

Electromagnetics Spring 2020

Homework 5

Deadline: 4.14 23:59pm

说明：全用英文作答；

每道题要对所有小问作答，要给出全部必要的推导过程，计算题要算出最终的数值结果，比如开根号之类的；

所有计算出来的结果如果有单位的物理量，一定要写明单位；

每题的分数在括号中给出；

可以互相讨论，也可以上网查，但是不能抄袭，也不能找别人代做；

可以在电脑敲字解答，也可以手写解答，最后统一转换为 PDF 格式，按分组信息邮件 或 BB 上提交；

邮件主题&附件命名规范：姓名_章节，不按规定发送扣除一半分数；

请在作业 PDF 的第一行写上姓名和学号；

有问题请给老师或助教发邮件；

Textbook: Fundamentals of Applied Electromagnetics, 7th edition

Part I. Problems in textbook.

6.6 (20 points)

6.10 (10 points)

6.11 (20 points)

6.13 (10 points)

6.16 (20 points)

6.18 (20 points)

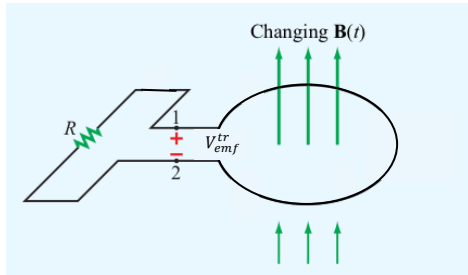
6.23 (10 points)

PART II. Problems in quiz

1. (9 points)

(a) **(2 points)** Write out the expression of the most general electromotive force V_{emf} induced by time-varying magnetic flux Φ .

(b) **(3 points)** If \mathbf{B} field in the circuit increases, what is the direction of the induced current in the circuit (label it with an arrow)? What is the direction of the induced magnetic field (draw it out)? The V_{emf}^{tr} defined with the polarity as shown in the figure is positive or negative?



(c) (4 points) A wire with length l along the x direction is moving in a magnetic field (\mathbf{B} is in $+z$ direction) with velocity \mathbf{u} in the $+y$ direction. Write out the expression of the induced voltage V_{12} by \mathbf{u} , \mathbf{B} and l . Point 1 has a large x coordinate. What is the direction of the induced current in it?

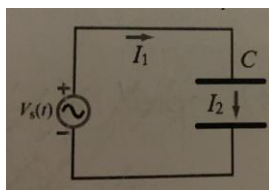
2. (4 points)

(a) (2 points) Write out the relationship (in differential form) between the charge Q and contained in a volume and the total current I flowing out of the volume.

(b) (2 points) Write out the expression of the charge-current continuity relation using current density and charge density. Either differential and integral form is fine.

3. (8 points)

(a) (2 points) For the following circuit with a capacitor C , what are the types of the current I_1 and I_2 ? Conduction or displacement? Assume all the conductors are ideal.



(b) (2 points) What are the relations between I_1 and I_2 ?

(c) (4 points) Write out the general expressions of displacement current density and displacement current.

4. (4 points) Write out the expression of the divergence $\nabla \cdot \mathbf{A}$ of a vector $\mathbf{A}(x, y, z)$ in the Cartesian coordinate systems. Write out the expression of the gradient of the gradient $\nabla \phi$ of a scalar $\phi(x, y, z)$ in the cartesian systems.