UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE AND ENGINEERING
Department of Electronic and Electrical Engineering

July 2015
SUPPLEMENTARY EXAMINATION

Title of the Paper:

EE341
Electromagnetic Fields
Time Allowed: Three Hours

Instructions:

1. The answer has to be written in the space provided in the question paper. Consider only the material in the answer space be the answer. If need more space, the previous page is the best option. Use the answer book as a scratch pad. Both books must be marked with the student identity
2. There are 9 questions in the question book. Answer Questions 1 to 5 (Compulsory, 60 points) and pick 2 from Questions 6 to 9(40 points). Total 100 pts and mark the not picked question with a big X in the answer space; or leave the grading person to pick according to the worst case first.
3. This paper has 7 pages, including this page.

DO NOT OPEN THE PAPER
UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR.

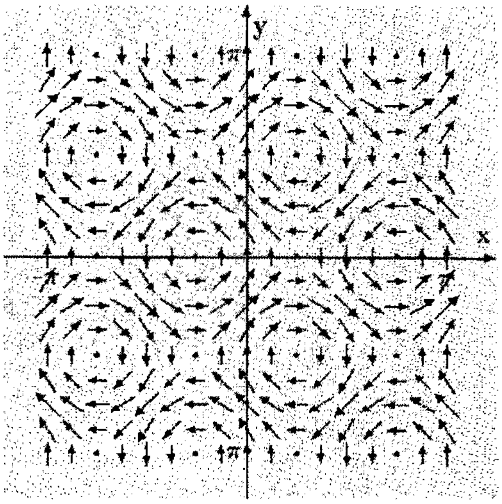
Compulsory Q1-5:

Q1, 10pts: Given a scalar function $f(x,y,z) = x^2 + y$, find (i) $\int f \cdot d\vec{l}$ and (ii) $\int f \cdot dl$ along a straight line $y = x + 1$ from $x = 0$ to $x = 1$.

Q2, 10 pts: Given a scalar function, $h(x,y,z) = (x^2 \cdot y + z)$ calculate: (i) the gradient of $h(x,y,z)$, (ii) the direction of the gradient.

Q3, 10 pts: Given the field pattern equation below, analyze and locate (i) the position of non-zero and zero curl, (ii) do the same for divergence. The fields are in *xy*-plane only, no contribution in z-axis top and bottom.

$$\mathbf{A} = -\hat{\mathbf{x}} \sin 2y + \hat{\mathbf{y}} \cos 2x,$$
$$\text{for } -\pi \le x, y \le \pi$$



Q4, 15 pts: A parallel plate cable, shown in Fig. Q4-1, has a width "w" and separation "d" with insulation material ε/μ_o. Consider no fields outside of the space between the plates (that is no end fringing effects). (i) Find the total electric energy stored in this 1 meter long cable, energized by a total source charge ±q Coul. (ii) Find the total magnetic energy stored in this 1 meter long cable, energized by a total source current I.

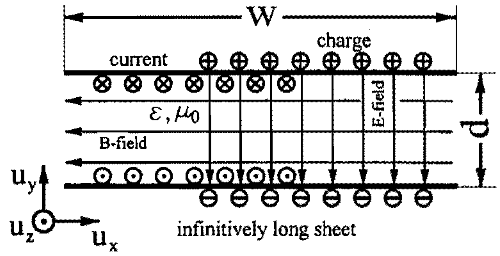


Fig. Q4-1

Q5, 15 pts: The same cable as in Q4, Calculate the cable (i) inductance and (ii) capacitance per unit length.

Optional Q6-9- free to pick 2 out of 4

Q6, 20 pts: A point charge of +q Coul is located d Mtr above an infinitively large perfect conducting plane. Find the charge density on the plane. Use the image method. That is to find the $\vec{D}$ on the conducting plane.

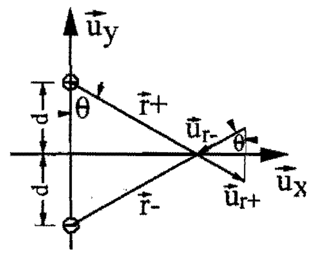


Fig. Q6-1

Q7, 20 pts: List five pairs of dual equations

term	Time-domain	Phasor-domain
	$A\cos(\omega t+45)$	
	$\frac{d}{dt}A\cos(\omega t+\varphi)$	
	Electric	Magnetic
	$\vec{D}=\varepsilon\vec{E}$	
		$\vec{F}=Id\vec{l}\times\vec{B}$
	$\vec{\nabla}\circ\vec{D}=q_v$	

Q8, 20 pts:: A current coil of radius r_o, shown in Fig. Q11-1, carries a current I. Determine the vector potential of this coil at the point on its axis and z meters away from the coil plane.

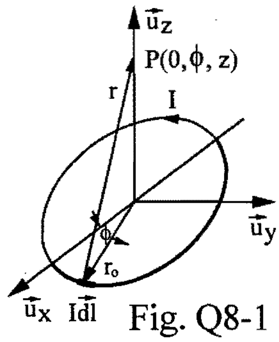


Fig. Q8-1

Q9, 20 pts:: A densely wound toroidal coil of total N turns, with an inner radius 5 cMeters and a square cross-section of 5 cMtrs on the sides, has an air gap of 0.5 cMtrs wide shown in Fig. Q9-1. If the current through the coil is 1.0 A, (i) determine the coil turns N in order to maintain a flux of 1.0 mWb in the air gap. Assume the permeability of the magnetic material is $\mu_r = 500$. (ii) Compute the ratio of the mmf drop across the air gap to the applied mmf. Use average radius 7.5 cM to calculate the length of the H-field.

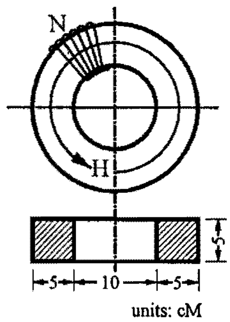


Fig. Q9-1