1. (1) Explain why a contact difference of potential must develop across an open-circuited p-n junction.
(2) Discuss the two possible sources of breakdown in a transistor as the collector-to-emitter voltage is increased.
(3) What is a Schottky transistor? Why is storage time eliminated in such a transistor?
(4) Explain the function of a tristate (3-state) TTL gate. (16%)

2. (1) Show the truth table for the half edder, and the implementation for the digit D and the carry C.
(2) Give the truth tables for each FLIP-FLOP type: (a) S-R; (b) J-K; (c) D; and (d) T.
(3) What do the acronymns FAMOS mean? How is such a cell programmed? How is the cell erased?
(4) Define f_β and f_T. What is the relationship between f_β and f_T? (16%)

3. (1) Sketch the circuit of a logarithmic amplifier using one OP AMP and explain its operation.
(2) Show that the maximum conversion efficiency of the idealized class B push-pull power amplifier is 78.5%.
(3) Give the Barkhausen conditions required in order for sinusoidal oscillations to be sustained.
(4) Show the model of an OP AMP taking into account I_{B1}, I_{B2}, V_{io}, R_i, R_o, and A_{vr}. What is the output offset voltage in terms of parameters of this model? (16%)

4. (1) Sketch the block diagram for the 5-stage twisted-ring counter.
(2) Write the truth table of FLIP-FLOP outputs Q_4, Q_3, Q_2, Q_1 and Q_0 after each pulse. Assume that initially $Q_4 = Q_3 = Q_2 = Q_1 = Q_0 = 0$.
(3) By what number N does this system divide.
(4) Show that two-input AND gates can be used for decoding. (16%)

5. In the circuit of Fig. 1, $R_d = r_d = 15\,k\Omega$, $R_s = 2\,k\Omega$, and $\mu = 24$. Find the voltage gains A_1 and A_2 defined by $V_{o2} = A_1V_1 + A_2V_2$. (18%)

6. For the amplifier of Fig. 2, $h_{fe} = 100$, $h_{ie} = 1\,k\Omega$, $R_c = 3\,k\Omega$, $C_b = C_2 = 100\,\mu F$, $\omega C_2 R_e \gg 1$, and the shunting effect of $R_1 \| R_2$ is negligible. It is desired that the absolute value of the midband voltage gain A_o be more than 160, and that the lower 3-dB frequency f_L be at most 90 Hz. Find the range of values for R_s which satisfies these two requirements. (18%)

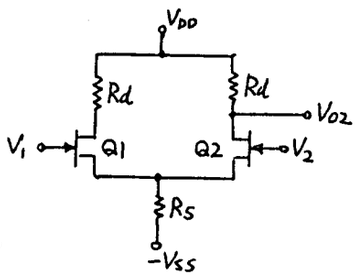

Fig. 1

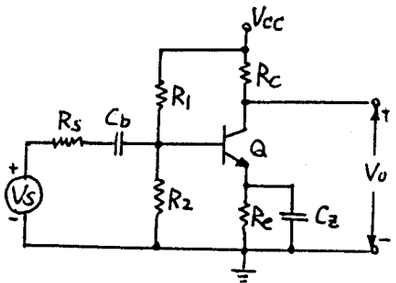

Fig. 2