

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Field classification. (20%)

- (a) Give a concrete example of a solenoidal and irrotational field in electromagnetics. (5%)
- (b) Give a concrete example of a field that is solenoidal but not irrotational in electromagnetics. (5%)
- (c) Give a concrete example of a field that is irrotational but not solenoidal in electromagnetics. (5%)
- (d) Give a concrete example of a field that is neither solenoidal nor irrotational in electromagnetics. (5%)

2. What is a magnetic dipole? Define magnetic dipole moment. Draw a two-dimensional graph of the magnetic flux lines of a magnetic dipole. (25%)

3. Given a  $h$  by  $h$  square conducting loop that is placed in a time-varying magnetic field  $\mathbf{B} = \mathbf{a}_x B_0 \cos(\omega t)$ , where  $B_0$  and  $\omega$  are constants. The normal of the loop initially makes an angle  $\beta$  with  $\mathbf{a}_x$ . Find the induced emf in the loop when the loop rotates with an angular velocity  $\omega$  about the  $y$ -axis. (25%)

4. Given a long, straight conducting wire (with radius  $a$  and conductivity  $\sigma$ ) that carries a direct current  $I$ . (30%)

- (a) Find the Poynting vector at the surface of the wire. (15%)
- (b) Verify Poynting's theorem. (15%)