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Important Questions *for* GATE 2022

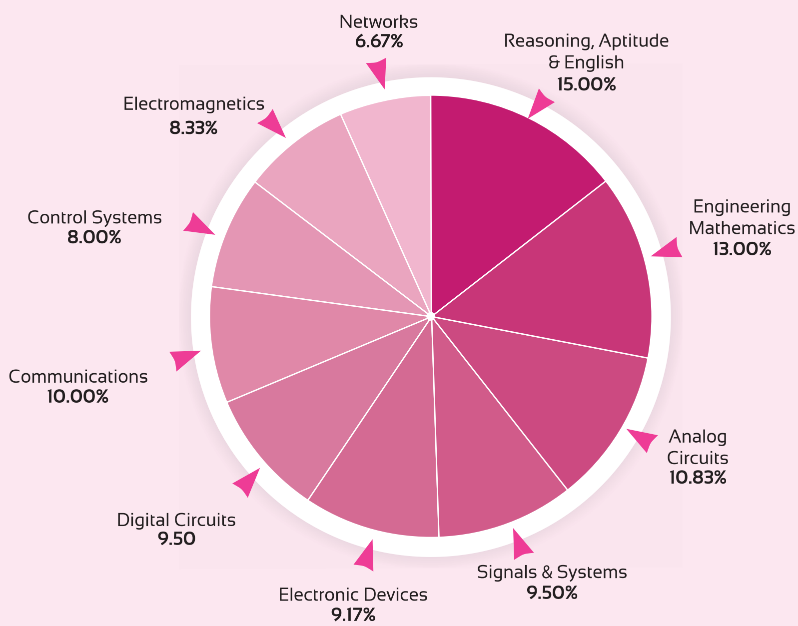
ELECTRONICS ENGINEERING

Day 6 of 8

Q.126 - Q.150 (Out of 200 Questions)

Communications and Electromagnetics

SUBJECT-WISE WEIGHTAGE ANALYSIS OF GATE SYLLABUS



Subject	Average % (last 5 yrs)*
Reasoning, Aptitude & English	15.00%
Engineering Mathematics	13.00%
Analog Circuits	10.83%
Signals & Systems	9.50%
Electronic Devices	9.17%
Digital Circuits	9.50%
Communications	10.00%
Control Systems	8.00%
Electromagnetics	8.33%
Networks	6.67%
Total	**100%**

Communications and Electromagnetics

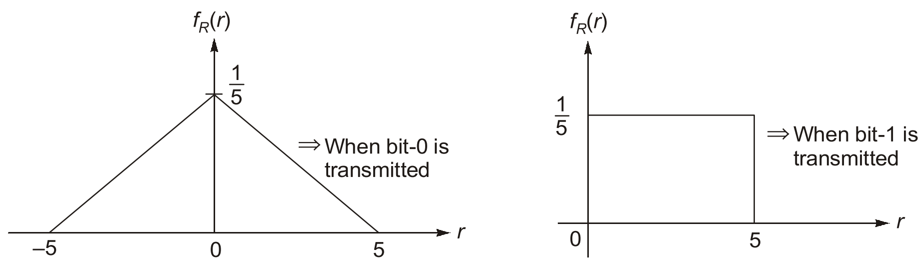
Q.126 The parity-check matrix of a (6, 3) linear block code is given by,

$$H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

If the code word received by the receiver is [001110], then the syndrome vector corresponding to the received code word will be equal to

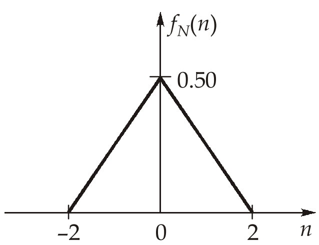
(a) [000] (b) [100]
(c) [101] (d) [110]

Q.127 In a binary baseband communication system, bit-0 and bit-1 are transmitted with probabilities 0.6 and 0.4 respectively. The received signal PDFs for both the bits are given below.



Bits are decided at the output of the receiver by comparing the received signal with a threshold value. If the optimum threshold is decided using MAP criteria, then the probability of error in producing the bits at output of the receiver is equal to ________ .
[Round-off your answer to 2 decimal places]

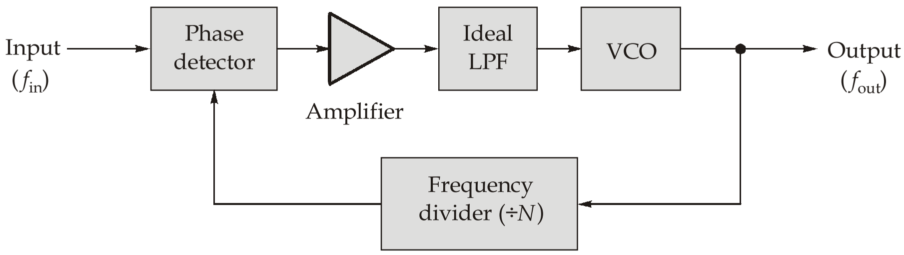
Q.128 The variable at the input of a threshold detector is given by, $R = X + N$. Here $X \in (-\alpha, +\alpha)$ is the transmitted symbol and N is an independent random variable whose probability density function is shown below:



The probability of transmitting $X = +\alpha$ is "P" and "α" is a positive real value. To get zero probability of error in decision making, the minimum value of "α" should be

(a) 1 (b) 2
(c) 4 (d) depends on the value of "P"

Q.129 Consider the block diagram of a frequency synthesizer consisting of a phase locked loop (PLL) as shown below:



If the reference input frequency (f_{in}) to the above synthesizer is 0.48 MHz and the frequency divider in the feedback path has N = 50, then the steady state output frequency (f_{out}) will be ____________ MHz.

Q.130 The modulation index of a single-tone amplitude modulated (AM) signal is increased from 0.20 to 0.25. The corresponding percentage increase in the transmission power efficiency of the AM signal is _________ %.

Q.131 A data with a rate of 400 kbps is to be transmitted using M-ary PSK modulation through a channel whose bandwidth is 100 kHz. If the baseband modelling of the data is done by a raised cosine filter with a roll-off factor of 0.50, then the minimum value of 'M' required to feasible the transmission will be

(a) 16 (b) 32
(c) 64 (d) 128

Q.132 A TE mode operating at 4 GHz is propagated in the airfilled wave guide.

If, $\vec{H}_z = 4\cos\left(\frac{3\pi}{a}x\right)\cdot\cos\left(\frac{\pi}{b}y\right)\cos(\omega t - 40z)\,\hat{a}_z$ A/m, then the cutoff frequency of the wave is

(a) 2.85 GHz (b) 3.51 GHz
(c) 3.89 GHz (d) 4.52 GHz

Q.133 The samples of a sinusoidal message signal $m(t) = 2\cos(200t)$ V are applied to a delta modulator, whose step size is 1 V. The minimum sampling rate required to eliminate the slope-overload distortion, for the given message signal, is __________ samples/s.

Q.134 The characteristic impedance of a $\frac{\lambda}{8}$ transmission line is given by 50 Ω. If the load impedance of this line is given by Z_L = (40 + jX) Ω then the value of 'X' such that the input impedance of this line becomes real is

(a) 45 Ω (b) 90 Ω
(c) 180 Ω (d) 30 Ω

Q.135 A dielectric material has relative permittivity of 18. If the loss tangent is 10^{-3} at 100 MHz then the distance over which the wave amplitude reduces to $1/e$ of its original amplitude will be

(a) 225.22 m (b) 318.12 m
(c) 444.42 m (d) 582.62 m

Q.136 A lossless transmission line having Z_0 = 75 Ω, and VSWR = 3. The first voltage minima occurs at a distance of 20 cm from the load end. If the operating frequency is 150 MHz then the load impedance is __________ Ω.

Q.137 At 3 GHz a certain material has $\varepsilon_r = 2$, $\mu_r = 1$ and $\tan\theta = 10^{-3}$. The distance travel by a uniform plane wave before its power gets reduces by 20% is ________ m.

Q.138 Given that,

$$\vec{E} = 50\pi e^{j(\omega t - \beta z)}\hat{a}_x \text{ V/m}$$

and $\vec{H} = H_m e^{j(\omega t - \beta z)}\hat{a}_y$ A/m

in free space, if $\omega = 10^9$ then, the value of H_m is

(a) $-\frac{5}{12}$ (b) $\frac{5}{12}$

(c) $\frac{12}{50}$ (d) $-\frac{50}{12}$

Q.139 An electromagnetic wave travelling in free space is incident normally on the interface with a perfect dielectric with $\varepsilon_r = 5$. If the incident electric field in medium 1 is given by $E_i = 1.5$ mV/m then the transmitted magnetic field is

(a) $5.49\,\frac{\mu A}{m}$ (b) $2.42\,\frac{\mu A}{m}$

(c) $3.97\,\frac{\mu A}{m}$ (d) $8.89\,\frac{\mu A}{m}$

Q.140 A 50 Ω transmission line is connected to a parallel combination of a 100 Ω resistance and 1 nF capacitance. The VSWR on the line at a frequency of 2 MHz is

(a) 1.245 (b) 2.945

(c) 5.89 (d) 4.169

Q.141 A fiber has refractive indices of core is 1.47 and cladding is 1.46 respectively. The minimum angle at which the ray will strike the core-cladding interface to be guided in the core is __________ (degree).

Q.142 A plane wave in free space has an average Poynting vector of 1 W/m^2. The average energy density is

(a) 1.1 nJ/m^3 (b) 2.2 nJ/m^3

(c) 3.3 nJ/m^3 (d) 4.4 nJ/m^3

Q.143 The maximum electric field strength impressed on a half wave dipole is 5 mV/m at 40 MHz. If the directivity of half wave dipole is 1.64 then, the maximum power received by the antenna is

(a) 33.15 nW (b) 54.36 nW

(c) 130.47 nW (d) 243.35 nW

Q.144 A homogeneous non conducting medium has $\mu_r = 1$. If the electric field and magnetic field of the medium is respectively.

$$\vec{E} = 85\pi e^{j(wt-(2/3)y)}\,\hat{a}_z \text{ V/m} \quad \text{and} \quad \vec{H} = 2.5e^{j(\omega t-(2/3)y)}\,\hat{a}_x \text{ V/m}$$

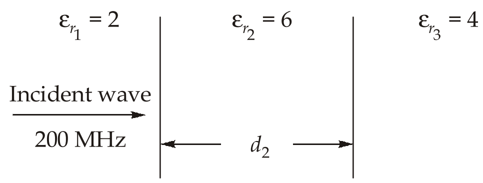
Then the frequency ω will be __________ Mrad/sec.

Q.145 A uniform plane wave in a lossy medium has phase constant of 1.6 rad/s, at 10^7 Hz. If its magnitude is reduced by 60% in every 2 meter travelled, the skin depth will be

(a) 0.625 m
(b) 2.18 m
(c) 3.91 m
(d) 5.52 m

Q.146 A circularly polarized plane wave is incident at an angle of 63° to the normal to an air dielectric interface. If the reflected wave is linearly polarized then the relative dielectric constant of the medium is __________.

Q.147 The three regions shown below are lossless and non-magnetic. The standing wave ratio for E in the left region when d_2 equal to zero will be ___________.

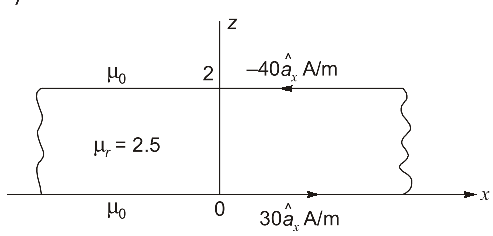


Q.148 For a fiber having $\eta_{core} = 1.47$ and $\eta_{cladding} = 1.45$, the maximum value of core radius for single mode operation will be __________ μm.
(Assume λ = 1.6 μm).

Q.149 A 50 Ω distortionless transmission line has capacitance of 15 nF/m. If the attenuation on the line is 1.2×10^{-3} Np/m then the resistance per unit length will be ___________ mΩ/m.

Multiple Select Questions (MSQ)

Q.150 In the figure given, the region $0 \le z \le 2$ is filled with an infinite slab of magnetic material with $\mu_r = 2.5$. The surface of the slab at $z = 0$ and $z = 2$ respectively, carry surface current $30\hat{a}_x$ A/m and $-40\hat{a}_x$ A/m as shown:-



(a) In the region $0 < z < 2$, $\vec{H} = 35\,\hat{a}_y$ A/m

(b) In the region $z < 0$, $\vec{H} = -5\,\hat{a}_y$ A/m

(c) In the region $z > 2$, $\vec{H} = 5\,\hat{a}_y$ A/m

(d) The magnitude of $\vec{H}$ is directly proportional to μ_r in the region $0 < z < 2$.

■■■■

Detailed Explanations

126. (b)

If the received code vector is r and the parity-check matrix is H, then the syndrome vector can be can be given as,

$$s = rH^T$$

$$= [0\,0\,1\,1\,1\,0]\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix} = [1\,0\,0]$$

Note : In the problems related to linear block codes, use Ex-OR operation, whenever there is an addition operation of bits.

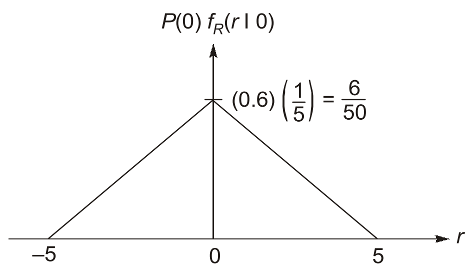
127. (0.27) (0.25 to 0.29)

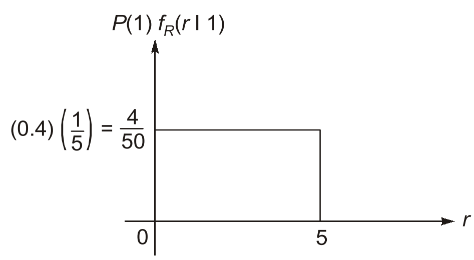
MAP criteria,

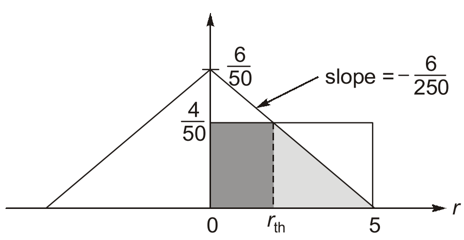
$$f_R(r|0)P(0) \underset{H_1}{\overset{H_0}{\gtrless}} f_R(r|1)P(1)$$

Given that, $P(0) = 0.6$ and $P(1) = 0.4$

Optimum threshold exists at the intersection of the curves, $f_R(r|0)\,P(0)$ and $f_R(r|1)\,P(1)$







$$-\frac{6}{250}r_{th} + \frac{6}{50} = \frac{4}{50}$$

$$\frac{6}{5}r_{th} = 2$$

$$r_{th} = \frac{10}{6} = \frac{5}{3}$$

Probability of error, P_e = sum of two shaded areas

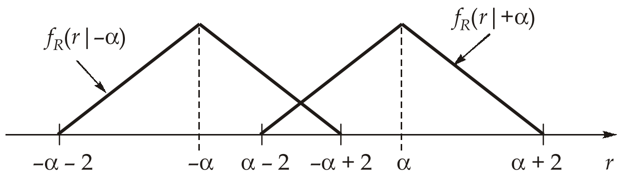
$$P_e = \frac{4}{50}(r_{th}) + \frac{1}{2}\times(5-r_{th})\left(\frac{6}{250}\right)(5-r_{th})$$

$$= \left(\frac{4}{50}\times\frac{5}{3}\right)+\frac{1}{2}\left(5-\frac{5}{3}\right)^2\left(\frac{6}{250}\right)$$

$$= \frac{4}{30}+\frac{4}{30} = \frac{8}{30}=\frac{4}{15}\simeq 0.27$$

128. (b)

Probability of error on decision making will be zero, when there will not be any common area between $f_R(r|-\alpha)$ and $f_R(r|+\alpha)$ as shown below.



To avoid the intersection of the two PDFs,

$$(\alpha - 2) \geq (-\alpha + 2)$$

$$2\alpha \geq 4$$

$$\alpha \geq 2$$

$$\alpha_{min} = 2$$

129. (24) (23.90 to 24.10)

For the given frequency synthesizer, in the steady state,

$$\frac{f_{out}}{N} = f_{in}$$

$$f_{out} = Nf_{in} = 50 \times 0.48 = 24 \text{ MHz}$$

130. 54.60 (53 to 56)

When μ = 0.20, $$\eta_1 = \frac{\mu^2}{2+\mu^2}=\frac{0.04}{2.04}=0.0196$$

When μ = 0.25, $$\eta_2 = \frac{\mu^2}{2+\mu^2}=\frac{0.0625}{2.0625}=0.0303$$

$$\%\text{Increase in the efficiency} = \frac{\eta_2-\eta_1}{\eta_1}\times 100\%$$

$$= \frac{0.0303-0.0196}{0.0196}\times 100\%$$

$$\approx 54.6\%$$

131. (c)

BW of the M-PSK signal, when the baseband modelling is done by a raised cosine filter is,

$$(\text{BW})_{M\text{-PSK}} = \frac{R_b(1+\alpha)}{\log_2(M)}$$

For feasibility of transmission,

$$(\text{BW})_{M\text{-PSK}} \le (\text{BW})_{\text{channel}}$$

$$(\text{BW})_{M\text{-PSK}} \le 100 \text{ kHz}$$

$$\frac{400(1+0.50)}{\log_2(M)} \le 100$$

$$\log_2(M) \ge 4(1.50) = 6$$

$$M \ge 2^6 = 64$$

$$M_{\min} = 64$$

132. (b)

Here, $m = 3$ and $n = 1$

$$\beta_g = 40 \text{ rad/m}$$

and $$\beta = \frac{\omega}{v_p} = \frac{2\pi f}{v_0} = \frac{2\pi\times 4\times 10^9}{3\times 10^8} = 83.77 \text{ rad/m}$$

$\because$ $$\beta_g = \beta\sqrt{1-\left(\frac{f_c}{f}\right)^2}$$

$\therefore$ $$\left(\frac{\beta_g}{\beta}\right)^2 = 1-\left(\frac{f_c}{f}\right)^2$$

$\Rightarrow$ $$\left(\frac{40}{83.77}\right)^2 = 1-\left(\frac{f_c}{4}\right)^2$$

$$\left(\frac{f_c}{4}\right)^2 = 0.772$$

or $$f_c = \sqrt{0.772}\times 4 \text{ GHz} = 3.51 \text{ GHz}$$

133. (400)

The condition required to eliminate the slope-overload distortion is,

$$\frac{\Delta}{T_s} \ge \left|\frac{dm(t)}{dt}\right|_{\max}$$

$$\left|\frac{dm(t)}{dt}\right|_{\max} = \left|400\sin(200t)\right|_{\max} = 400 \text{ V/s}$$

So, $$\Delta f_s \ge 400 \text{ V/s}$$

$$f_s \ge \frac{400}{\Delta} = 400 \text{ samples/s} \qquad \because \Delta = 1 \text{ V}$$

So, $$f_{s(\min)} = 400 \text{ samples/s}$$

134. (d)

Input impedance of the transmission line is

$$Z_{in} = Z_0\left(\frac{Z_L + jZ_0 \tan\beta L}{Z_0 + jZ_L \tan\beta l}\right)$$

For $l = \frac{\lambda}{8}$, then $\beta l = \frac{2\pi}{\lambda}\times\frac{\lambda}{8} = \frac{\pi}{4}$

$$Z_{in} = Z_0\left(\frac{Z_L + jZ_0}{Z_0 + jZ_L}\right)$$

$$= 50\left(\frac{40 + jX + j50}{50 + j(40 + jX)}\right) = 50\left(\frac{40 + j(50 + X)}{50 + j40 - X}\right)$$

$$= 50\left(\frac{40 + j(50 + X)}{(50 - X) + j40}\right)$$

$$= 50\frac{[40 + j(50 + X)][(50 - X) - j40]}{(50 - X)^2 + 40^2}$$

$$Z_{in} = 50\left(\frac{40\left[(50 - X) + j(50^2 - X^2) - 40^2 j + (50 + X)40\right]}{(50 - X)^2 + 40^2}\right)$$

Thus, for Z_{in} to be real, the imaginary part must be equal to zero.

Thus, $50^2 - X^2 - 40^2 = 0$

$X^2 = 900$

$X = 30\ \Omega$

135. (a)

$$\tan\delta = \frac{\sigma}{\omega\varepsilon}$$

$$\sigma = \omega\varepsilon \tan\delta$$
$$= 2\pi f\, \varepsilon_0\, \varepsilon_r \tan\delta$$
$$= 2\pi \times 100 \times 10^6 \times 18 \times 8.854 \times 10^{-12} \times 10^{-3}$$
$$= 10^{-4}\ \mho/\text{m}$$

$\because$ tan δ << 1, the dielectric is a low loss dielectric,

$\therefore$
$$\alpha = \frac{\sigma}{2}\sqrt{\frac{\mu}{\varepsilon}} = \frac{\sigma}{2}\sqrt{\frac{\mu_0}{\varepsilon_0\varepsilon_r}}$$

$$= \frac{10^{-4}}{2}\times 120\pi \times \frac{1}{\sqrt{18}} = 4.44 \times 10^{-3}\ \text{N/m}$$

$\therefore$ distance over which the wave amplitude reduces to $1/e$ of its original value is $\frac{1}{\alpha} = 225.22$ m.

136. (32.88) (30 to 34)

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{150\times10^6} = 2 \text{ m}$$

For the first minimum voltage,

$$2\,\beta\, x_{min} - \theta = \pi$$

$$2\times\frac{2\pi}{\lambda}\times0.2-\theta = \pi$$

or $$\theta = -0.6\pi = -108°$$

and $$\Gamma = \frac{S-1}{S+1} = \frac{3-1}{3+1} = \frac{1}{2}$$

$\because$ $$|\Gamma|e^{j\theta} = \frac{Z_L - Z_0}{Z_L + Z_0}$$

$$\therefore 0.5\,(\cos 108° - j\sin 108°) = \frac{Z_L - 75}{Z_L + 75}$$

on solving for magnitude,

$$|Z_L| = 32.88\ \Omega$$

137. 2.518 (2.1 to 2.9)

$$P = P_0\, e^{-2\alpha Z}$$

$$(1 - 0.2)P_0 = P_0\, e^{-2\alpha Z}$$

$$0.8\, P_0 = P_0\, e^{-2\alpha Z}$$

or $$e^{2\alpha Z} = 1.25$$

or $$2\alpha Z = 1.25$$

$$Z = \frac{1}{2\alpha}\ln(1.25) = \frac{\ln(1.25)}{2\times\alpha}$$

where, $$\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+(\sigma/\omega\in)^2}-1\right)}$$

$$\alpha = \frac{2\pi\times3\times10^9}{c}\sqrt{\frac{\mu_r\varepsilon_r}{2}\left(\sqrt{1+10^{-6}}-1\right)}$$

$$= \frac{6\pi\times10^9}{3\times10^8}\sqrt{\frac{2}{2}\times4.99\times10^{-7}}$$

or $$\alpha = 0.0443$$

$\therefore$ $$Z = \frac{\ln(1.25)}{2\times0.0443} = 2.518 \text{ m}$$

138 . (b)

from wave equation, we know that,

$$\frac{E}{H} = \eta = 120\pi \text{ (in free space)}$$

$\therefore$ $$\frac{50\pi}{H_m} = 120\,\pi$$

or $$H_m = \pm\frac{5}{12}\text{ A/m}$$

also, $$\nabla\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$$

$\therefore$ $$\nabla\times\vec{E} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & 0 & 0 \end{vmatrix}$$

$$= -50\pi\beta e^{j(10^9 t - \beta z)}\hat{a}_y \quad \text{...(i)}$$

and $$-\frac{\partial\vec{B}}{\partial t} = -\frac{\partial}{\partial t}\mu\vec{H}$$

$$= -\mu_0\frac{\partial}{\partial t}\left(H_m e^{j(10^9 t - \beta z)}\right)\hat{a}_y$$

$$= -j\times 10^9\times\mu_0\times H_m e^{j(10^9 t - \beta z)}\hat{a}_y \quad \text{...(ii)}$$

from equation (i) and (ii)

$$-50\pi\,\beta e^{j(10^9 - \beta z)} = -j\times 10^9\,\mu_0\times H_m e^{j(10^9 t - \beta z)}$$

it is clearly seen that H_m must be positive.

139. (a)

$$\eta_1 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi\ \Omega = 377\ \Omega$$

$$\eta_2 = \sqrt{\frac{\mu}{\varepsilon}} = 120\pi\frac{1}{\sqrt{\varepsilon_r}} = \frac{120\pi}{\sqrt{5}} = 168.59\ \Omega$$

$\therefore$ $$T = \frac{E_t}{E_i} = \frac{2\eta_2}{\eta_1+\eta_2} = \frac{2\times 168.59}{168.59+377} = 0.618$$

Therefore, $$E_t = 0.618\times 1.5 = 0.927\text{ mV/m}$$

and transmitted magnetic field $= H_t = \frac{E_t}{\eta_2} = \frac{0.927}{168.59}$

$$H_t = 5.49\ \mu\text{A/m}$$

140. (b)

The load Z_L is a parallel combination of R = 100 Ω and C = 1 nF

$\therefore$ $$Z_L = \frac{R}{1+j\omega RC} = \frac{100}{1+j2\pi\times 2\times 10^6\times 100\times 10^{-9}}$$

$$= \frac{100}{1+0.4\pi j} = 38.77 - j48.72$$

$\therefore$ $$\Gamma_r = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{38.77 - j48.72 - 50}{38.77 - j48.72 + 50}$$

$$= \frac{-11.33 - j48.72}{88.77 - j48.72} = \frac{50.02\angle 76.90°}{101.26\angle -28.95°}$$

$$= 0.493\angle 105.66°$$

$$= (0.134 - j0.475)$$

$$\therefore \quad \text{VSWR} = \frac{1+|\Gamma_r|}{1-|\Gamma_r|} = \frac{1+0.493}{1-0.493} \approx 2.945$$

141. 83.31 (83.00 to 83.50)

The minimum angle is the critical angle for total internal reflection at core cladding interface.

$$\therefore \quad \phi_c = \sin^{-1}\left(\frac{n_{\text{cladding}}}{n_{\text{core}}}\right)$$

$$= \sin^{-1}\left(\frac{1.46}{1.47}\right) = 83.31°$$

142. (c)

$$\because \quad \eta = \frac{E}{H}$$

$$\text{or} \quad H = \frac{E}{\eta}$$

$$\because \quad P = E \times H$$

and energy density $W = \mu H^2$

$$P = \eta \times H^2$$

$$= \eta \times \frac{W}{\mu} = \eta_0 \sqrt{\frac{\mu_r}{\varepsilon_r}} \times \frac{W}{\mu}$$

$$W = \frac{P}{v_0} = \frac{1}{3\times 10^8} = 3.3\ \text{nJ/m}^3$$

143. (d)

$$P_r = P_i A_e = P_i \times \frac{\lambda^2}{4\pi} G_d$$

$$\text{but} \quad \lambda = \frac{c}{f} = \frac{3\times 10^8}{40\times 10^6} = 7.5\ \text{m}$$

$$G_{d\,\max} = D = 1.64$$

$$\text{and} \quad P_i = \frac{E^2}{2\eta} = 3.315\times 10^{-8}$$

$$\text{and} \quad P_{r\,\max} = P_i \times \frac{\lambda^2}{4\pi} G_{d\,\max}$$

$$\therefore \quad P_{r\,\max} = 3.315\times 10^{-8} \times \frac{(7.5)^2}{4\pi} \times 1.64$$

$$= 2.4 \times 10^{-7} = 243.35\ \text{nW}$$

144. 56.818 (56.50 to 57.50)

$$\frac{\omega}{\beta} = \frac{3\times10^8}{\sqrt{\varepsilon_r}}\ \text{m/s}$$

or $$\omega = \frac{\frac{2}{3}\times3\times10^8}{\sqrt{\varepsilon_r}} \quad ...(i)$$

$\because$ $$\frac{E}{H} = \eta = \eta_0\sqrt{\frac{1}{\varepsilon_r}}$$

$\therefore$ $$\frac{85\pi}{2.5} = \frac{120\pi}{\sqrt{\varepsilon_r}}$$

$$\sqrt{\varepsilon_r} = \frac{120\pi}{106.81} = 3.52$$

or $$\varepsilon_r = 12.46$$

and $$\omega = \frac{2\times10^8}{\sqrt{\varepsilon_r}} = \frac{2\times10^8}{3.52} = 56.818\ \text{Mrad/sec}$$

145. (b)

$$\beta = 1.6\ \text{rad/s}$$

and $$f = 10^7\ \text{Hz}$$

Here, the reduction in magnitude is 60% in 2 m.

$\therefore$ $$0.4E = Ee^{-2\alpha}$$

$$-2\alpha = \ln(0.4)$$

or $$\alpha = 0.458$$

$\therefore$ $$\text{Skin depth} = \frac{1}{\alpha} = 2.18\ \text{m}$$

146. 3.85 (3.50 to 4.00)

$$\tan\theta_B = \sqrt{\frac{\varepsilon_{r_2}}{\varepsilon_{r_1}}}$$

Here, $$\theta_B = 63°$$

and $$\varepsilon_{r_1} = 1$$

$\therefore$ $$\sqrt{\varepsilon_r} = \tan63° = 1.96$$

and $$\varepsilon_r = 3.85$$

147. 1.41 (1.00 to 2.00)

Here, frequency = 200 MHz and $\sigma = 0$

Since $d_2 = 0$, $$\Gamma = \frac{\eta_2-\eta_1}{\eta_2+\eta_1} = \frac{\sqrt{\varepsilon_2}-\sqrt{\varepsilon_1}}{\sqrt{\varepsilon_2}+\sqrt{\varepsilon_1}} = \frac{\sqrt{4}-\sqrt{2}}{\sqrt{4}+\sqrt{2}} = 0.1716$$

$\therefore$ $$S = \frac{1+|\Gamma|}{1-|\Gamma|} = \sqrt{2} = 1.41$$

148. **2.534 (2.20 to 2.80)**

The V parameter and core radius a are related as

$$V = \frac{2\pi}{\lambda} \times a \times \sqrt{\eta_{core}^2 - \eta_{clad}^2}$$

The maximum value of core radius for single mode operation corresponds to the V_{cut} of 2.405.

$$\therefore \quad 2.405 = \frac{2\pi}{1.6 \times 10^{-6}} \times a_{max} \times \sqrt{(1.47)^2 - (1.45)^2}$$

$$2.405 = 949 \times 10^3\, a_{max}$$

or, $$a_{max} = \frac{2.405 \times 10^{-3}}{949} = 2.534\ \mu m$$

149. **(60)**

For a distortionless transmission line

$$\frac{R}{L} = \frac{G}{C}$$

∵ Characteristic impedance,

$$Z_0 = \sqrt{\frac{L}{C}} = 50\ \Omega$$

And the attenuation, $$\alpha = R\sqrt{\frac{C}{L}}$$

$$R = \alpha\sqrt{\frac{L}{C}} = \alpha \times Z_0$$

$$= 1.2 \times 10^{-3} \times 50 = 60\ m\Omega/m$$

150. **(b, c)**

The magnetic field intensity due to an infinite sheet of current is given by

$$\vec{H} = \frac{1}{2}\vec{K} \times \hat{a}_n \qquad \vec{K} = \text{current density vector in A/m}$$

In the region $0 < z < 2$,

$$\vec{H} = \vec{H}_1 + \vec{H}_2$$

$$= \frac{1}{2}(-40\hat{a}_x \times -\hat{a}_z) + \frac{1}{2}(30\hat{a}_x \times \hat{a}_z)$$

$$\vec{H} = -35\hat{a}_y \text{ A/m}$$

In the region, $z < 0$

$$\vec{H} = \overrightarrow{H_1} + \overrightarrow{H_2}$$

$$= \frac{1}{2}(-40 + 30)\hat{a}_x \times (-\hat{a}_z) = -5\hat{a}_y \text{ A/m}$$

In the region, $z > 2$

$$\vec{H} = \overrightarrow{H_1} + \overrightarrow{H_2}$$

$$= \frac{1}{2}(-40 + 30)\hat{a}_x \times \hat{a}_z = 5\hat{a}_y \text{ A/m}$$

$\vec{H}$ is independent of μ_r whereas $\vec{B} = \mu\vec{H}$ depends on μ_r.

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