Phys 241 SB 2002 Test 2 Solution

1. (4 points) In the dc circuit shown the directions chosen for the algebraic currents in the various branches of the circuit are shown. A valid equation relating these currents is
   A. $i_1 + i_2 + i_3 = 0$
   B. $i_1 - i_2 + i_3 = 0$
   C. $i_1 + i_2 - i_3 = 0$
   D. $i_1 - i_2 - i_3 = 0$
   E. $i_1 = i_2 - i_3$

2. (5 points) In the previous problem, Kirchhoff's Loop equation around ABCFEA can be written
   A. $\mathcal{E}_1 - i_1R_1 + \mathcal{E}_2 - i_2R_2 = 0$
   B. $\mathcal{E}_1 - i_1R_1 - \mathcal{E}_2 - i_2R_2 = 0$
   C. $\mathcal{E}_1 - i_1R_1 - \mathcal{E}_2 + i_2R_2 = 0$
   D. $\mathcal{E}_1 + i_1R_1 + \mathcal{E}_2 + i_2R_2 = 0$
   E. $\mathcal{E}_1 - i_1R_1 - \mathcal{E}_2 - i_2R_2 = 0$

3. (3 points) A uniform magnetic field of 0.100 T is in the y direction as shown. A charged particle q = -0.500 C moves in the xy plane at a speed of 100.0 m/s with its velocity making an angle $\theta = 45°$ with respect to $\vec{B}$ as shown. What is the direction of the force on this charged particle?
   A. into the paper
   B. out of the paper

4. (6 points) In the previous problem, what is the magnitude of the force on the charged particle?
   A. 5.00 N
   B. 3.54 N
   C. 7.08 N
   D. 2.24 N
   E. 55.5 N

5. (6 points) A galvanometer gives a full scale deflection with a galvanometer current i_g = 5.00E-3 A. The internal resistance of the galvanometer is R_g = 10.0 Ω. With the help of a resistor R_x connected in parallel with the galvanometer, the galvanometer is converted into an ammeter deflects full scale deflection when a current i = 3.00 A flows into the meter as shown.
What value of R_x should be used?
A. 59.9 Ω
B. 6000 Ω
C. 0.0167 Ω
D. 0.0500 Ω
E. 0.125 Ω

6. (3 points) In the larger loop, a current flows clockwise as shown. The variable resistor R is used to cause the current in this loop to decrease. Which way does the induced current flow in the smaller loop which contains only a resistive element r? (The two loops are coplanar as shown.)
A. clockwise
B. counter-clockwise
C. $i_{ind} = 0$

7. (8 points) A circular 3 turn coil has a cross sectional area A = 1.50E-3 m^2. The coil is in a uniform magnetic field directed perpendicular to the plane of the coil. This magnetic field rises from 0 to 10.0 T at a constant rate in 0.100 s. What emf appears in the coil during this time interval?
A. 4.5 V
B. 15 V
C. 0.15 V
D. 0.45 V
E. 0.015 V

8. (6 points) An ideal battery of emf $\mathcal{E} = 15.0$ V is connected in series with a resistor R = 5.00 Ω, an initially unenergized inductor L = 20.0 mH, and a switch. The switch is closed at t = 0. When the current in the circuit is 1.00 A, what is the value of di/dt?
Hint: you can start with the equation $i(t) = \frac{\mathcal{E}}{R}\left(1 - e^{(-t/\tau)}\right) \quad with \;\; \tau = \frac{L}{R}$
but the problem is easier if you start by writing down Kirchhoff's Loop Eq.

A 750 A/s
B 0.200 A/s
C. 1000 A/s
D. 300 A/s
E. 500 A/s

(Soln 1) The loop Eq, $\mathcal{E}$ - iR = $\frac{di}{dt}$ = 0, when i = 1.00 A is
15.0 - 1.00(5.00) = 20E-3$\frac{di}{dt}$. Thus di/dt = 10/(20E-3) = 500 A/s.
(Soln 2) $i(t) = \frac{\mathcal{E}}{R}\left(1 - e^{(-t/\tau)}\right) \quad with \;\; \tau = \frac{L}{R}$. Differentiating $|di/dt| = \frac{\mathcal{E}}{L}e^{(-t/\tau)}$
With i = 1.00, the current equation is $1.00 = 3.00(1 - e^{(-t/\tau)})$. Thus $e^{(-t/\tau)} = 2/3$.
Hence the di/dt equation becomes di/dt = (15/20E-3)(2/3) = 500 A/s.
(Soln 3) Yes you can solve the i(t) equation for t and put this into di/dt equation but this is the hard way..

9. (8 points) A single turn rectangular loop in the plane of the paper (the xy plane) has length L and width W of 0.100 m and 0.0500 m respectively and lies in a region of uniform magnetic field. The magnetic field has components B_x = 0.100 T, B_y = 0.0 T and B_z = 0.0 T. If a current i = 1.00 A flows around the loop as shown, what is the magnitude of the torque on the loop? (The parallel leads bringing the current in and out lie essentially on top of each other and can be ignored.)
A. 0.25 N·m
B. 0.00175 N·m
C. 0.0005 N·m
D. 0.05 N·m
E. 0

10. (4 points) The direction of the torque vector in the previous problem is
A. $-\hat{k}$
B. $-\hat{k}$
C. $-\hat{}$
D. $-\hat{}$
E. $-\hat{}$

11. (4 points) A portion of a circuit with current i = 25.0 A consists of a circular arc about O and two radial directed straight wires ℓ_1 and ℓ_2 both 0.30 m in length. The arc subtends 120° and has a radius R = 0.100 m. The above wires lies in the xy plane. What is the direction of the magnetic field produced by this portion of a circuit at point O?
    A 'into paper
    B. out of paper
    C. in the xy plane

12. (7 points) In the previous problem, what is the magnitude of the magnetic field at the point O due to the portion of the circuit shown?
    A. 6.56E-4 T
    B 5.23E-5 T
    C. 1.31E-3 T
    D. 1.05E-4 T
    E. 0

13. (7 points) A copper wire of length L, circular cross section A has a resistance R = 6.00 Ω. It is then drawn out through a series of die (smaller and smaller openings) until its length is three times its original length. Assuming that the resistivity and density of the wire is unchanged, what is the new resistance of the wire in ohms?
    A. 6
    B. 18
    C. 36
    D. 54
    E. 31.2

14. (3 points) A long solenoid with a radius of 29.0 mm (hence cross sectional area = 0.00264 m^2) has 10 000 turns/m. A single loop of radius 67.0 mm (hence cross sectional area = 0.0141 m^2) is placed around the solenoid, the central axis of the loop and the solenoid coinciding. The current hence the magnetic field in the solenoid is increasing. The magnetic field in the solenoid increases from 0.00 T to 0.0500 T in 0.0200 s. Seen from an end, the solenoid current flows clockwise. Seen from this same end, the induced current in the loop flows
A. Clockwise
B. Counter-clockwise

15. (7 points) In the previous problem, what is the magnitude of the induced emf that appears in the loop?
A. 0.0352 V
B. 0.328 V
C. 0.404 V
D. 0
E. 0.00660 V

16. (7 points) In problem 14, when the magnetic field inside the solenoid is 0.0500 T, what is the current in the solenoid?
A. 2.04 A
B. 10.0 A
C. 2.98 A
D. 5.53 A
E. 2.21 A

PHYSICS 241 EXAM 2 April 1, 2002

The first posting had the number of points for problem 4 incorrectly stated as 4 points but 6 points is correct..

241 spring 2002 test 2

prob number, points, key (green and salmon same)

01. 4 D
02. 5 A
03. 3 A
04. 6 B
05. 6 C
06. 3 A
07. 8 D
08. 6 E
09. 8 C
10. 4 D
11. 4 A
12. 7 B
13. 7 D
14. 3 B
15. 7 E
16. 7 C
17. 8 E
18. 4 E

Total = 100

will post average as message on CHIP when known (about 3:00 pm Wed??). Scores should be in CHIP gradebook shortly thereafter.