Student Name:
Student ID:

Instructor: Natalia K. Nikolova

COURSE **ELECTRICAL ENGINEERING 2FH3**

Duration of Examination: **3 hours**
McMaster University **Final Examination** April 22, 2010

THIS EXAMINATION PAPER INCLUDES **1 PAGE** AND **6 QUESTIONS** plus 4 pages of formulas. YOU ARE RESPONSIBLE FOR ENSURING THAT YOUR COPY OF THE PAPER IS COMPLETE. BRING ANY DISCREPANCY TO THE ATTENTION OF YOUR INVIGILATOR.

Instructions:
1. You can use only a standard calculator (Casio-FX991).
2. Write your name and student ID on each page, the exam booklets incl.
3. You are allowed to bring 2 sheets of letter-size paper with any writing on both sides of the sheet.
4. Answer ALL questions. Provide the solutions in the exam booklet.

Problem 1 [9 points] (T06, 3.30 HB)
Let $\mathbf{D} = 20\rho^2\mathbf{a}_\rho$ nC/m^2. Find the total charge enclosed by the closed surface $\rho \le 3$ m, $0 \le z \le 2$ m.

Problem 2 [42 points] (HWL04, 2.20 HB)
The portion of the z axis, for which $|z| \le 2$, carries a nonuniform line charge density $\rho_l = |z|$ nC/m. For $|z| > 2$, $\rho_l = 0$.
(a) Find the total charge Q. [4 points]
(b) Using the principle of superposition, find the potential V at the point $P(0,4,0)$ m. [9 points]
(c) Find the electric field $\mathbf{E}$ at $P(0,4,0)$ m. [14 points]
(d) Write a Matlab code for the computation of the problem in (b). [15 points]

Problem 3 [18 points] (T12)
If a solenoid has 2000 turns, a length of l = 75 cm, a radius of a = 5 cm, and carries current of 50 mA along $\mathbf{a}_\phi$, find the magnetic field $\mathbf{H}$ at the centre of the solenoid and at its edges.

Problem 4 [18 points] (HL18 8.36 HB)
Let $\mathbf{A} = (3y - z)\mathbf{a}_x + 2xz\mathbf{a}_y$ Wb/m in a certain region of free space ($\mu = \mu_0$). Find $\mathbf{B}$, $\mathbf{H}$, and $\mathbf{J}$ at $P(2,-1,3)$ m.

Problem 5 [9 points] (L19 example)
An infinite straight filament with current I lies along the z axis. A rectangular loop lies in the yz plane with its four corners at: (0, 1, 0), (0, 3, 0), (0, 3, 1), and (0, 1, 1). Find the magnitude of the flux $|\Phi|$ through the loop due to the current I of the filament if $I = 2$ A. Medium is vacuum and coordinates are in meters.

Problem 6 [4 points] (L19 example)
Find the mutual inductance M between the straight wire and the rectangular loop in Problem #5 if the loop consists of 150 turns.

END OF QUESTION SHEET
A sheet of mathematical formulas follows (4 more pages)
TOTAL MARKS FOR THIS EXAM = 100

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