M.Sc. Examination 2019

Semester-IV

Physics

Course: MPC-456 (Special Paper)

(Astrophysics)

Time: Three Hours **Full Marks: 40**

Questions are of equal value.

Symbols bear their usual meanings.

Answer ***any four*** questions.

1. Describe
   (a) Celestial equator
   (b) Celestial Poles
   (c) Ecliptic
   (d) Declination
   (e) Right Ascention 2×5

2. (a) Write down the TOV equation.
   (b) Find the limiting relation of mass and radius of a star of uniform density. (2+8)

3. (a) Explain homogeneous model of star stating clearly the assumptions.
   (b) Show that for such model
      i. $T \propto \frac{M}{R}$
      ii. $L \propto M^3$
   (c) Is this model realistic? Justify your answer. 3+4+3

4. (a) Define opacity of stellar material. Establish the radiative transfer (luminosity relation) equation of a main sequence star.
   (b) Show that the total energy of a perfect gas in gravitational equilibrium is given by $E = \frac{\Omega(3\gamma - 4)}{3(\gamma - 1)}$ 2+5+3

5. (a) In a spherically symmetric stationary static metric a particle's $p_0 = -E$ is constant of motion along the geodesic. Find the energy of the particle to a locally inertial observer.
   (b) What is gravitational redshift? Find an expression for this.
   (c) What is Kretschmann scalar? (3+2+3 +2)

6. (a) Show that for any star in equilibrium configuration, the function $P + \frac{Gm^2(r)}{8\pi r^4}$ decreases outward.
   (b) Prove that the lower limit of the central pressure P_c is $\frac{GM^2}{8\pi r^4}$.

P.T.O.

(c) Show that for any equilibrium configuration

$$I_\nu = \int_0^R \frac{Gm(r)dm(r)}{r^\nu} = 4\pi(4-\nu)\int_0^R Pr^{3-\nu}dr$$

if $\nu < 4$

(d) Find the relation between I_ν and $-\Omega$. (3+2+3+2)

7. (a) What are Killing vectors? How many Killing vectors are allowed by Kerr metric? Find their values.

(b) Write down the first law and Bekenstein generalised second law of black hole thermodynamics. (2+2+3+3)