(1) In the circuit shown in Figure 1, the transistor used for Q1 and Q2 has the β_F=200.(15%)
- (a) With $v_1=v_2=0$, determine the bias currents I_{CQ} and I_{BQ}, and the output voltages v_{o1} and v_{o2}.
- (b) Evaluate A_{DM}, A_{CM}, and the CMRR.
- (c) Determine R_{id} and R_{ic}.
- (d) Design a current mirror to replace the 14.3-KΩ resistance to establish the same bias currents, and find the CMRR.

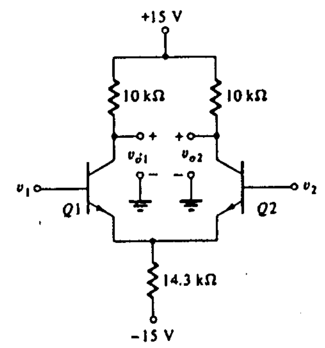

Figure 1

(2) Figure 2 shows the general form of an oscillator circuit.(20%)
- (a) Draw the equivalent circuit and determine the return ratio.
- (b) Draw the Colpitts oscillator, determine its oscillation frequency, and explain its operation.
- (c) Repeat (b) with the Hartley oscillator.

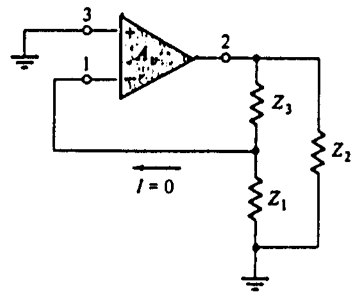

Figure 2

(3) In the circuit shown in Figure 3, it is assumed that $R_D >> r_\pi$, $r_d >> r_\pi$, $\beta_o >> 1$, and $\mu >> 1$.(15%)
- (a) Determine $A_{v1}=v_{o1}/v_s$.
- (b) Determine $A_{v2}=v_{o2}/v_s$.

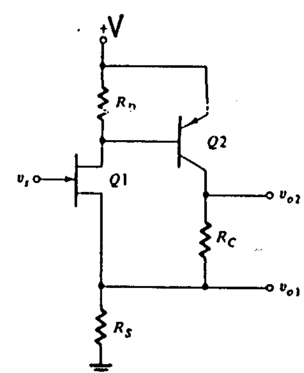

Figure 3

(4) Assuming that the op-amps in Figure 4 are all ideal, find the $Z_{in}(j\omega)$.(15%)

(5) (15%)
- (a) Draw the block diagram of a successive approximation type of analog-to-digital (A/D) converter. Explain the operation principle.
- (b) Compare four different types of A/D, successive approximation, integrating, flash, and V/F counting converters, in speed, resolution, noise immunity, and cost.

(6) Figure 5 shows the circuit of a low-pass Butterworth filter.(20%)
- (a) Determine the v_o/v_i.
- (b) Explain the aliasing phenomenon during data sampling.
- (c) Assuming that a bio-signal with frequency bandwidth 0-200 Hz, choose the appropriate sampling rate. Utilize the Butterworth filter, shown in Figure 5, to design an anti-aliasing filter. (R=100 KΩ)

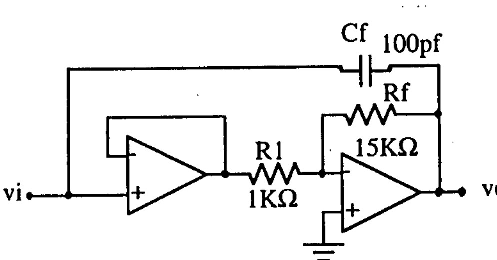

Figure 4

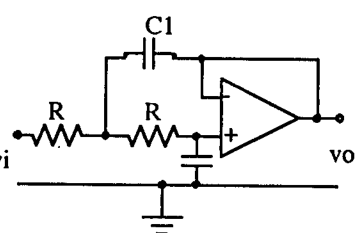

Figure 5