HW#3
Problem 1

5.62 The essence of transistor operation is that a change in \( v_{BE} \), \( \Delta v_{BE} \), produces a change in \( i_C \), \( \Delta i_C \). By keeping \( \Delta v_{BE} \) small, \( \Delta i_C \) is approximately linearly related to \( \Delta v_{BE} \), 

\[ \Delta i_C = g_m \Delta v_{BE} \]

where \( g_m \) is known as the transistor transconductance. By passing \( \Delta i_C \) through \( R_C \), an output voltage signal \( \Delta v_O \) is obtained. Use the expression for the small-signal voltage gain in Eq. (5.56) to derive an expression for \( g_m \). Find the value of \( g_m \) for a transistor biased at \( I_C = 1 \) mA.

Problem 2

5.64 Sketch the \( i_C-v_{CE} \) characteristics of an npn transistor having \( \beta = 100 \) and \( V_A = 100 \) V. Sketch characteristic curves for \( i_B = 20 \) \( \mu \)A, 50 \( \mu \)A, 80 \( \mu \)A, and 100 \( \mu \)A. For the purpose of this sketch, assume that \( i_C = \beta i_B \) at \( v_{CE} = 0 \). Also, sketch the load line obtained for \( V_{CC} = 10 \) V and \( R_C = 1 \) k\( \Omega \). If the dc bias current into the base is 50 \( \mu \)A, write the equation for the corresponding \( i_C-v_{CE} \) curve. Also, write the equation for the load line, and solve the two equations to obtain \( V_{CE} \) and \( I_C \). If the input signal causes a sinusoidal signal of 30-\( \mu \)A peak amplitude to be superimposed on \( I_B \), find the corresponding signal components of \( i_C \) and \( v_{CE} \).
Problem 3 and 4 (A “very high” $\beta$ just means that $I_B = 0$.)

**5.69** The transistor in the circuit of Fig. P5.69 has a very high $\beta$. Find $V_E$ and $V_C$ for $V_B$ (a) +2 V, (b) +1 V, and (c) 0 V. Assume $V_{BE} \approx 0.7$ V.

**FIGURE P5.69**

**5.70** The transistor in the circuit of Fig. P5.69 has a very high $\beta$. Find the highest value of $V_B$ for which the transistor still operates in the active mode. Also, find the value of $V_B$ for which the transistor operates in saturation with a forced $\beta$ of 1.