

EMT Objective Solution

1. (D)

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

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 (1/e) of its value.

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

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

$$\tau = \frac{8.85 \times 10^{-12}}{8.85 \times 10^9} = 10^{-21} = 10^{-9} \text{ psec}$$

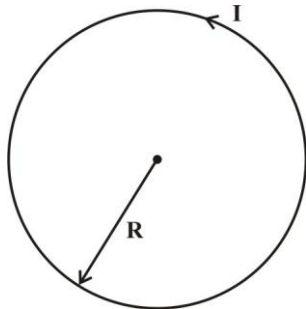
5. (B) $E \longrightarrow E_0/e = 0.37E_0$

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) $P = 10^{-5} \text{ C/m}^3$ $V = a^3 = 8\text{cm}^3$

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

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

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

$$\frac{F}{A} = \frac{1}{2} \epsilon_0 E^2 = \left(\frac{\epsilon_0}{2} \times \frac{V_0^2}{d^2} \right)$$

Another Method

$$F = QE = \sigma A \cdot \frac{\sigma}{2\epsilon_0}$$

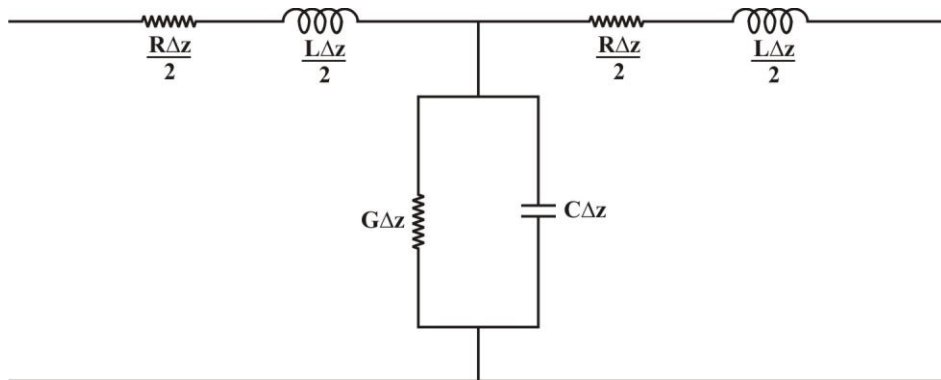
$$\frac{F}{A} = \frac{\sigma^2}{2\epsilon_0} = \frac{\epsilon_0^2 E^2}{2\epsilon_0} = \frac{1}{2} \epsilon_0 E^2 = \frac{1}{2} \epsilon_0 \frac{V_0^2}{d^2}$$

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

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

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

10. (B)



$$\tan \delta = 0$$

⇓

No loss

∴ $G\Delta z$ 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) $\lambda_c = \frac{2\pi a}{1.841} = \frac{2\pi \times 1\text{cm}}{1.841}$ $f_c = \frac{3 \times 10^8}{2\pi \times 10^{-2}} \times 1.841 \approx 8.71\text{GHz}$

13. (A)

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

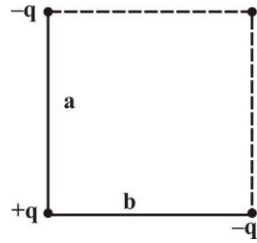
14. (C)

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) $FBR = \frac{3000}{500} = 6$
(in dB) = $10 \log 6 = 7.8$

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

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

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

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) $1.64 \sin^2 \theta = \frac{1.64}{2}$

$$\theta = 45^\circ$$

$$HPBW = 2 \times 45^\circ = 90^\circ$$

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

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

(taking real part)

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

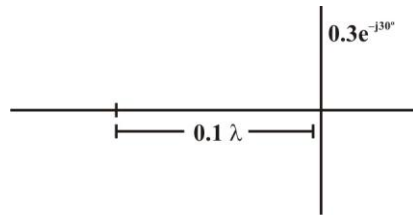
$$= \epsilon E_m \omega \cos \omega t$$

24. (B) $VSWR = 4 \quad |k| = 0.6$

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

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

25. (B)



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

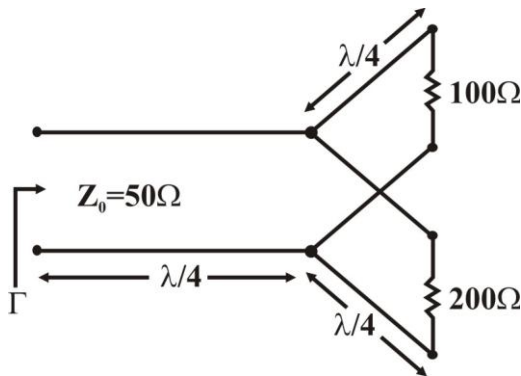
$$2\beta x = 0.1\lambda \times \frac{2\pi}{\lambda} \times 2 = 72^\circ$$

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

26. (B)

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

28. (D)



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

$$Z = 25 \parallel 12.5 = \frac{25}{3}$$

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

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

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

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

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

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

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

33. (A) Geometric Mean

34. (D)

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

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

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

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

37. (C) $L \propto \frac{1}{d}$

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

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

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

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

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

40. (A)

41. (B) Sea water = Good conductor

$$\frac{\sigma}{\omega \epsilon} = \frac{5}{80 \times 8.85 \times 10^{-12} \times 25 \times 10^3}$$

$$= 44.9 \times 10^3 \gg 1$$

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

42. (B) Surface is always closed

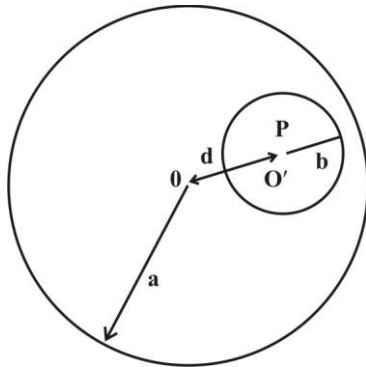
43. (A)

44. (B) $C = \frac{4\pi \epsilon_0 ab}{b-a} \quad C \propto \sqrt{A_a \cdot A_b} \quad C \propto \frac{1}{(b-a)}$

45. (B) Quanderpole $\propto \frac{1}{r^3}$

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) $\oint \vec{E} \cdot d\vec{l} \neq 0$ in time varying.
 $E = -\nabla V$ if valid for time varying,
 $\nabla \times \vec{E}$ should be zero.
 $\therefore E = -\nabla V - \frac{\partial A}{\partial t}$
52. (C) Brewster angle is not valid only for perfect conductor
53. (B) $k_1 = \frac{1}{4\pi \epsilon_0}$ $k_2 = \frac{\mu_0}{4\pi}$
 $\sqrt{k_1 k_2} = \sqrt{\frac{\mu_0}{\epsilon_0}} \rightarrow$ Resistance
54. (A) $V = \frac{1}{4\pi \epsilon} \int \frac{P dv}{r}$
 $A = \frac{\mu}{4\pi} \int \frac{Idl}{r} = \frac{\mu}{4\pi} \int \frac{dq}{dt} \cdot \frac{dl}{r}$
 $A = \frac{\mu}{4\pi} \cdot \frac{q\vec{v}}{r}$
55. (B)
56. (A)
57. (A) $\vec{H} = \frac{\vec{J} \times \vec{r}}{2}$





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$$\vec{H}_1 = \frac{\vec{J} \times \vec{OP}}{2}$$

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

$$\vec{H} = \vec{H}_1 + \vec{H}_2 \quad \vec{H} = \frac{\vec{J} \times (\vec{OP} - \vec{O'P})}{2} = \frac{\vec{J} \times \vec{d}}{2}$$

58. (B)

59. (D)

60. (B)