DHWU

M.Sc. ($2^{nd}$ Year) $3^{rd}$ Semester Examination, 2020

Subject : Physics

(Phy/ThE/3S/304)

Astrophysics

Time : 2 Hours | Full Marks : 40

*The figures in the right hand margin indicate full marks.*
*Candidates are required to give their answers*
*in their own words as far as practicable.*
*Illustrate the answers wherever necessary.*

*Answer any four questions*

1. (a) The declination of Sirius is $16^0 38'$H. Find its Zenith distance at Diamond Harbour (Latitude $22.1927^0$) at the time of crossing the meridian.

(b) Show that the rate of change of the redshift of a galaxy at present time is given by

$$\frac{dz}{dt_0} = H_0(1+z) - H(z)$$

4+6=10

2. (a) Find the optical depth ($\tau$) in a media for which a passing radiation's intensity falls to $1/e^9$ of its initial one. If the said media has a constant mass absorption factor ($k_\nu = 1$) then find the elementary distance ($s$) traveled by the radiation in this problem. It has been given that the density of the media is proportional to $s^2$ with a proportionality constant 1.

(b) The scale factor of a flat universe is defined as, $a(t) = a_0(t/t_0)^n$ where $n < 1$ and $a_0$ and $t_0$ are constants. Show that the coordinate distance of an object seen at redshift $z$ is

$$r = \frac{ct_0}{(1-n)\, a_0^{\frac{1}{n}}} \left[1 - (1+z)^{1-\frac{1}{n}}\right]$$

5+5=10

3. (a) Why do we need Fermi gas model to describe the formation of White Dwarfs?

(b) In a universe with scale factor $a(t) \propto t^p$ (where $p$ is a positive constant but not necessarily to be an integer), show that the deceleration parameter $q(t)$ is a constant and also find the constraint values of $p$ for $q(t) < 0$ and $q(t) > 0$ respectively. 5+5=10

4. (a) Draw a neat diagram of scale factor vs. time for the universe in presence of gravity and discuss about expanding, static and contracting universe. Also draw the variation of the scale factor for the absence of gravity alongside and conclude.

(b) Show that the coordinate distance of a galaxy at redshift $z = 5$ in a matter dominant universe is

$$r = \frac{2c}{H_0}\left(1 - \frac{1}{\sqrt{6}}\right).$$

5+5=10

5. (a) Write a short note on Neutron star.

(b) Show that in a FRW universe with $k = 0$, the luminosity distance to a galaxy observed with redshift $z$ for a curvature dominant regime is

$$d_L(z) = \frac{c}{H_0}\left(z + \frac{z^2}{2} + ...+\right)$$

5+5=10

6. (a) Comment on the singularities of the Schwarzschild metric. Introducing tortoise coordinates find the corresponding Kruskal metrics and comment on its singularity thereafter.

(b) Find the metric tensor in 3-D Euclidean space for the coordinates

$$3x = u + 2v,$$
$$3y = u - v$$
$$z = w$$

7+3=10