1. Find the input resistance R_{in} of the circuit in Fig. 1.(10%)

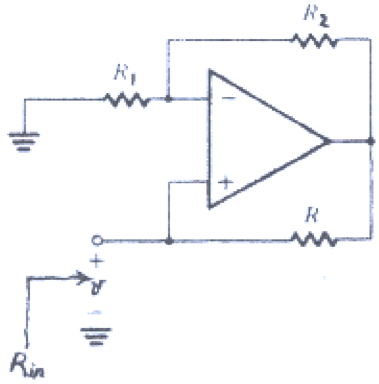


Fig. 1

2. A transistor amplifier is shown in Fig. 2. (a) Determine the quiescent operating point for demonstrating that the transistor will be operating in active mode, and (b) Find the voltage gain for the v_L.(20%) (Assume that β is 100 and V_T is 25 mV.)

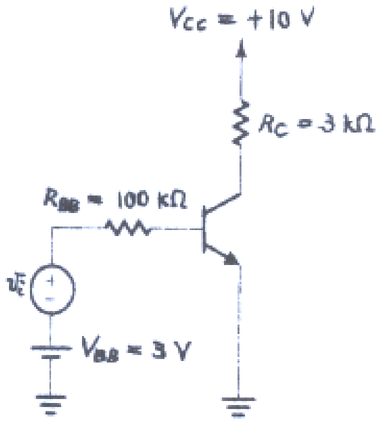


Fig. 2

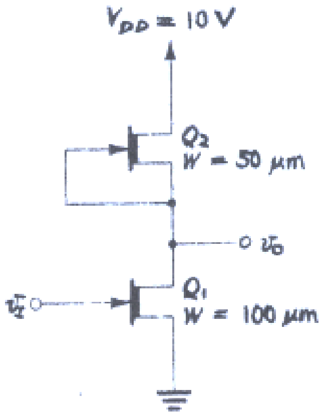
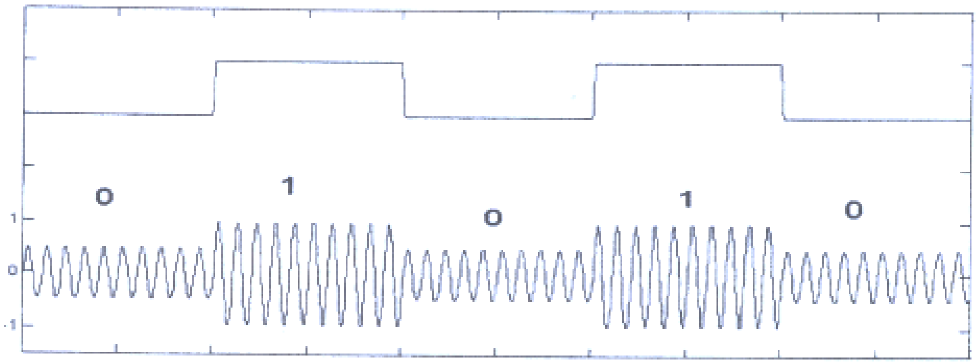


Fig. 3

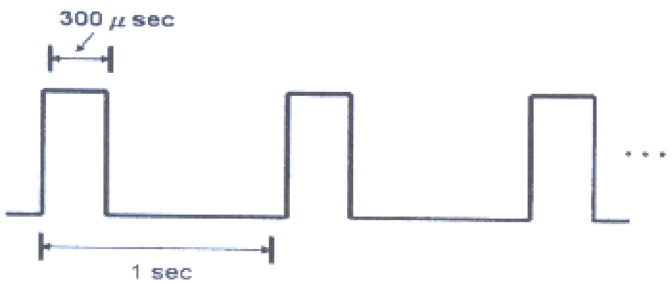
3. Fig. 3 shows a simple GaAs MESFET amplifier. Assume that the dc component of v_I biases Q_I at the current provided by the current source Q_2 so that both devices operate in saturation and that the dc output is at half of the supply voltage. Find (a) the β values for Q_I and Q_2, (b) V_{GS1}, (c) g_{m1}, r_{o1}, and r_{o2}, and (d) the small-signal voltage gain. (20%) (The typical parameter values for GaAs MESFET in L = 1 μm technology, normalized for W = 1 μm are listed in the following: V_t = -1.0 V, $\beta = 10^{-4}$ A/V^2, λ = 0.1 V^{-1}, $I_s = 10^{-15}$ A, and n = 1.1)

4. (15 %) The lower trace in Fig. 4 is a signal of amplitude shift key (ASK) modulation to represent the digital signal (upper trace). ASK technique is important for various communication applications. Please design a circuit to extract (or demodulate) the digital signal from the lower trace of signal. You can make any assumption about the carrier frequency. Please describe your design principles.



(Figure 4)

5. (15 %) Pulse generator is important for biomedical applications. Please utilize combinations of any types of flip-flops (or your own design) to construct a pulse generator with 1 Hz pulse rate and pulse width of 300 μsec, as shown in Fig. 5.



(Figure 5)

6. (20 %) Explain the terminologies generally used in electronics:
(a) FPGA
(b) DeMorgan's law
(c) Emitter-coupled logic (ECL)
(d) Class C amplifier
(e) SPICE