ELECTRONICS

1) Figure 1 is designed as a "FOLLOWER", which means an output follows the input in status change. The typical saturation characteristics for a silicon transistor have: $V_{CE,sat} = 0.2V$, $V_{BE,sat} = 0.8\,V$ at 25° C. If $h_{FE,dc} = 100$, find the best choice of R_B for saturation operation of this transistor, and its output voltage when the input is $5.0V$. (15%)
2) Figure 2 is a simple adaptor designed for "SONY" walkman tape players. The specifications for this adaptor is: DC $9V$ $\pm 5\%$ at 700 mA with a maximum allowable ripple voltage 5% to the output voltage. The diodes used are 1N4001 with PIV $70V$, $1000mA$. The indication LED used is red LED with $1.8V$ minimum forward voltage and $12mA$ minimum forward current. Caculate from this circuit the followings. (15%)
   (a) The transformer output (secondary) voltage, AC voltage
   (b) The filter capacitor in μF
   (c) The LED resistence R_s
3) For the astable multivibrator circuit shown in figure 3a, the operational characteristics of the working transistors is drawn in figure 3b. If the pulsed output of the circuit is to be as that shown in figure 3c with the saturating collector current limited to be $7mA$. Caculate the followings. (20%)
   (a) The value of V_{cc}.
   (b) The values of R_{c1}, R_{c2}
   (c) The value of $R_{B1}C_1$, $R_{B2}C_2$
4) Compare the functionings of the inductor filters and that of the capacitor filters used in the general retifier circuit based power supply. (10%)

MECHANICS

5) For the simple harmonic system shown in figure 4, mass m is moving along Y-axis in a simple harmonic motion (SHM) with respect to the point O which, by the way, is moving along the X-axis in a constant speed V. (10%)
   (a) Figure out the locus of mass m in this compounded motion.
   (b) Discuss what force exerts on the mass m.
6) For the pully system shown in figure 5, m_1 is pulled through a roller by a free falling body m_2. With f_1 and f_0 representing the friction on the surface and that in the roller respectivelly and assume that the roller is massless. Discuss the force balance and write down the equation of motion of the system. (10$)
7) A particle of mass m rests at a distance l from the hinged end of a horizontal uniform rod of length L and mass M. The particle is not attached to the rod. (See figure 6.)
   (a) Compute the reaction force between the particle and the rod as a function of l at the instant after release of the rod from the rest position. (5%)
   (b) For the case in which $l = L$, compute the angular velocity of the rod as it passes through the vertical position. (5%)
8) Compute the period of oscillation for small motions of the system shown in figure 7. The stiffness of the spring is k and the system is in equilibrium when the arm holding the mass m is horizontal. The link AOB and the spring are taken to be massless. (10%)

(See page 2 for the figures)

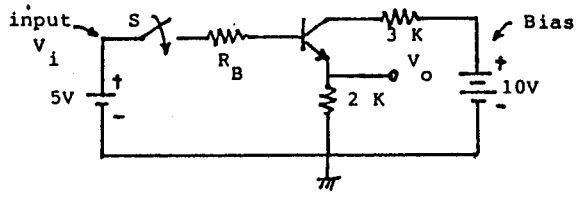


Fig. 1

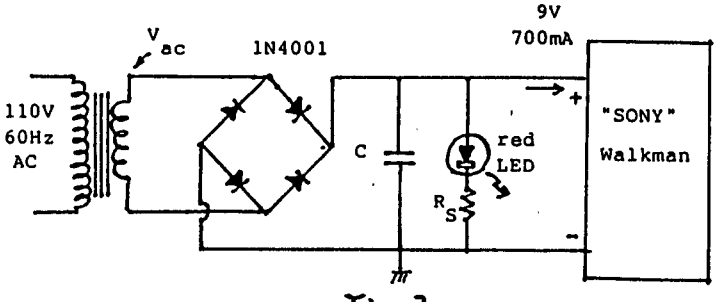
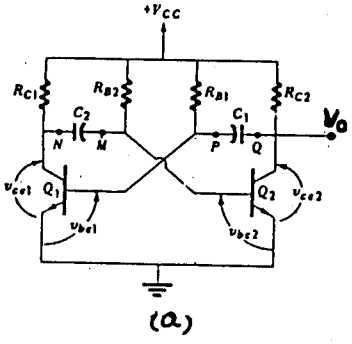
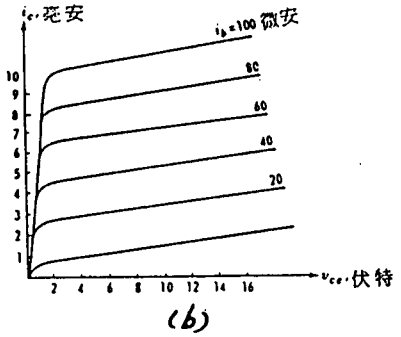


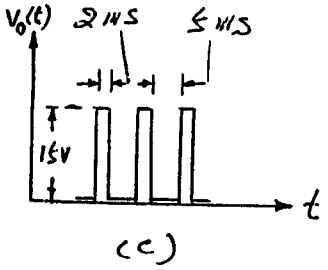
Fig. 2



(a)



(b)



(c)

Fig.3

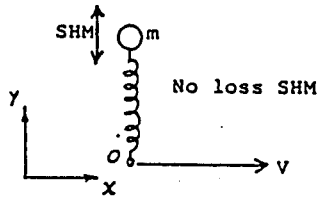


Fig. 4

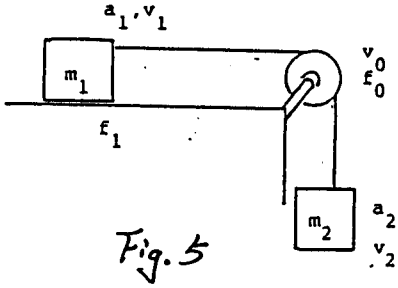


Fig. 5

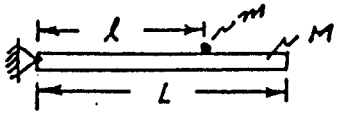


Fig. 6

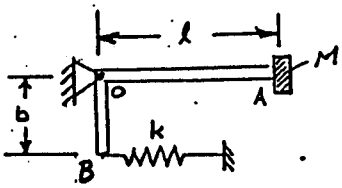


Fig. 7