EMT Objective Solution

1. (D)

2. (C) Maximum power handling capability $= 6.67 \times 10^{-4} E_{rms}^2 \, ab \left(\lambda_0 / \lambda_g\right)$

3. (C) $P = \frac{E_m^2}{2\eta} \times e^{-2\alpha z}$ so Electric field will be reduced to 1/e value

$\alpha z = 0.5z$

$\delta =$ Distance at which electric field is reduced to (i/e) of its value.

$\delta = \frac{1}{\alpha} = 2m$

4. (C) $P = P_0 e^{-(t/\tau)}$ $\quad \tau =$ Time constant $= \frac{\in}{\sigma}$

$\tau = \frac{8.85 \times 10^{-12}}{8.85 \times 10^{9}} = 10^{-21} = 10^{-9} \, p\,sec$

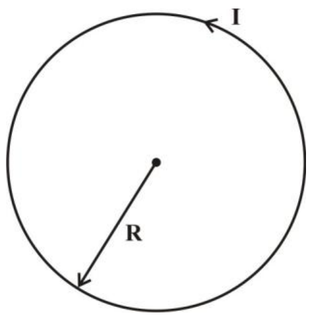
5. (B) $E \longrightarrow E_0/e = 0.37E_0$

63% Attenuated

$E \longrightarrow E_0 e^{-\alpha z} = 0.9E_0$

$e^{+\alpha z} = \frac{1}{0.9} = 1.11 \quad \alpha z = \ln(1.11) \quad \delta = \frac{0.1}{\alpha}$

6. (A)



$B = \frac{\mu_0 I}{2R} \quad M = IA = I\pi R^2$

7. (B) $P = 10^{-5} \, c/m^3 \qquad V = a^3 = 8cm^3$

$Q = \frac{10^{-5}}{m^3} \times 2 \times 2 \times 2 \times 10^{-6} m^3$

$= 8 \times 10^{-11} C = 80 \, pc$

8. (C) Force per unit area = Stored energy / volume

$$\frac{F}{A} = \frac{1}{2} \in_0 E^2 = \left(\frac{\in_0}{2} \times \frac{V_0^2}{d^2}\right)$$

Another Method

$$F = QE = \sigma A \cdot \frac{\sigma}{2 \in_0}$$

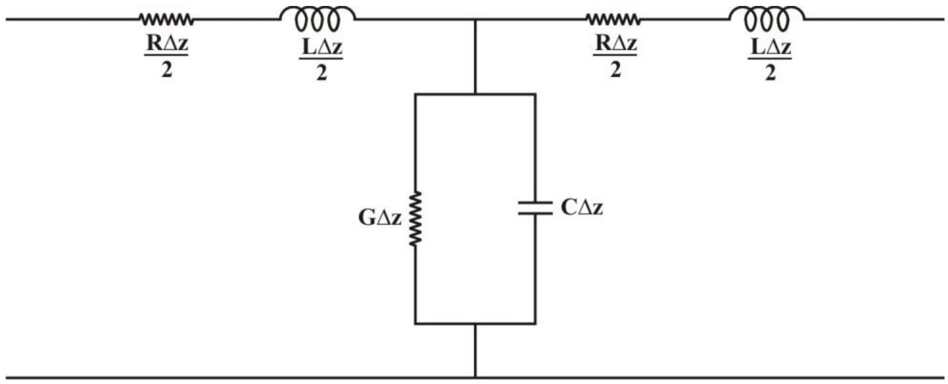
$$\frac{F}{A}=\frac{\sigma^2}{2\epsilon_0}=\frac{\epsilon_0^2 E^2}{2\epsilon_0}=\frac{1}{2}\epsilon_0 E^2=\frac{1}{2}\epsilon_0\frac{V_0{}^2}{d^2}$$

9. (A) $\theta_n = 30^o$

Less tangent $\{\theta = 2\theta_n = 60^o\}$

$(\tan\theta) = \tan 60^o = \sqrt{3}$

10. (B)



$\tan\delta = 0$

$\Downarrow$

No loss

$\therefore$ GΔz will not be present.

11. (B) $\eta_{TE} = \frac{\eta_0}{\sqrt{1-(f_c/f)^2}}$

$\eta_{TM} = \eta_0\sqrt{1-(f_c/f)^2}$

$\eta_{TEM} = \eta_0$

12. (D) $\lambda_c = \frac{2\pi a}{1.841} = \frac{2\pi\times 1cm}{1.841}$ $f_c = \frac{3\times 10^8}{2\pi\times 10^{-2}}\times 1.841 \simeq 8.71GHz$

13. (A)

$$R_s = \sqrt{\frac{2}{w\mu\sigma}} = \sqrt{\frac{2}{(5\times 10^{-4})^2\sigma^2}} = 1\mu m$$

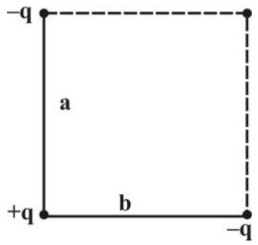
14. (C)

15. (B) $\nabla^2 r^n = n(n+1)r^{n-2}$

$\nabla^2 r^{-1} = (-1)(0)r^{-3} = 0$

16. (B)

17. (B) Calculate potential at 4th corner and multiply with q.



$$V = \frac{q}{4\pi\epsilon_0 a\sqrt{2}} - \frac{q}{4\pi\epsilon_0 a} - \frac{q}{4\pi\epsilon_0 a}$$

$$W = V\cdot q$$

$$= \frac{q^2}{4\pi\epsilon_0}\left[\frac{1}{a\sqrt{2}} - \frac{2}{a}\right]$$

18. (A) $\text{FBR} = \frac{3000}{500} = 6$

(in dB) = $10\log 6 = 7.8$

19. (B) Broad side array: $D = 2\left(\frac{nd}{\lambda}\right)$

End fire array: $D = 4\left(\frac{nd}{\lambda}\right)$

$\therefore \quad D = 2\times\frac{10\times\lambda}{4\times\lambda} = 5$

20. (C) Directivity of Isotropic:

$$D = \frac{4\pi}{\lambda^2}\cdot Ae = 1 \quad Ae = 0.08\lambda^2$$

HPBW $\rightarrow$ Does not exist.

21. (D) $1.64\sin^2\theta = \frac{1.64}{2}$

$$\theta = 45^\circ$$

$$\text{HPBW} = 2\times 45^\circ = 90^\circ$$

22. (C) Incident wave: $H_i = H_o e^{j(\omega t - \beta x)}$ & $H_r = H_o e^{j(\omega t + \beta x)}$

$$H = H_i + H_r \quad = H_o e^{j(\omega t-\beta x)} + H_o e^{j(\omega t+\beta x)} = 2H_o\cos\beta x\cos\omega t$$

(taking real part)

23. (D) $\nabla\times\vec{H} = \varepsilon\frac{d}{dt}\left(E_m\sin\omega t\right)$

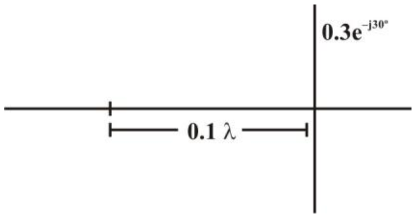
$$= \in E_m\omega_m\cos\omega t$$

24. (B) $\text{VSWR} = 4 \qquad |k| = 0.6$

$$\theta = 720\left(\frac{x_{vm}}{\lambda} - \frac{1}{4}\right) \qquad x_{vm} = 0$$

$$\theta = -180^\circ \qquad k = -0.6$$

25. (B)



$$k_x = k(\text{at } x = 0)e^{-j2\beta x} = 0.3e^{-j30} \times e^{-j2\beta x}$$

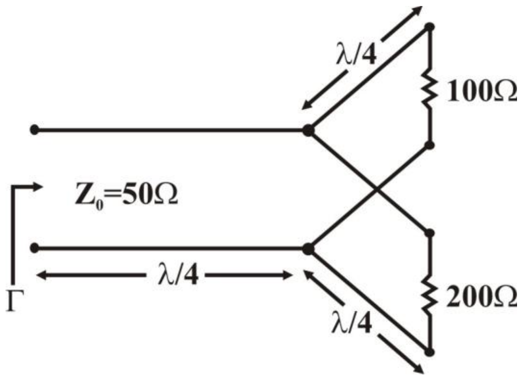
$$2\beta x = 0.1\lambda \times \frac{2\pi}{\lambda} \times 2 = 72^\circ$$

$$k_x = 0.3e^{-j102^\circ}$$

26. (B)

27. (B) $\tan\theta = \sqrt{\frac{9}{4}} = \frac{3}{2}$

28. (D)



$$Z_{i1} = \frac{(50)^2}{100} = 25 \; \& \qquad Z_{i2} = \frac{(50)^2}{200} = 12.5$$

$$Z = 25 \,||\, 12.5 = \frac{25}{3}$$

$$Z_i = \frac{(50)^2}{25/3} = 300 \qquad k = \frac{300-50}{300+50} = \frac{5}{7}$$

29. (C) $\alpha_c \cdot \alpha \frac{1}{b}$

30. (D) $\frac{\beta}{\omega\in} = \frac{\omega\sqrt{\mu\in}}{\omega\in} = \sqrt{\frac{\mu}{\in}} \rightarrow$ Resistance

$$\frac{\omega\mu}{\beta} = \frac{\omega\mu}{\omega\cdot\sqrt{\mu\in}} = \sqrt{\frac{\mu}{\in}} \rightarrow \text{Resistance}$$

31. (B) $\beta_x = 6 \qquad \beta_y = 8$

$$\beta = 10 \quad \lambda = \frac{2\pi}{\beta} = \frac{2\pi}{10} = \frac{\pi}{5} \qquad \text{so } f = \frac{c}{\lambda} = \frac{5c}{\lambda}$$

32. (A) $E = -\nabla V = -\left(-30e^{-6x}\right) = 30\,e^{-6x}$

33. (A) Geometric Mean

34. (D)

35. (B) $R.I.(\eta)\;\; K = \dfrac{\eta - 1}{\eta + 1}$

$$VSWR = \frac{1 + \dfrac{\eta-1}{\eta+1}}{1 - \dfrac{\eta-1}{\eta+1}} = \eta$$

36. (A) $\dfrac{P_r}{P_i} = \left(\dfrac{\eta-1}{\eta+1}\right)^2$

$$\frac{P_r}{P_i} = \left(\frac{2-1}{2+1}\right)^2 = \frac{1}{9} = 11.11\%$$

37. (C) $L\,\alpha\,\dfrac{1}{d}$

38. (C) $\vec{D} = \left(20r + \dfrac{r^2}{3}\right)\vec{a}_r = \left(20\rho + \dfrac{\rho^2}{3}\right)\vec{a}_p \rightarrow$ Taking in cylindrical coordinates

$$\rho = \nabla \cdot \vec{D} = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(20\rho^2 + \frac{\rho^3}{3}\right) = \frac{1}{\rho}\left[40\rho + \frac{3\rho^2}{3}\right] = 40 + \frac{3\rho}{3}$$

$\nabla \cdot \vec{D} = 40(\text{at}\,\rho = 0) \quad \therefore \;\; \nabla \cdot \vec{D} = 40 = \rho =$ Charge Density

39. (C) $\ell = 3m \qquad \lambda = 8m$

$\ell = \dfrac{3}{8}\lambda > \dfrac{\lambda}{4} \quad \therefore$ Capacitive.

40. (A)

41. (B) Sea water = Good conductor

$$\frac{\sigma}{\omega \in} = \frac{5}{80 \times 8.85 \times 10^{-12} \times 25 \times 10^3}$$
$$= 44.9 \times 10^3 >> 1$$

$E = E_0 e^{-\alpha z} = 0.1E_0 \qquad \alpha z = \ln 10 \qquad \alpha = \sqrt{\dfrac{\omega\mu\sigma}{2}}$

42. (B) Surface is always closed

43. (A)

44. (B) $C = \dfrac{4\pi \in_0 ab}{b-a} \quad C\alpha\sqrt{A_a \cdot A_b} \quad C\alpha\,\dfrac{1}{(b-a)}$

45. (B) Quanderpole $\alpha\,\dfrac{1}{r^3}$

46. (C)

47. (C) Dielectric constants:
Paraffin $\rightarrow 2$
Flint Glass $\rightarrow 10$
Distilled water $\rightarrow 81$

48. (A) when wave is reflected from perfect conductor then electric field is changed in phase by 180

49. (D)

50. (C) $H_{t1} = K \rightarrow$ Medium 2 has a current sheet of infinitesimal at the boundary, H_{t2} and K are normal to each other.

51. (D) $\oint \vec{E} \cdot \vec{dl} \neq 0$ in time varying.

$E = -\nabla V$ if valid for time varying,

$\nabla \times \vec{E}$ should be zero.

$\therefore \quad E = -\nabla V - \frac{\partial A}{\partial t}$

52. (C) Brewster angle is not valid only for perfect conductor

53. (B) $k_1 = \frac{1}{4\pi \in_0} \qquad k_2 = \frac{\mu_0}{4\pi}$

$\sqrt{k_1 k_2} = \sqrt{\frac{\mu_0}{\in_0}} \rightarrow$ Resistance

54. (A) $V = \frac{1}{4\pi \in} \int \frac{Pdv}{r}$

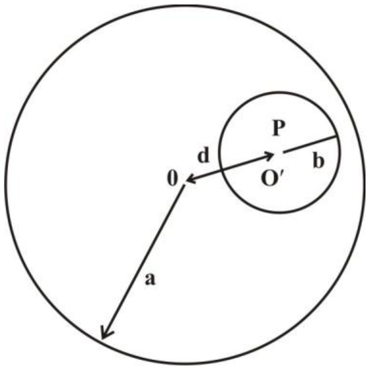
$$A = \frac{\mu}{4\pi} \int \frac{Idl}{r} = \frac{\mu}{4\pi} \int \frac{\frac{dq}{dt} \cdot dl}{r}$$

$$A = \frac{\mu}{4\pi} \cdot \frac{q\vec{v}}{r}$$

55. (B)

56. (A)

57. (A) $\vec{H} = \frac{\vec{J} \times \vec{r}}{2}$



$$\vec{H}_1 = \frac{\vec{J}\times\overrightarrow{OP}}{2} \qquad \vec{H}_2 = \frac{-\vec{J}\times\overrightarrow{O'P}}{2}$$

$$\vec{H} = \vec{H}_1 + \vec{H}_2 \qquad \vec{H} = \frac{\vec{J}\times\left(\overrightarrow{OP} - \overrightarrow{OP'}\right)}{2} = \frac{\vec{J}\times\vec{d}}{2}$$

58. (B)

59. (D)

60. (B)