Problem Set 3

This problem set contains questions related to the subject EIE304 Electronic Circuits. You will be required to submit solutions to selected problems, as announced in the lecture.

Question 1  The circuit below shows a single stage transistor amplifier with un-bypassed emitter resistance $R_E$. It is driven by a voltage signal generator $v_i$.

![Circuit Diagram]

**Figure 1**

(a) Determine the quiescent collector current $I_c$.
(b) Sketch the output characteristic ($I_c$ versus $V_{CE}$) and the load line.
(c) Explain in qualitative terms how the circuit is used in small-signal voltage amplification, and suggest possible ways of maximizing the small-signal voltage gain.
(d) Draw a small signal circuit model, if at the signal frequency the reactance of the coupling capacitors is assumed zero.
(e) Find the small signal voltage gain $\frac{v_o}{v_i}$, input resistance, and output resistance of the amplifier.
Write clearly your name and student number in the space provided, and include this page in your answer script, if you choose to attempt Question 8.

NAME: ___________________________ STUDENT NUMBER: _______________________

Question 2

The simple transistor amplifier circuit shown in Figure 2(a) is to be biased at a collector current of 10 mA and a collector voltage of 8 V. The transistor’s output characteristics are shown in Figure 8 (b) for two slightly different operating conditions near the quiescent point, corresponding to $V_{BE} = 0.64$ V and $V_{BE} = 0.66$ V. You may assume that the value of $\beta$ is 100.

\[ +15V \]
\[ R_1 \]
\[ R_c \]
\[ R_2 \]
\[ C_c \]
\[ v_i \]
\[ v_o \]

(a) Calculate the value of $R_c$. 

(b) Find the approximate values of $R_1$ and $R_2$ which give the required quiescent condition. You may ignore the base current if it is ten times smaller than the current flowing in $R_1$ and $R_2$. 

(c) From the characteristics shown in Figure 2(b), find the small-signal transconductance of the transistor, i.e., $\frac{\Delta I_c}{\Delta V_{BE}}$. 

(d) Suppose a small-signal input voltage of 20 mV (peak-to-peak) is applied to the base of the transistor through a coupling capacitor, as shown in Figure 2 (a). Find, graphically, the amplitude of the output voltage variation. 

(e) Hence, calculate the small-signal gain of the amplifier. 

(f) Develop a small-signal circuit model for the amplifier. 

(g) Using the small-signal circuit model developed in (f), re-calculate the small-signal gain of the amplifier. 

\[ 0 \quad 5 \quad 10 \quad 15 \]
\[ V_{CE} (V) \]
\[ 0 \quad 5 \quad 10 \quad 15 \]
\[ I_c \]
\[ 6mA \]
\[ 12mA \]
\[ 18mA \]
\[ V_{BE} = 0.64V \]
\[ V_{BE} = 0.66V \]

Figure 2