Q1. (a) \( r_o = 50\, k\Omega, r_\pi = 1.25\, k\Omega, r_e = 12.5\, \Omega, g_m = 80 \, mA/V \)
(b) maximum symmetric voltage is ±4.3V, \( R_{\text{load}} = 86\, \Omega, \eta = 21.5\% \)
(c) \( \theta = 1.6^\circ C/W \)
(d) \( A = 19 \, dB \)
(e) sensitivity = 28

Q2. (b) \( \frac{v_o}{v_{b2}} = -g_{m2} \frac{R_o}{R_{\text{load}}} \), \( \frac{v_{b2}}{v_{b1}} = \frac{R_3}{r_{\pi2}} \frac{r_{\pi2}}{r_i} \), \( \frac{v_{b1}}{v_s} = \frac{R_1}{r_{\pi2}} \frac{r_{\pi2}}{r_i} \), where \( r_i = (r_{ei} + R_s) R_s r_{\pi2} (1 + \beta) \)
(c) \( R_m = R_1 \frac{R_s}{r_i} \) where \( r_i \) is defined in (b)
(d) \( R_{\text{out}} = r_{o2} \frac{R_6}{R_5} \)
(e) \( R_{\text{cin}} = R_s + \frac{R_3}{r_{\pi2}} r_i, R_{\text{c1}} = R_4 \left( \frac{r_{\pi2} + R_5 \frac{R_3}{r_{\pi2}}}{1 + \beta_i} + R_4 \frac{r_{\pi2} + R_5 \frac{R_3}{r_{\pi2}}}{1 + \beta_i} \right) \)
(f) \( \omega_{\mu1} = \frac{1}{C_{\mu1} R_s \frac{R_3}{r_{\pi2}} \frac{r_{\pi2}}{r_i}}, \omega_{p2} = \frac{1}{C_{\mu2} R_4 \frac{R_3}{r_{\pi2}} \frac{r_{\pi2}}{r_i}} \), \( C_A = C_{\mu2} \left( 1 - \frac{v_o}{v_{b2}} \right), C_B = C_{\mu2} \left( 1 - \frac{v_{b2}}{v_o} \right) \), where \( \frac{v_o}{v_{b2}} = -g_{m2} R_o \frac{R_{\text{load}}}{R_{\pi2}} \) as in part (b)
(g) \( R_1 = 21.444k\Omega, R_2 = 30.7k\Omega, R_4 = 13.954k\Omega, R_5 = 3.5k\Omega, R_6 = 1.125k\Omega \)

Q3. (i) \( R_{\text{idm}} = r_{\pi1} + r_{\pi2} = 2r_\pi \)
(ii) \( \frac{v_o}{v_{\pi4}} = -g_{m2} R_s, \frac{v_{\pi4}}{v_{\pi2}} \approx -g_{m2} r_e = -\alpha \approx -1, \frac{v_{\pi2}}{v_{dm}} = \frac{r_\pi}{R_s + 2r_\pi} \)
(iii) \( \frac{v_{\pi2}}{v_{cm}} = \frac{r_\pi/2}{R_s + r_\pi/2 + R_{EE} (1 + \beta)} \)
(iv) \( R_{\text{icm}} = r_\pi/2 + R_{EE} (1 + \beta) \)
(v) \( \frac{v_{s2}}{v_{cm}} = 2 \left( \frac{r_\pi + r_\pi/2 + R_{EE} (1 + \beta)}{R_s + 2r_\pi} \right) \)
(b) pnp current mirrors with \( R_{\text{bias}} = 14.3k \)
(c) pnp current mirrors with \( R_5 = 28.6k \)
(c) \( v_{\text{inmax}} = 13.7V, v_{\text{inmin}} = -14.5V \)
(d) ±0.5V/\mu s

Q4. (a) \( \frac{v_o}{v_{ij}} = \frac{s}{(K-1)CR_1} \) \( (2015 \, \text{corrected numerator, added} \, R_1) \)
(b) R(s) is LPF with \( \omega_0 = 1, Q=1, H_0 = \pi, S(s) \) is HPF with \( \omega_0 = 10, \) high freq gain = 1, gain at \( \omega_0 = 10, \) Adding the two, LPF + HPF results in a band-stop filter: lowpass gain at \( \pi, \) very little overshoot since \( Q = 1, \) dropping off in gain at -20dB/decade, but picking up for the high-pass filter with \( \omega_0 = 10, \) quite a bit of a peak since gain at \( \omega_0 \) is equal to 10 then back down to 1 for higher frequencies.

Q5. (a) \( \omega_0 = \frac{1}{\sqrt{2}RC}, \) \( K = \frac{3}{2} \) (b) peak voltage about ±5.7V