The candidate will be randomly assigned three questions from the list below and will be asked to write an exhaustive report on the topics drawn.

- 1 Levi-Civita connection, local inertial coordinates, Riemann curvature tensor and its properties.
- 2 The Kruskal-Szekeres extension of the Schwarzschild metric.
- 3 The Schwarzschild metric: geodesics, circular causal geodesics.
- 4 The Schwarzschild metric: gravitational redshift, weak field light bending.
- 5 The Schwarzschild metric: Perihelion/periastron precession.
- 6 Linearised Einstein equations: TT-gauge, linearised waves.
- 7 Linearised Einstein equations: slowly varying weak gravitational fields, quadrupole formula.
- 8 Change of Keplerian orbits due to gravitational radiation, chirp mass.
- 9 Cosmological redshift, Hubble law and its second-order correction, deceleration parameter.
- 10 FLRW metric, Friedmann equations, continuity equation, solutions. The following equations are admitted:

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G\rho}{3} - \frac{Kc^2}{a^2} + \frac{\Lambda c^2}{3}, \qquad \dot{\rho} + 3\frac{\dot{a}}{a}\rho(1+w) = 0.$$

- 11 Cosmological distances: luminosity and angular diameter distance, measurements of accelerated expansion.
- 12 Cosmological horizons: particle and event horizon, Hubble length.