1) a. $S = \frac{F d^2 L (2(1+\upsilon))}{2.25 a^4 E}$, $2a = 10\times10^{-6}\,\mu m \rightarrow a = 5\times10^{-6}\,\mu m$

$= \frac{(20\times10^{-6})(1\times10^{-3})^2(1\times10^{-3})(2(1+0.2))}{2.25(5\times10^{-6})^4(170\times10^9)}$

$= 200.78\,\mu m$ $\boxed{S = 200.78\,\mu m}$

b. $\Phi = \frac{S}{d} = \frac{200.78\times10^{-6}}{1\times10^{-3}} = 0.20078\ rad = 11.50^\circ$

2) $C_{PPA} = \frac{\varepsilon_0 \varepsilon_r A}{d} = \frac{(8.854\times10^{-12})(1)(500\times10^{-6})^2}{10\times10^{-6}} = 0.22135\,pF$

$C_s = \frac{1}{2} C_{PPA} = 0.110675\,pF$ $\boxed{C_s = 0.110675 pF}$

3) $F_s = F_{PPA}$

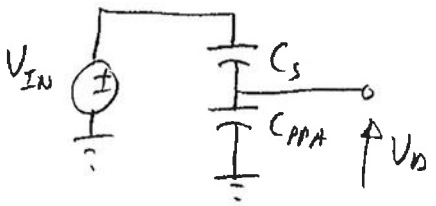
$Kx = \frac{\varepsilon_0 \varepsilon_r A V_0^2}{2(x_0 - x)^2}$

$V_0 = \sqrt{\frac{2(x_0-x)^2 Kx}{\varepsilon_0 \varepsilon_r A}}$

$= \sqrt{\frac{2(10\times10^{-6} - 5\times10^{-6})^2 (25)(5\times10^{-6})}{8.854\times10^{-12}(1)(500\times10^{-6})^2}}$

$= 53.14V$ $\boxed{V_0 = 53.14V}$

4)



at $X = 5\mu m \rightarrow C_{PPA}\big|_{X=5\mu m} = 2C_{PPA}\big|_{X=0\mu m} = 0.4427\,pF$

$V_D = \frac{V_{IN} C_s}{C_s + C_{PPA}}$

or $V_{IN} = \frac{V_D(C_s + C_{PPA})}{C_s} = \frac{53.14(0.110675 + 0.4427)}{0.110675} = 265.7V$

$\boxed{V_D = 265.7V}$

5) $F_{EL} = \frac{n\varepsilon_0\varepsilon_r A\beta}{2}\left[\frac{1}{(d_1-x)^2} - \frac{1}{(d_2+x)^2}\right]V^2$

$= \frac{25(8.854\times10^{-12})(1)(500\times10^{-6})(100\times10^{-6})(1.2)}{2}\left[\frac{1}{(10\times10^{-6}-0)^2} - \frac{1}{(15\times10^{-6}+0)^2}\right](10)^2$

$= 3.689\times10^{-6}\,N = 3.689\,\mu N$ $\boxed{F_{EL} = 3.689\,\mu N}$

6) $F_T = \frac{n\varepsilon_0\varepsilon_r b\beta V^2}{d_0}$

$= \frac{(25)(8.854\times10^{-12})(1)(100\times10^{-6})(1.2)(10)^2}{10\times10^{-6}}$

$= 2.656\times10^{-7}\,N = 0.265\,\mu N$ $\boxed{F_T = 0.265\,\mu N}$

7) $A\beta = A\left(\frac{1/RC}{s+1/RC}\right)^3 = 1\angle -180^\circ \Big|_{\omega=\omega_n}$

For each stage: $\theta = -60^\circ = -\tan^{-1}(\omega RC) = -\tan^{-1}(2\pi fRC)$

$C = \frac{\tan(60)}{2\pi fR} = \frac{\tan(60)}{2\pi(10{,}000)(1000)} = 27.566\,nF$

$A = \left[\left|\frac{1/RC}{j\omega + 1/RC}\right|\right]^{-3}$

$= \left(\frac{(RC)^{-1}}{\sqrt{(2\pi f)^2 + (RC)^{-2}}}\right)^{-3}$

$= \left[\frac{[(1000)(27.566\times10^{-9})]^{-1}}{\sqrt{[2\pi(10{,}000)]^2 + [(1000)(27.566\times10^{-9})]^{-2}}}\right]^{-3}$

$= 8\ V/V$

$\boxed{C = 27.566\,nF}$

$\boxed{A = 8\ V/V}$