I am posting here the question Paper for the subject: Astronomy and Astrophysics (Theory I) for the III semester year 2017. The question paper is for the students of M.Sc Physics at the University of Delhi.
Future students taking this course might find it helpful.

Department of Physics & Astrophysics
(University of Delhi)
M.Sc. PHYSICS/III Sem.

PHYS-555
(Astronomy & Astrophysics-I)

Time: 3 Hours Maximum Marks:70

(Write your Roll No. on the top immediately on receipt of the question paper.)
Attempt any four questions. All symbols have their usual meanings.

1. (a) Describe the equatorial system of co-ordinates. How would you convert the equatorial co-ordinates to ecliptic co-ordinates?

(b) A star is above the horizon for 9h40m. What is its azimuth as it sets, if we observe from a place of latitude $40^o\,02'\,14''$ N and longitude $75^o\,20'\,57''$ W?

(c) We observe two stars precisely due east, one is rising and the other is 30^o above the horizon. The two stars do not culminate at the same time. Which one will culminate first and what will be the difference in the time of culminations of these two stars? We are observing from a place of latitude $40^o\,02'\,14''$ N, and longitude $75^o\,20'\,57''$ W. $(8, 4, 5\frac{1}{2})$

2. (a) The absolute magnitude of a star in the Andromeda galaxy (distance 690 kpc) is M=5. It explodes as a supernova, becoming one billion times brighter. What is its apparent magnitude after the explosion?

(b) Describe the method of spectroscopic parallax to determine stellar distances.

(c) Describe the modern stellar spectral classification scheme, starting with the Harvard classification system ?

(d) Using Newton's form of Kepler's third law, how can one find the masses of the components of a visual binary system? Assume circular orbits. $(3, 4, 5, 5\frac{1}{2})$

3. (a) Derive the relation to calculate the magnitude of the faintest object that a telescope can detect.

(b) The Hubble Space Telescope has a mirror D = 2.4m in diameter, and has diffraction-limited optics with resolution given by $\theta = 1.22\lambda/D$. It orbits the Earth about 560 km high. Suppose we pointed it at the ground and looked in visible light with $\lambda = 500$nm. Could it resolve individual people, about 2m in size? Could it read street signs, with letters about 50cm high? Could it read your smart phone, with letters about 5mm high?

(c) The distance between the components of a binary star is $1.38''$. What should the diameter of a telescope be to resolve the binary? If the focal length of the objective is 80 cm, what should the focal length of the eyepiece be to resolve the components, when the resolution of the eye is $2'$(arc-min)? $(5, 6, 6\frac{1}{2})$

4. (a) Assume that a star with a measured flux F has a corresponding magnitude m. If its flux

changes by δF, i.e. $F = F + \delta F$, show that a corresponding change in the stellar magnitude is

$$\delta m = \delta F/F,$$

when $\delta F \ll F$. You will need to use a Taylor expansion.

(b) If the sky background and CCD noise are negligible, how many photons do you need to measure the magnitude of a star to an accuracy of ± 0.02 mag? What value of S/N ratio does this accuracy correspond to? (use the result of part (a))

(c) On a 1-meter telescope, how long an exposure do you need to measure the apparent V magnitude of a star with $m_V = 15$ to an accuracy of ± 0.02 mag? A star with $m_V = 15$ has total detected flux (through the V-band filter) of about 1 photon/s/cm^2. How does the signal-to-noise ratio (SNR) scale with time in this limit?

(d) An observatory has a computer-controlled 10 inch Meade LX200-GPS telescope. The telescope is an f/10 system, and has a CCD camera having the following specifications:

CCD	Kodak KAF-1301E
Pixel Array	1280 × 1024 pixels (20.4 x 16.4 mm)
Total Pixels	1,310,720
Pixel Size	16 × 16 microns

What is the image scale of the KAF-1301E CCD in arcsec/pixel ? What is the field of view of the CCD Camera, in arc-minutes? $(3,4,5,5\frac{1}{2})$

5. (a) What does the butterfly diagram tell us regarding the formation and evolution of sunspots and the solar activity cycle?

(b) Parker's solar wind model gives the expression for the solar wind velocity (v) in terms of the radial distance (r) as:

$$\left(\frac{v}{c_s}\right)^2 - \log\left(\frac{v}{c_s}\right)^2 = 4\log r + 4\frac{r_c}{r} + C,$$

where C is a constant, c_s is the isothermal sound speed and r_c is the critical radius. Depending on the value of C chosen, the equation gives four distinct classes of solutions. Discuss the acceptability of the different classes of solutions. Which is the most plausible solution?

(c) Above the earth's atmosphere, a star has a magnitude of 7.5. If at an observatory site, the zenith magnitude gain is +0.6, what would be the apparent magnitude of the star at a zenith distance of 30^o? What is the transmission percentage of the earth's atmosphere at this zenith distance?

(d) Describe the technique of differential photometry for studying variable stars. How does this technique differ from standard photometry? Hence, discuss the advantages of differental photometry. $(4, 5\frac{1}{2}, 4, 4)$

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I’m a physicist specializing in computational material science with a PhD in Physics from Friedrich-Schiller University Jena, Germany. I write efficient codes for simulating light-matter interactions at atomic scales. I like to develop Physics, DFT, and Machine Learning related apps and software from time to time. Can code in most of the popular languages. I like to share my knowledge in Physics and applications using this Blog and a YouTube channel.

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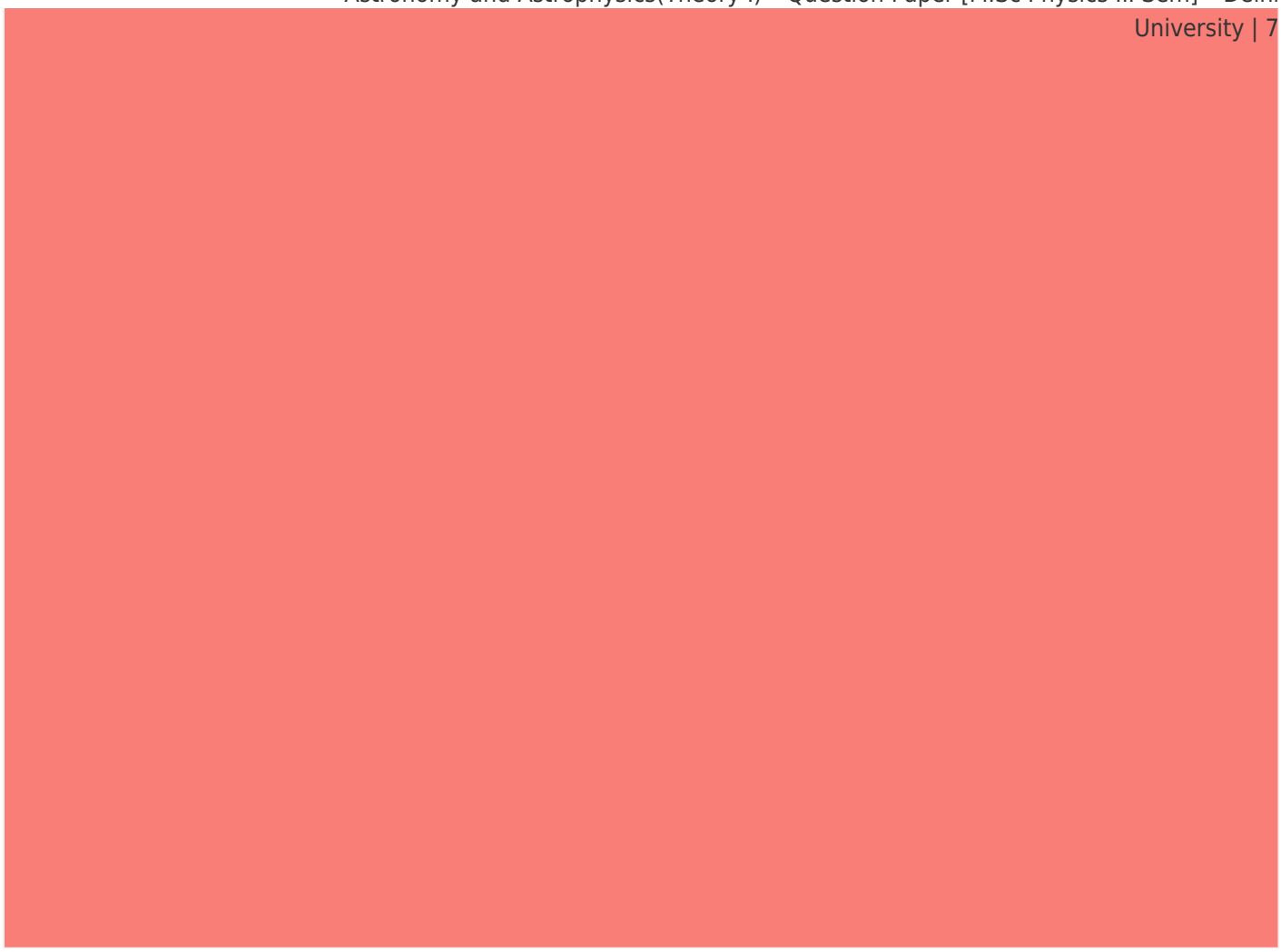

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