?	
	h) What is the equatorial coordinate system in spherical astronomy, and how is it defined? How are right ascension and declination used to specify the position of celestial objects in the equatorial coordinate system?	
	Critical Thinking Questions *(Answer based on knowledge and understanding)*	
Q2	a) What are the antenna parameters? How could you explain reflection coefficient of antenna? What is return loss?	5x5
Any five	b) How does the mass of a star influence its evolution and eventual fate?How do astronomers determine the age of a star cluster?	
	c) How the star's luminosity can be used to measure the interstellar distance?	
	d) What is the role played by Laser Ablation Mass Spectrometer in HST ? Explain in detail.	
	e) What observational evidence supports the Standard Solar Model?	
	f) How do particle instruments on spacecraft protect themselves from damage caused by high-energy particles?	

	g) How are azimuth and altitude used in the horizontal coordinate system to locate celestial objects in the sky?	
	h) How do variations in sunspot numbers affect space weather and geomagnetic storms on Earth?	
	i) How the mixing length parameter is typically defined and measured?	
	Analysis and Design Questions	
Q3	a) How does a discrete electron multiplier compare to a photomultiplier tube in terms of performance? What are the advantages and limitations of using discrete electron multipliers in detecting charged particles?	5x5
Any five	b) How do microchannel plates handle high-intensity particle fluxes?	
	c) What is the expected operational lifetime of a microchannel plate, and how is it affected by usage conditions?	
	d) What is the difference between Smoothing and filtering? Can simple exponential smoothing be used for forecasting?	
	e) How does the aperture size of a telescope affect its light-gathering power and resolving power? How is the angular resolution of a telescope calculated, and why is it important for astronomical observations?	
	f) How do adaptive optics systems improve the performance of ground-based telescopes? How does a radio telescope differ from an optical telescope, and what types of astronomical phenomena can it observe?	
	g) How do space flight particle instruments calibrate their measurements to ensure accuracy in the data collected?	
	h) What types of particles are typically detected by Faraday cups in space missions? How does the design of a Faraday cup ensure accurate measurements of particle flux in the vacuum of space?	
	Application and Problem-Solving Questions	
Q4	a) An aeroplane flies in a great circle course from a point A (lat 30oN; long 10oE) to a point B on the equator, the initial direction of departure being 20oE of S. Find the longitude of B, and the length of the journey, taking the earth to be a sphere of radius 4000 miles	5x5
Any five	b) In a spherical triangle on a unit sphere (radius = 1), the sides a b, and c are 1.0472 radians, 1.2217 radians, and 1.3963 radians respectively. Calculate the angle A opposite side a	
	c) A rocket injects a satellite with a certain horizontal velocity from a height of 620 km from the surface of the Earth. The velocity of the satellite at a point distant 9000 km from the centre of the Earth is observed to be 8 km/s. If the direction of the satellite makes an angle of 30◦with the local horizontal at that point, determine the apogee	

distance of the satellite orbit.(Assume that the radius of the Earth is 6380 km and $GxM_{EARTH} = 39.8 \times 10^{13}\ m^3/s^2$.)

d) Calculate the great-circle distance between two points on the Earth's surface: Point A (latitude 40°N, longitude 75°W) and Point B (latitude 34°N, longitude 118°W). Assume the Earth is a perfect sphere with a radius of 6371 km.

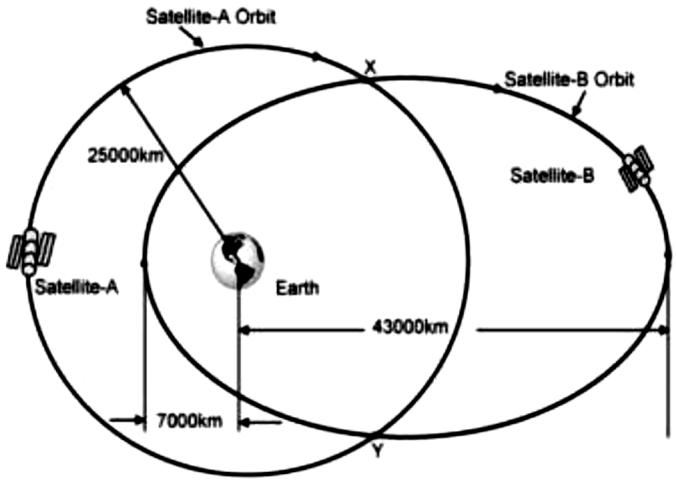
e) Illustrate the diagram of the Dobsonian telescope and mounting and explain.

f) How do orbital parameters impact the energy requirements and propulsion systems needed for satellite deployment and station-keeping?

g) A telescope with a diameter of 1 metre is observing two stars that are 1 arcsecond apart. Can the telescope resolve these stars using light of wavelength 600 nm?

h) Calculate the orbital parameters of a hypothetical satellite orbiting Earth with the following characteristics:

- Semi-major axis: 20,000 km
- Eccentricity (e): 0.2
- Inclination: 30 degrees (i)
- Argument of Periapsis (ω): 60 degrees



i) Satellite A is orbiting Earth in a circular orbit of radius 25 000 km. Satellite B is orbiting Earth in an elliptical orbit with apogee and perigee distances of 43000 km and 7000 km respectively. Determine the velocities of the two satellites at the indicated points X and Y. (Take $\mu = 39.8 \times 10^{13}\ m^3/s^2$.)