THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

Department of Electrical and Computer Engineering

ELEC 318 Electromagnetic Fields **Exam #3 Review Problem Answers**

1. (a) **E**, V/m
   (b) **H**, A/m
   (c) **D**, C/m^2
   (d) **B**, Wb/m^2
   (e) ρ_v, C/m^3
   (f) **J**, A/m^2
   (g) **P**, C/m^2
   (h) ε, F/m
   (i) μ, H/m
   (j) V, V
   (k) C, F
   (l) L, H
   (m) Ψ, Wb
2. 1.26 Wb
3. $-50\,\hat{\mathbf{z}}$ μA/m
4. 1.66 μWb
5. $743\,\hat{\mathbf{x}}+382\,\hat{\mathbf{y}}+140\,\hat{\mathbf{z}}$ mA/m
6. 3.2 μWb/m^2
7. (a) $28.5\,\hat{\mathbf{y}}$ mA/m
   (b) $-13\,\hat{\mathbf{x}}+13\,\hat{\mathbf{y}}$ mA/m
   (c) $-5.1\,\hat{\mathbf{x}}+1.7\,\hat{\mathbf{y}}$ mA/m
   (d) $5.1\,\hat{\mathbf{x}}+1.7\,\hat{\mathbf{y}}$ mA/m
8. (a) $-679\,\hat{\mathbf{z}}$ mA/m
   (b) $199\,\hat{\mathbf{z}}$ mA/m
   (c) $199\,\hat{\mathbf{x}}+199\,\hat{\mathbf{y}}$ mA/m
9. $-16\,\hat{\mathbf{z}}$ A/m
10. 800 mA, clockwise
11. (a) $\dfrac{I_2}{2\pi y_0}\hat{\mathbf{x}}-\dfrac{I_1 a^2}{2\left(a^2+h^2\right)^{3/2}}\hat{\mathbf{z}}\ \dfrac{\text{A}}{\text{m}}$
    (b) $31.8\,\hat{\mathbf{x}}+36\,\hat{\mathbf{z}}$ A/m
12. (a) $\left(2k_0/a\right)\hat{\mathbf{z}}$
    (b) $\left(k_0 a/r\right)\hat{\boldsymbol{\phi}}$
13. (a) $\pi a^2 J_0/2$
    (b) $\begin{cases} J_0 r\left(2-r^2/a^2\right)\hat{\boldsymbol{\phi}}/4 & r<a \\ J_0 a^2\hat{\boldsymbol{\phi}}/4r & r>a \end{cases}$
14. $16e^{-2r}\hat{\mathbf{z}}$ A/m^2
15. 220 mA
16. $149\,\hat{\boldsymbol{\phi}}$ A/m
17. $-8\,\hat{\mathbf{z}}$ A/m^2
18. (a) $\begin{cases} 0 & r<a \\ \dfrac{I}{2\pi r}\cdot\dfrac{r^2-a^2}{b^2-a^2}\hat{\boldsymbol{\phi}} & a\le r\le b \\ \dfrac{I}{2\pi r}\hat{\boldsymbol{\phi}} & r>b \end{cases}$
19. (a) $76.4\,\hat{\mathbf{z}}$ A/m^2
    (b) $\mathbf{H}=\begin{cases} 0 & r<a \\ 38.2\left(r^2-.01\right)/r\ \hat{\mathbf{z}} & a\le r\le b \\ 0.477/r\ \hat{\mathbf{z}} & r>b \end{cases}$
20. 8.37 x 10^{-20} J
21. –1.56 J
22. (a) $4\,\hat{\mathbf{x}}$ mN/m (repulsive)
    (b) $-4\,\hat{\mathbf{x}}$ mN/m (repulsive)
    (c) $0.72\,\hat{\mathbf{x}}+0.96\,\hat{\mathbf{y}}$ mN/m (attractive)
    (d) $-3.28\,\hat{\mathbf{x}}+0.96\,\hat{\mathbf{y}}$ mN/m
23. (a) $32\,\hat{\mathbf{z}}$ mN
    (b) $-32\,\hat{\mathbf{z}}$ mN
    (c) $-2\,\hat{\mathbf{x}}$ N·mm
24. $1.95\,\hat{\mathbf{x}}$ mN/m
25. $0.4\,\hat{\mathbf{y}}$ N
26. (a) $\left(1.43\,\hat{\mathbf{x}}+4.29\,\hat{\mathbf{y}}-2.14\,\hat{\mathbf{z}}\right)\cdot 10^{-2}$ A·m^2
    (b) $\left(30\,\hat{\mathbf{x}}-20\,\hat{\mathbf{y}}-20\,\hat{\mathbf{z}}\right)\cdot 10^{-3}$ N·m
27. $17.5\,\hat{\mathbf{x}}+35.1\,\hat{\mathbf{y}}+87.7\,\hat{\mathbf{z}}$ A·cm^2
28. (a) $\hat{\mathbf{z}}\left(3\cdot 10^{-2}\right)\left\{2\cos\phi-\sin\phi\right\}$ N·m

(b) 63.4° or −116.6°
(c) −26.6° or −153.4°

29. 49.5°
30. $0.05\,\hat{\mathbf{x}} + 3\,\hat{\mathbf{y}} - 1\,\hat{\mathbf{z}}$ A/m
31. $-1.05\,\hat{\mathbf{x}} + 1.26\,\hat{\mathbf{y}} + 2\,\hat{\mathbf{z}}$ Wb/m^2
32. (a) 5.83
    (b) $4.86\,\hat{\mathbf{x}} - 8.64\,\hat{\mathbf{y}} + 3.95\,\hat{\mathbf{z}}$ A/m
    (c) 76.3°, 77.6°
33. (a) $-27.7\,\hat{\mathbf{x}} + 49\,\hat{\mathbf{y}} - 12.6\,\hat{\mathbf{z}}$ μWb/m^2
    (b) 116°, 92.8°
34. (a) $2.51\,\hat{\mathbf{x}} + 3.77\,\hat{\mathbf{y}} - 0.0037\,\hat{\mathbf{z}}$ mWb/m^2
    (b) 0.047°
35. (a) $-5\,\hat{\mathbf{r}} + 20\,\hat{\boldsymbol{\phi}} + 40\,\hat{\mathbf{z}}$ A/m
    (b) 6.2°
36. 304 pJ
37. 6.56 pJ
38. (a) 8.04 H/m
    (b) 1.01 J/m
39. 148
40. 3.91 cm
41. (a) 916 nH
42. 13.4 mA_{RMS}
43. 0.474 sin(377t) V
44. 31.8 sin(30πt – 0.3) A
45. 2.4 V
46. 3 sin(10t) – 0.06 cos(20t) V
47. 6.3 A, counter-clockwise
48. (a) 278 A/m^2
    (b) 77.8 mA
49. 600 kHz