(1). The expressions of ionospheric phase refractive index (or Appleton Formula) and wave polarization are given by, respectively,

$$n_{\mp}^2 = 1 - \frac{X}{1 - iZ - \frac{Y_T^2}{2(1-X-iZ)} \mp \sqrt{\frac{Y_T^4}{4(1-X-iZ)^2} + Y_L^2}}$$

$$R_{\pm} = \frac{i}{2Y_L}\left[\frac{Y_T^2}{1-X-iZ} \pm \sqrt{\frac{Y_T^4}{(1-X-iZ)^2} + 4Y_L^2}\right]$$

(a) Please show that for extraordinary-wave (X-wave) at the level of reflection the relation between wave frequency f, plasma frequency f_N, and electron gyro-frequency f_H can be approximated to the following expression. (15%)

$$f \approx \frac{f_H}{2} + f_N,$$

where the assumptions that $f >> f_H$ and $f >> \nu$ (electron-neutral collision frequency) have been made.

(b) Please state the reason why the absorption coefficient of the radio wave propagating in ionosphere is in unit of neper per unit distance and show that the ionospheric absorption coefficient can be formulated in accordance with following expression under the condition of $f >> f_H$. (15%)

$$\kappa = \frac{e^2}{2\varepsilon_0 mc}\frac{1}{\mu}\frac{N\nu}{\omega^2 + \nu^2}$$

(2). What is the Faraday rotation effect? Please calculate the Faraday rotation angle in condition of quasi-longitudinal approximation by giving wave frequency of 100 MHz, magnetic field flux of 0.4 Gauss, 30° between ray direction of EM wave and magnetic field line, and the slant TEC of 150 ele/m^2. (15%)

(4). Please explain the reason why the ionosphere still can be maintained in a form of the layer during the nighttime. (15%)

(5) Please explain the reason why quasi-longitudinal approximation can be applied to the propagation of GPS signal in the ionosphere in most of the cases. (10%)

(6). It is well known that the magnetic field plays a critical role in dominating the properties of radio waves at HF band propagating in the ionosphere. Please state the differences in the properties of the HF waves propagating in plasma with and without magnetic field. (10%)