國立中央大學106學年度碩士班考試入學試題

所別： 太空科學研究所 碩士班 不分組(一般生)
太空科學研究所 碩士班 不分組(在職生)

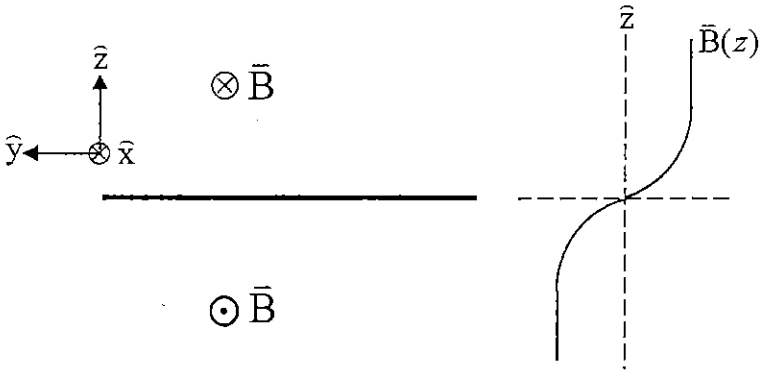
科目： 太空物理學

本科考試禁用計算器

＊請在答案卷內作答

Space Physics: Magnetosphere (50 points)

1.(a) Please explain the existence of cross-tail current from the equilibrium state of MHD momentum equation. (b) Assuming that the magnetic field in the magnetotail only has the x component and varies with z, as shown below, plot the possible trajectories of ions in different regions (i.e., far from z=0, cross the z=0, and the region in between) and explain your answers in detail. (c) Compare the direction of cross-tail current in your answers (a) and (b). (25 points)



2.(a) Please explain the frozen-in condition. (b) Illustrate the properties of low-beta and high-beta plasma under the frozen-in condition, respectively. (c) Derive the corotation electric potential of the inner magnetosphere on the equatorial plane by assuming the Earth's magnetic field is a dipole field. (25 points)

注意：背面有試題

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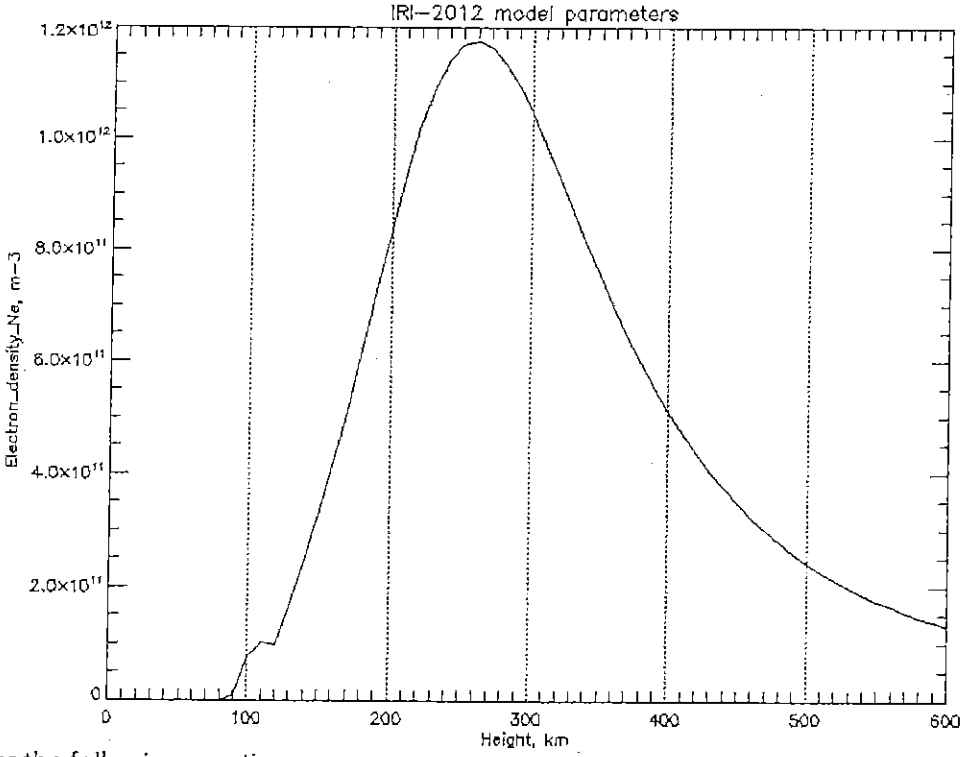
Graduate School Entrance Exam: Space Physics (Ionosphere)
50 points total. Show all calculations and explain your answers. Answers in English or Chinese are both acceptable.

Useful Hints:
Plasma frequency (MHz): $(9\times10^{-3})\sqrt{n_e}$, ($n_e$ units: cm^{-3}).
Vector Triple Product: $\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}\cdot\vec{C}) - \vec{C}(\vec{A}\cdot\vec{B})$

3. The following figure shows the ionospheric electron density as a function of altitude over Taiwan at 15:00 local time. The units of electron density are m^{-3}.



Answer the following questions.

a) (6 points) What is the highest radio frequency that can be reflected off of the ionosphere at this time?

b) (7 points) Would you expect the value of this maximum usable radio frequency to be higher or lower during the daytime or during the nighttime? Explain your reasoning.

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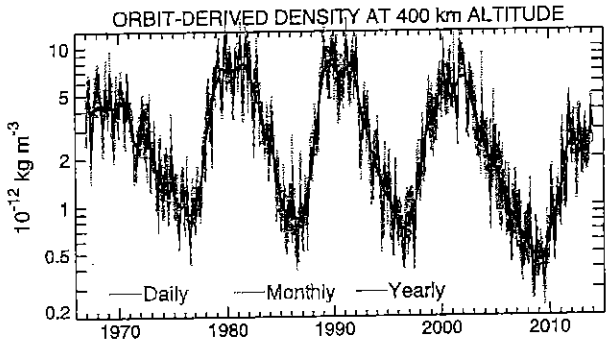
4. The following figure shows global average neutral atmospheric density measured at 400 km altitude by satellites in Low Earth Orbit from 1967 – 2013.



Answer the following questions:

a) (6 points) How does the neutral density at 400 km vary interannually? Explain the physical mechanism driving this variation.

b) (6 points) Using the neutral density data in the figure, do you expect the ionospheric total electron content (TEC) to be higher in 2000 or 2010? Why? Name at least two reasons.

5. Consider a location where the Earth's gravitational acceleration is in the same direction as the Earth's magnetic field. Answer the following questions:

a) (7 points) Where would such a location exist? Explain your reasoning.

b) (8 points) Consider the gravitational force and the magnetic force acting on positive ions and electrons at this location. Assume that the charged particles are initially at rest and do not interact with each other. Will an electric current be induced? Why?

6. (10 points) Solve for the steady-state velocity $\vec{v}$ of a charged particle under the influence of a magnetic field $\vec{B}$ and a force $\vec{F}$. $\vec{F}$ is perpendicular to $\vec{B}$. The particle is initially at rest.