1. (a) In a single-loop feedback oscillator, describe (i) the conditions necessary for oscillation to be sustained and (ii) what starts the oscillation and what determines the oscillation frequency ? (8%)
   (b) Use a minimum number of Flip-Flops to design a 12:1 counter (use no logic gates). (8%)
   (c) Explain the operation of a dual-slope A/D converter as shown in Fig. 1. Assume $V_a > 0$ and $V_R < 0$. (5%)
   (d) Sketch the circuit diagrams of an NMOS and a CMOS NAND gates, respectively. (4%)

2. For the circuit shown in Fig. 2, determine the closed-loop gain A_{vF} (= v_o/v_s). (7%)

3. Draw the circuit configuration of a cascode amplifier. Explain why it is favorable for high frequency operation ? (8%)

4. For a two pole system, use the pole separation factor n (=ω_2/ω_1)as a parameter to determine the pole frequency ω_o, the pole Q factor, and the angular gain-crossover frequency ω_G. Assume the transfer ratio of the feedback network, β, is constant and the open-loop gain function is given by (12%)

$$A_{OL}(s) = \frac{A_o}{(1+\frac{s}{\omega_1})(1+\frac{s}{\omega_2})}$$

5. (a) Plot the block diagram of the complete power supply circuit and describe briefly the basic operation of each block. (10%)
   (b) Explain concisely the operation of a switching regulator (see Fig. 3). Under what condition(s) the output voltage V_o will be a constant and what is the value of this constant ? Why ? (10%)

6. (a) For the circuit shown in Fig. 4(a), R_2 = 100 KΩ. Find the values of R_1 and C for a low-frequency voltage gain of -100 and a 3-dB frequency of 1 MHz.(5%)
   (b) Derive the gain-bandwidth product of the amplifier circuit shown in Fig. 4(b). Note that all bias components have been removed for simplicity. (5%)

7. (a) For a single-pole (low-pass) system, show that the 10% to 90% rise time t_{rise} can be characterized in terms of the time constant τ and the 3-dB bandwidth BW, respectively. (5%)
   (b) In a practical integrator as shown in Fig. 5, describe how to minimize the error in the output due to bias current of the Op-Amp. (5%)

8. For the NOR-gate astable multivibrator shown in Fig. 6, derive the voltage v_x and the oscillation frequency f_o. (8%)

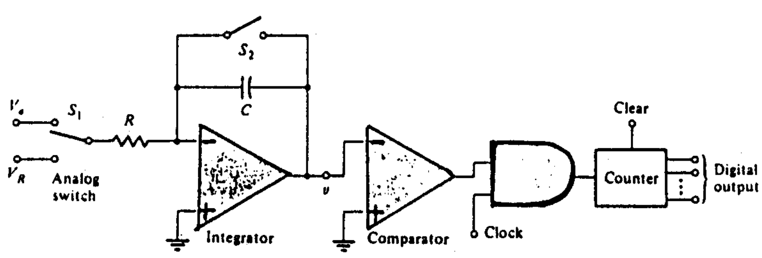

Fig. 1

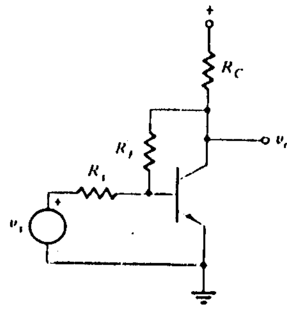

Fig. 2

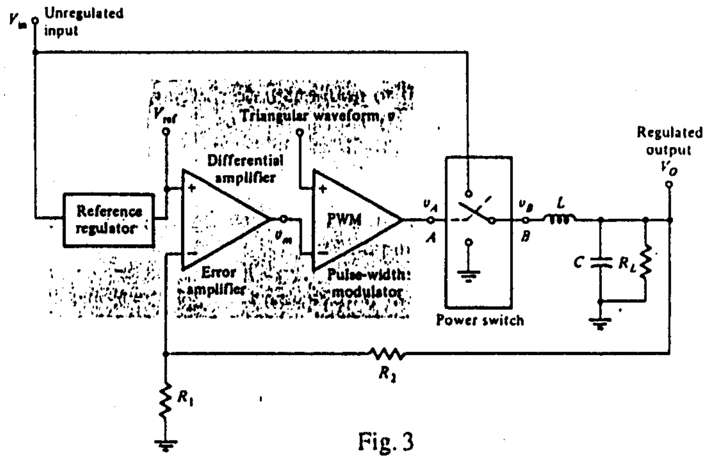

Fig. 3

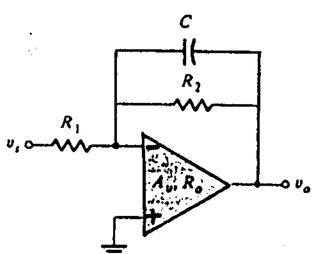

Fig. 4(a)

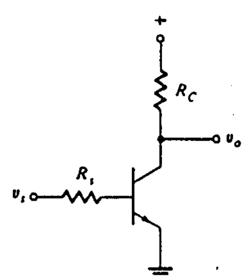

Fig. 4(b)

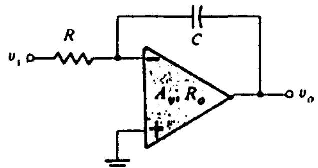

Fig. 5

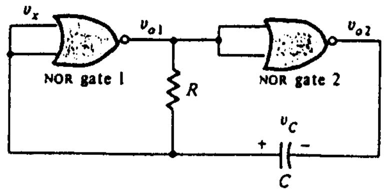

Fig. 6

079