Ques. 1.

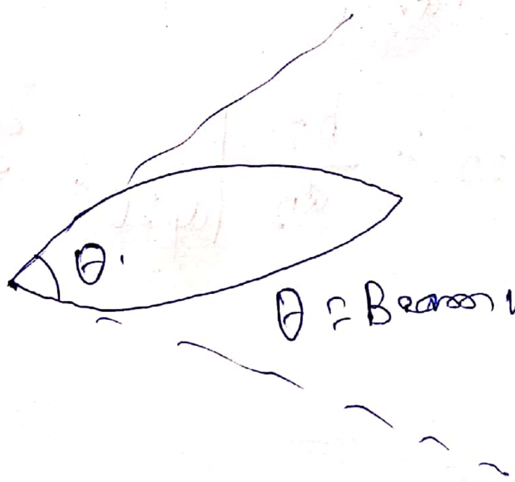
I - a , II - a , III - c , IV - a

Ques. (2)

Solⁿ:- Advantages of microwave :-

(i) It increases the B.W. availability.
(ii) Directivity increases.
(iii) Size of components decreases.
(iv) Fadding effect and Reliability improves.
(v) Transmitter / Receiver power requirement are low at microwave frequency.
(vi) Transparency properties of microwave.

As we know, Directivity $\propto \frac{1}{\text{Beam width}}$



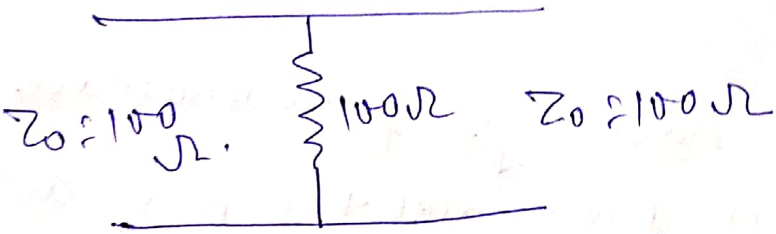
θ = Beam width.

If frequency increases, wavelength (λ) will decreases.

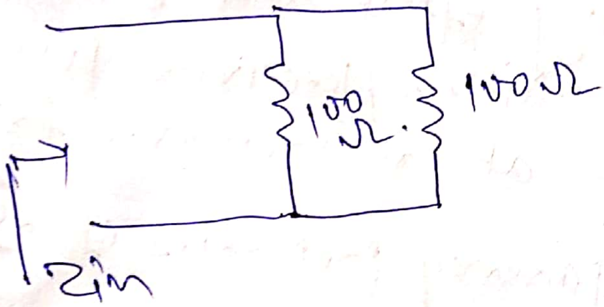
And Beam width is directly proportional to λ So, thus Beam width decreases.

∴ Directivity will increased.

Ans: (B)



To calculate S_{11}, terminate port to in 100Ω.



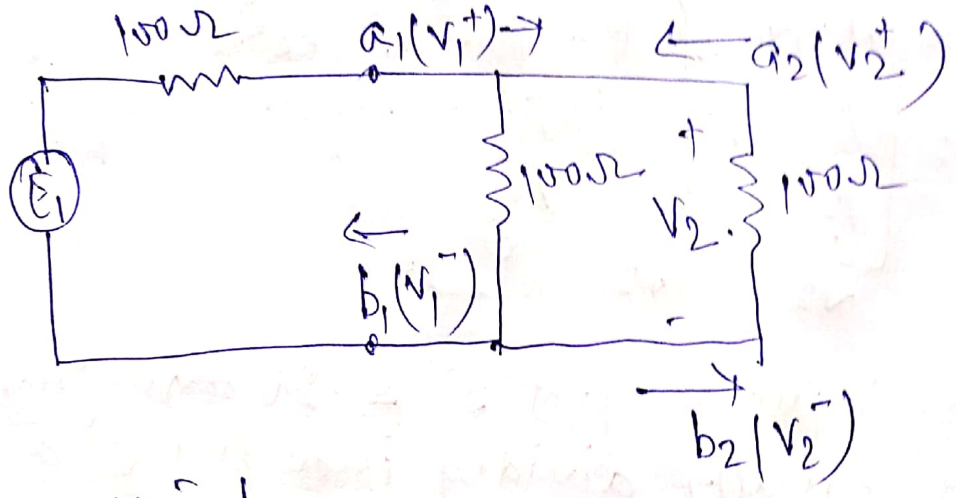
Zin = 50 Ω.

$$S_{11} = \frac{b_1}{a_1}\Big|_{a_2=0} = \frac{Z_{in}-Z_0}{Z_{in}+Z_0} = \frac{50-100}{50+100} = -1/3$$

Similarly, $S_{22} = \frac{b_2}{a_2}\Big|_{a_1=0} = \frac{Z_{out}-Z_0}{Z_{out}+Z_0} = -1/3$

$$S_{21} = \frac{b_2}{a_1}\Big|_{a_2=0}$$

Terminate port-2 in 100Ω and drive port 1 with 100Ω generator of open circuit voltage E_1



$$S_{21} = \left.\frac{V_2^-}{V_1^+}\right|_{V_2^+=0}, \quad I = \frac{E_1}{Z_0 + Z_{in}}$$

$V_2 = V_2^- + V_2^+$; since $V_2^+ = 0$, $V_2^- = \frac{I}{2} \times Z_0$

$= 50 I$.

$$V_1 = V_1^+ + V_1^- = V_1^+(1 + S_{11})$$

$$Z_{in} I = V_1^+(1+S_{11})$$

$$\therefore V_1^+ = \frac{Z_{in}}{(1+S_{11})} I.$$

$$\therefore S_{21} = \frac{\cancel{I}/2 \, Z_0 \,(1+S_{11})}{Z_{in} \cdot \cancel{I}} = \frac{Z_0}{2 Z_{in}}(1+S_{11})$$

$$= \frac{100}{2 \times 50}(1 - 1/3) = 1 - 1/3 = 2/3$$

Similarly, $S_{12} = 2/3$

$$\therefore [S] = \begin{bmatrix} -1/3 & 2/3 \\ 2/3 & -1/3 \end{bmatrix}$$ Ans.

OR..

S-matrix of E-plane Tee.

$$S = \begin{bmatrix} 1/2 & 1/2 & 1/\sqrt{2} \\ 1/2 & 1/2 & -1/\sqrt{2} \\ \frac{1}{\sqrt{2}} & -1/\sqrt{2} & 0 \end{bmatrix}$$

Now, input to port-3 is 20mw. This power gets equally divided into port-① and ② i.e. at port-1 and port-2, 10mw power will be delivered.

Since port-1 and port-2 have load of 60Ω and 75Ω respectively. Because of that that reflection will occur and some of the power gets reflected back.

If reflection co-efficient at port-1 is ρ_1 and ρ_2 at port-2.

Then, power delivered to load ① 60Ω at port-1.

$$= 10mw - 10mw\,\rho_1^2$$

$$= 10\left(1 - \left(\frac{60-50}{60+50}\right)^2\right) = 9.92\,mw. \text{ Ans.}$$

Power delivered to load 75Ω at port-2.

$$= 10mw\left(1 - \rho_2^2\right)$$

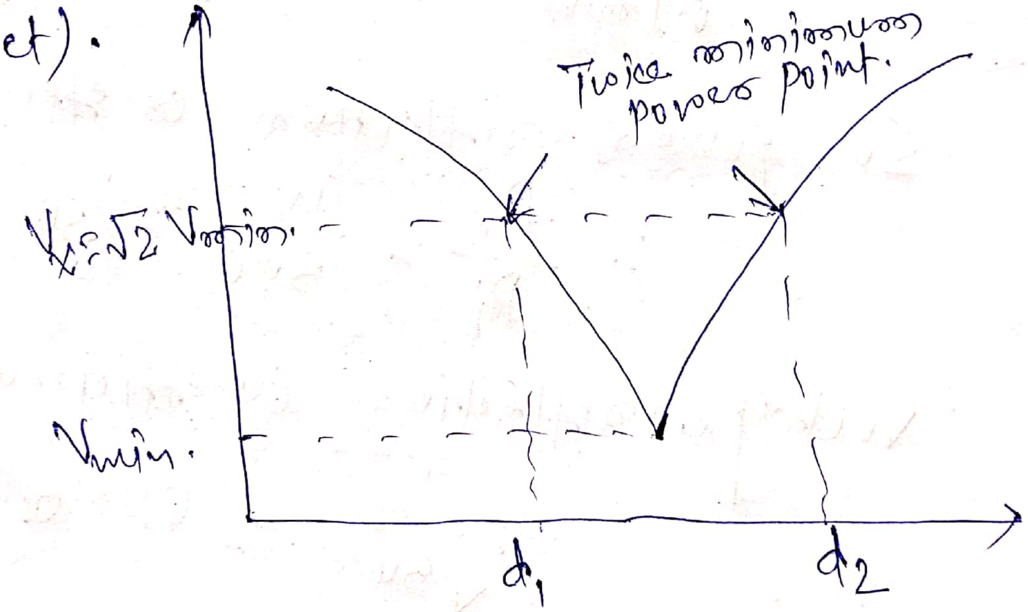
$$= 10mw\left[1 - \frac{(75-50)^2}{(75+25)^2}\right]$$

$$= 9.6\,mw. \text{ Ans.}$$

~~Reflected power goes to post~~

Ans. (4) (a)

Sol. → In double minimum method to measure VSWR, the probe is inserted to a depth where the min^m can be read out without difficulty. The probe is then moved to a point where power is twice the min^m. Let this position is 'd_1'. The ~~probe is mo~~ twice power point position is d_2 (let).



$$\therefore \; 2P_{min} \propto V_x^2$$

$$\frac{V_{min}^2}{V_x^2} = \frac{1}{2}$$

$$V_x = \sqrt{2}\, V_{min}$$

Further, $\lambda_c = 2a$ (for TE_{10})

$$\lambda_g = \frac{\lambda_0}{\sqrt{1 - (\lambda_0/\lambda_c)^2}}$$

Then VSWR, $= \dfrac{\lambda_g}{\pi(d_2 - d_1)}$

(4)(b) Given, Directivity = 20dB
$= 100$ (Linear scale)

$\therefore \dfrac{P_i}{3mW} = 100 \Rightarrow P_i = \underline{300 mW}$.

Now, $\dfrac{P_r}{0.1 mW} = 100 \quad \therefore P_r = 10 mW$

So, power reflection co-efficient,
$= \dfrac{P_r}{P_i} = \dfrac{10}{300} = 1/30$

voltage reflection co-efficient, $= \sqrt{\dfrac{P_r}{P_i}}$
$= \sqrt{\dfrac{1}{30}} = 0.1816$

VSWR $= \dfrac{1 + 0.1816}{1 - 0.1816} = \underline{1.44}$ $\underline{Ans.}$

(4) OR.

(a) Measurement of Impedance:-

(i) measurement of Impedance using Reflectometer

(ii) measurement of Impedance using slotted line.

(iii) measurement of Impedance using magic-T.

(b) Given, $f = 10\,GHz$, $a = 4\,cm$, $b = 2.5\,cm$.

λ_c (for TE_{10} mode) $= 2a = 8\,cm$.

$$\lambda_0 = \frac{c}{f} = \frac{3\times10^8}{10\times10^9} = 3\,cm.$$

$d_2 - d_1 = 1\,mm$.

We know that
$$\lambda_g = \frac{\lambda_0}{\sqrt{1-(\lambda_0/\lambda_c)^2}} = \frac{3}{\sqrt{1-(3/8)^2}}$$
$= 3.236\,cm$.

For double minimum method VSWR is given by,
$$VSWR = \frac{\lambda_g}{\pi(d_2-d_1)} = \frac{3.236}{\pi\times1\times10^{-1}} = 10.3.$$

(5) Given, $V_0 = 20kV$, $I_0 = 2$ amp, $f = 8GHz$
$\beta_i = \beta_0 = 1$, $\rho_0 = 10^{-6}\ C/m^3$, $V_1 = 10V$ (rms)
$R_{sh} = 10k\Omega$, $R_{shl} = 30k\Omega$.

(a) Plasma frequency, $(\omega_p) = \sqrt{\frac{e\rho_0}{m\epsilon_0}}$.

$$= \sqrt{\frac{1.7\times10^{11}}{8.85\times10^{-12}}\times10^{-6}} = 1.41\times10^{8}\ rad/sec.$$

(b) Reduced Plasma frequency of $R = 0.5$

$$\omega_q = R\,\omega_p = 0.705\times10^{8}\ rad/sec.$$

(c) Induced current in Output Cavity

$$(I_{2ind}) = \frac{1}{2}\beta_0^2\left(\frac{\omega}{\omega_q}\right)\cdot\frac{I_0}{V_0}|V_1|$$

$$= \frac{1}{2}\times1\times\left(\frac{2\pi\times8\times10^{9}}{0.705\times10^{8}}\right)\times\left(\frac{2}{20\times10^{3}}\right)\times10V$$

$$= 0.35565\ Amp.$$

(d) Induced voltage in output cavity,

$$V_{2ind} = I_{2ind}\cdot R_{shl} = 0.35565\times30$$

$$= 10.69\ kV$$

(e) Output Power delivered to the load.

$$= I_{2ind}^2 R_{SHL} = (0.35565)^2\times30 = 3.82\ KW.$$

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(5) OR.

Given, $N = 10$, $f = 3000\,MHz$, $a = 0.4\,cm$, $b = 0.9\,cm$

$l = 2.5\,cm$ (anode length)

$V_0 = 18\,KV$, $B = 0.2\,wb/m^2$.

(a) Angular velocity of electron

$$\omega = \frac{Bq}{m} = \frac{0.2 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$$= 0.2 \times 1.759 \times 10^{11}$$

$$= \cancel{5.9}\ .3518 \times 10^{11}\ rad/sec.$$

(b) Since the magnetic field is normal to ~~motti~~ motion of $\bar{e}$ ~~travell in a~~ $\bar{e}$ travell in a cycloidal path, then output centrifugal force is equal to pulling force.

$$\frac{mv^2}{R} = Bqv.$$

$$\frac{v}{R} = \frac{Bq}{m}.$$

$$R = \frac{vm}{Bq} = v/\omega$$

Now, $v = 0.593 \times 10^6 \sqrt{V_0} = 0.593 \times 10^6 \times \sqrt{18 \times 10^3}$

$= 79.55 \times 10^6.$

$\therefore R = 79.55 \times 10^6 / 0.3518 \times 10^{11} = 2.26\ mm.$

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