THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

Department of Electrical and Computer Engineering

ELEC 318 Electromagnetic Fields **Exam #1 Review Answers**

1. 106.4°
2. (a) $(9.16, 4.67, 12.26)$
   (b) $(10.27, 27°, 12.20)$
4. (a) $2\hat{\mathbf{x}} + 3\hat{\mathbf{y}} + 4\hat{\mathbf{z}}$
   (b) zero
6. 71.8 m^3
7. 3.6 Wb
8. (a) $-1.5\,\hat{\boldsymbol{\theta}} + 2.6\,\hat{\boldsymbol{\phi}}$
   (b) $8.67\hat{\mathbf{R}}$
9. (a) yes, $\nabla \times \mathbf{E} = 0$
   (b) yes, $\nabla \cdot \mathbf{E} = 0$
   (c) yes, $\nabla \times \mathbf{E} = 0$
10. (b) no, $\nabla \times \mathbf{A} \neq 0$ everywhere
11. (a) $-\left[10\sin(\phi/2)\right]/R^2\sin(\theta)$
    (b) $\dfrac{20\cos(\theta)\cos(\phi/2)}{R^2\sin(\theta)}\hat{\mathbf{R}} + \dfrac{30R}{\sin(\theta)}\hat{\boldsymbol{\phi}}$
12. both (a) and (c) are true
13. both sides equal 6
14. both sides equal 180π
15. $4\pi E_0 r_0^3$
16. 10^6 m/s
17. $0.00167\hat{\mathbf{x}} - 0.238\hat{\mathbf{y}} - 0.0355\hat{\mathbf{z}}$ V/m
18. (a) $-\hat{\mathbf{y}}$
    (b) zero
19. $Q_1 = 1\,\text{nC},\ Q_2 = 768\,\text{pC}$
20. $4.36\,\hat{\mathbf{z}}$ V/m
21. $1.8\,\hat{\mathbf{z}}$ mV/m
22. [point symmetry about *P*]
23. 2.67
24. $14.7\,\hat{\mathbf{x}} - 14.7\,\hat{\mathbf{z}}$ V/m
25. $\left[\dfrac{3\rho_s}{\varepsilon_0}, \dfrac{7\rho_s}{\varepsilon_0}, \dfrac{-5\rho_s}{\varepsilon_0}, \dfrac{-11\rho_s}{\varepsilon_0}, \dfrac{-3\rho_s}{\varepsilon_0}\right]\hat{\mathbf{y}}$
26. $12\,\hat{\mathbf{y}} + 19\,\hat{\mathbf{z}}$ V/m
27. $+\hat{\mathbf{z}}$
28. symmetrical charge distributions
29. $4\pi\rho_0 a^3$
30. negative
31. $17.4\ \text{pC/m}^3$
32. $5/4\pi R^2\,\hat{\mathbf{R}}\ \mu\text{C/m}^2$
33. $\begin{cases} \rho_L/2\pi\varepsilon_0 r\ \hat{\mathbf{r}} & r \geq a \\ \rho_L r/2\pi\varepsilon_0 a^2\ \hat{\mathbf{r}} & r < a \end{cases}$
34. $\rho_0 a^3/3\varepsilon_0 R^2\,\hat{\mathbf{R}}$
35. $\begin{cases} \rho_{v0}\left(5a^2R^3 - 3R^5\right)/15a^2\varepsilon_0 R^2\,\hat{\mathbf{R}} & R \leq a \\ 2\rho_0 a^3/15\varepsilon_0 R^2\,\hat{\mathbf{R}} & R > a \end{cases}$
36. $\begin{cases} 0 & R < a \\ \rho_0\left(a - R\right)/\varepsilon_0 R^2\ \hat{\mathbf{R}} & a \leq R \leq b \\ \rho_0\left(a - b\right)/\varepsilon_0 R^2\ \hat{\mathbf{R}} & R > b \end{cases}$
37. –30 V
38. 48 μJ
39. (b) 32 V
    (c) 18 V
    (d) 100 μJ
40. $\mathbf{E} = -200x^{1/3}\,\hat{\mathbf{x}}$, $\mathbf{D} = -600\varepsilon_0 x^{1/3}\,\hat{\mathbf{x}}$
    $\rho_v = -200\varepsilon_0 x^{-2/3}$
42. $Q\rho_0 a/2\varepsilon_0\sqrt{a^2 + z^2}$

43. $18x/\left(x^2+1\right)^2\ \hat{\mathbf{x}}$

44. $-2\hat{\mathbf{y}}$ V/m

45. $4.2\,\hat{\mathbf{x}}-4.2\,\hat{\mathbf{y}}$ V/cm

46. (a) $-100\dfrac{r\cos\phi}{z+1}\hat{\mathbf{R}}+50\dfrac{r\sin\phi}{z+1}\hat{\boldsymbol{\phi}}+50\dfrac{r^2\cos\phi}{(z+1)^2}\hat{\mathbf{z}}$

47. $\rho_L/8\varepsilon_0$

48. $(\rho_s/4\varepsilon_0)(a-b-c+d)$

49. (a) $(483/\varepsilon_0)\hat{\mathbf{z}}$ nV/m

50. $Q_1=-2.03$ nC, $Q_2=10.2$ nC

51. 684 pC

52. (a) $0.28\,\rho_0/\varepsilon_0$

(b) $0.0416\,\rho_0/\varepsilon_0\ \hat{\mathbf{z}}$

53. (a) $-5\varepsilon_0(R-8)e^{-R/4}/4R$

(b) –65.5 μJ

(c) zero

54. (a) $-y\,\hat{\mathbf{x}}-x\,\hat{\mathbf{y}}$

(e) radially away from the origin

(f) at the origin