Registration Number:

Date & session:

ST.JOSEPH'S UNIVERSITY, BENGALURU -27
MSc PHYSICS – III SEMESTER
SEMESTER EXAMINATION: OCTOBER 2023
(Examination conducted in November 2023)

PH 9523 – FOUNDATIONS OF ASTROPHYSICS AND MATERIALS SCIENCE
(For current batch students only)

Time: 2 Hours **Max Marks: 50**

This paper contains 2 printed pages and 2 parts

PART-A

Answer any five questions. Each question carries 7 marks. (5X7 = 35)

1. Describe the principle involved with suitable figures in the following techniques:
   a. Hydrothermal synthesis b. Physical Vapor Deposition.

2. Describe the principle and instrumentation involved in UV-Vis spectroscopy with a note on different electronic excitations in UV light.

3. a. Describe how Bragg's spectrometer is used for the determination of crystal structure.
   b. How do the Raman spectra and infrared spectra complement each other? (4+3)

4. a. How does the concept of right ascension and declination help astronomers precisely locate celestial objects, and what is their equivalent on Earth's surface?
   b. How does the size of a telescope's aperture impact its light-gathering power? Explain the concept of the collecting area and how it influences the telescope's performance.
   c. What are the significant challenges and advantages associated with space-based observation in the field of astronomy and Earth sciences? (2+2+3)

5. a. Draw the HR Diagram and represent different stages of low-mass stars. How are a star's color and surface temperature related, and how does this relationship manifest in an HR diagram? What do these properties reveal about the star's life stages?
   b. What do you understand by the term hydrostatic equilibrium? Explain what balances out gravity to maintain hydrostatic equilibrium in (i) Main sequence star (ii) White dwarf. (5+2)

6. a. Mention the different types of photometry and explain briefly each type.
   b. What are the various astrophysical sources in which polarization is observed? (4+3)

7. a. Both redshift and blueshift are phenomena observed in different fields of science. In astronomy, they relate to the motion of celestial objects, while in materials science, they are connected to nanomaterials. Can you explain the fundamental differences between redshift and blueshift in these two distinct domains, highlighting their significance and applications?
   b. Derive the relationship for the primitive translation vector of the reciprocal lattice in terms of those of the direct lattice. (3+4)

PART B

Answer any three questions. Each question carries 5 marks. (3x5=15)

8. The force constant for Carbon monoxide molecule is $1840\ Nm^{-1}$. Calculate the vibrational frequency in cm^{-1}. Given atomic masses are $^{12}C = 19.9 \times 10^{-27} kg$ and $^{16}O = 26.6 \times 10^{-27} kg$.

9. When an incident beam of wavelength 3000 Å was allowed to pass through 2 mm thick pyrex glass, the intensity of radiation was reduced to one-tenth of its incident value. What part of the same beam will be transmitted through 1mm thick same pyrex glass sheet?

10. In a distant galaxy, an astronomer identifies a spectral line as being CaII (ionized Calcium), which has a lab wavelength of 393.3 nm. If in this galaxy, the wavelength is observed to be 410 nm, then what would the equivalent recessional velocity be in km/s, and what is the galaxy's redshift? Using a Hubble constant of 75 km/s/Mpc, find the distance to this galaxy.

11. The luminosity of the star Betelgeuse is 10^4 times that of the sun and its surface temperature is about 3000K. Assuming the surface temperature of the sun to be 5800K, how much larger is the radius of Betelgeuse compared to that of the sun? If the radius of the sun is 7×10^8 m, then what is the radius of Betelgeuse?