Solutions

Q. 1

a-) $F_{1,2} = F_1 + \dfrac{F_2 - 1}{G_1}$

$F_{1,2}$ 8 dB $\Rightarrow$ $F_{1,2} = 6.31$

$F_1 = 6\text{ dB}$ $\rightarrow$ $F_1 = 4$

$F_2 = 6\text{ dB}$ $\rightarrow$ $F_2 = 4$

$$6.31 = 4 + \frac{3}{G_1} \Rightarrow 2.31 = \frac{3}{G_1}$$

$$G_1 = \frac{3}{2.31} = 1.3 \text{ times} \Rightarrow 1.135\text{ dB}$$

But there are 4 dB cable losses and 6 dB divider loss. Therefore gain of the antenna amplifier must be

$4 + 6 + 1.135 = 11.135\text{ dB}$

b-)

$$F_{1,2} = 6.31 = \frac{S_i/N_i}{S_o/N_o} = \frac{S_i/kT_oB}{10^{20/10}}$$

$$6.31 = \frac{S_i}{100kT_oB} \Rightarrow S_i = 6.31 \times 100 \times 1.38 \times 10^{-23} \times 290 \times 5.5 \times 10^{6}$$

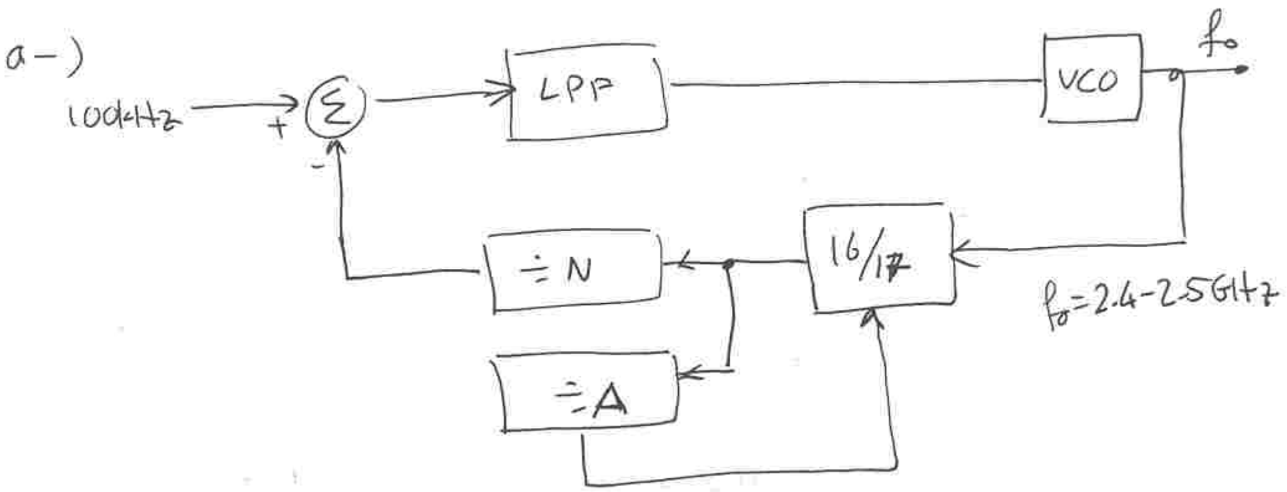
$S_i = 1.3889 \times 10^{-11}\text{ W} = 1.389 \times 10^{-8}\text{ mW}$

$$\boxed{S_i = 10 \times \log 1.389 \times 10^{-8} = -78.6\text{ dBm}}$$

Solutions

Q. 2

a-)

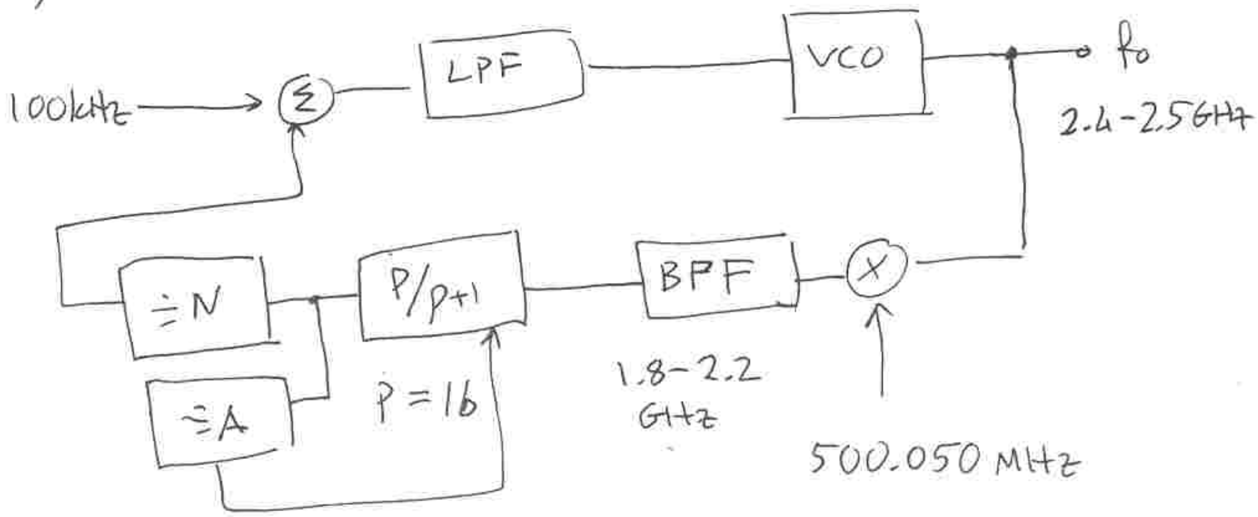


b-) $M = NP + A = \dfrac{2.455\ \text{GHz}}{0.0001\ \text{GHz}} = 24550$

$N = \dfrac{24550}{16} = 1534.375 \Rightarrow N = 1534$

$A = M - NP = 24550 - 1534 \times 16 = 6$

c-)



d-) $f_0 = 2455.05 \text{ MHz}$

$$f_{divider} = 2455.05 - 500.05$$
$$= 1955 \text{ MHz}$$

$$M = \frac{f_{divider}}{0.1 \text{MHz}} = \frac{1955}{0.1} = 19550$$

$$N = \frac{M}{P} = 1221.875 \Rightarrow N = 1221$$

$$A = M - NP = 19550 - 1221 \times 16 = 14$$

Solutions

Q.3

a-) $g_m > \dfrac{1}{R(n-n^2)}$

IV $R_p = (Q^2+1)R_I = 1501\,\Omega$

III $Q = \dfrac{wL_s}{R} = 38.73$

II $w_0 = \dfrac{1}{\sqrt{LC'}} = 387.3$ Mrad/sec

I $C_{eq} = \dfrac{C_1C_2}{C_1+C_2} = \dfrac{100 \times 200}{300} = 66.66$ pF

$f_0 = 61.64$ MHz

V $R_{eq} = 1500 // 10K = \dfrac{1500 \times 10}{11.5} = 1305\,\Omega$

$n = \dfrac{100}{100+200} = \dfrac{C_1}{C_1+C_2} = \dfrac{1}{3}$

$g_m > \dfrac{1}{1305\left(\frac{1}{3}-\frac{1}{9}\right)} = 3.45$ millisiemens

b-) $V_{tank} = 2I_{BIAS}R(1-n)$

$1V_{rms} \Rightarrow \sqrt{2}\,V$ peak

$\sqrt{2} = 2I_{BIAS} \times 1305(1-0.33)$

$I_{BIAS} = \dfrac{\sqrt{2}}{2 \times 1305 * 0.66} = 8.1 \times 10^{-4} = 0.81$ mA

Solutrons

Q-4

a-) This is a class-D amplifier. At Class-D amplifiers the output peak voltage is

$$V_{P_{output}} = \frac{4\,V_{DD}}{\pi}\,n \qquad \text{here } V_{DD} = 5V - 1V = 4V$$

because of the saturatron voltage

The ~~outptap~~ peak voltage required is

$$\frac{V_p^2}{2 \times 50\Omega} = 10W \Rightarrow$$

$$V_p^2 = 1000 \Rightarrow V_p = \sqrt{10} \times 10 = 31.6\,V_{peak}$$

Equatron both identities

$$\frac{4\,V_{DD}}{\pi}\,n = 31.6\,V$$

$$\Rightarrow \frac{4 \times 4}{\pi}\,n = 31.6V \Rightarrow \boxed{n = \frac{\pi \times 31.6}{16} = 6.21}$$

b-) Since Class-D amplifier has the effiency of 100% for the V_{DD} achievable, the amplifier must have $\frac{4}{5} = 80\%$ effrency because of the transistor saturatron voltage

$$\Rightarrow V_{DD} I_{DD} = \frac{10W}{0.8} = 12.5W$$

$$\boxed{I_D = \frac{12.5W}{5V} = 2.5A}$$

Solution

Q.5

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{300 \times 600}{900} = 200\,pF \qquad n = \frac{C_1}{C_1 + C_2} = \frac{300}{900} = 0.33$$

$$w_0 = \frac{1}{\sqrt{LC}} = 438.5 \text{ Mrad/sec}$$

$$f_0 = 69.795 \text{ MHz}$$

The output tank is tuned to the third harmonic of the input signal.

$$Q = \frac{R_{eq}}{wL} = \frac{450\Omega}{w \times 26nH} = 39.46$$

$$R_{eq} = 50 \times \frac{1}{n^2} = 50 \times 9 = 450\Omega$$

Since Q is high other harmonics including the fundamental are rejected.

$$V_{out} = I_{drain} \times 450\Omega \times \frac{1}{3}$$

$$I_{drain} = g_{m_{eff}} \times \frac{\theta_{gen}}{2} = \frac{g_m}{1 + g_m \times 500} \times \frac{\overset{2}{\cancel{6.28}} \times 4}{3\cancel{\pi}} \cdot \frac{1}{2}$$

$$= \frac{1}{2} \frac{\overset{2}{\cancel{6}} \times 10^{-3}}{\cancel{1+3}} \times \frac{\overset{2}{\cancel{8}}}{\cancel{3}} = \frac{4}{2} \times 10^{-3} A = 2 \times 10^{-3} A$$

$$\Rightarrow V_{out} = 2 \times 10^{-3} \times 450 \times \frac{1}{3} = 0.3 \, V_{peak}$$

$$P_{out} = \frac{(0.3)^2}{2 \times 50} = 0.9 \text{ mW} = -0.46 \text{ dBm}$$