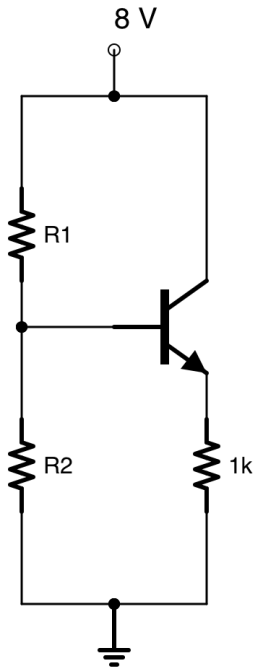
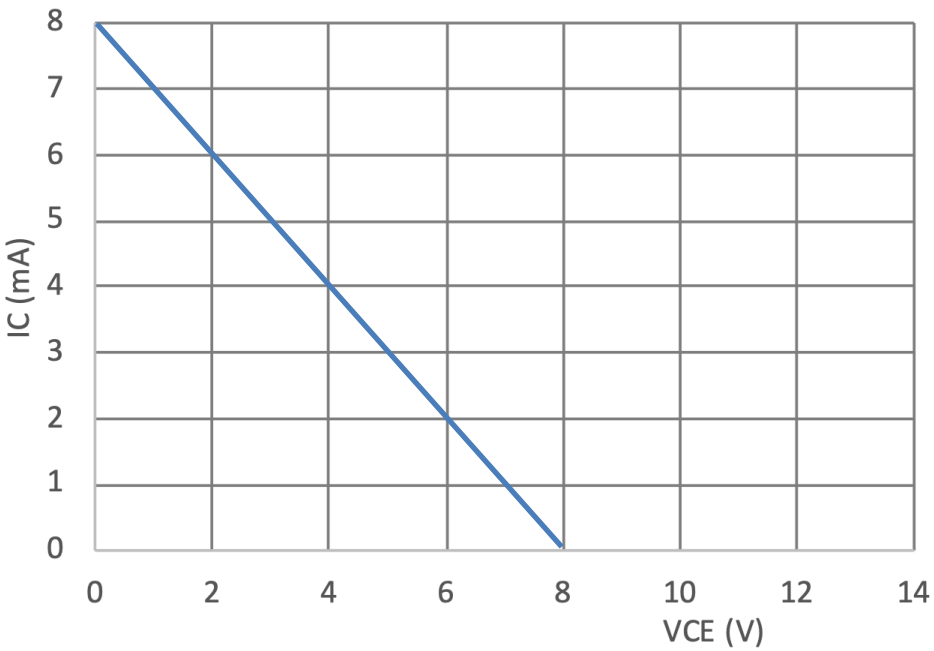
ENEL 469: Analog Electronic Circuits
Quiz-2, Fall 2023
Total marks: 20; Time: 11:00 am – 12:00 pm

ID (Optional)	**First Name (PRINT)**	**Last Name (PRINT)**

1. [**Total 4+1=5**] Consider the following circuit where I_B = 20 μA, β = 100, and V_A = 180 V. Assume $I_C = I_E$, and $V_{CE(Sat)}$ = 0V for simplicity.
   a) [**4**] Draw the load line for the following circuit in the given space. Neatly draw the line at scale. Any ambiguities will be deemed as incorrect answers.

Soln:

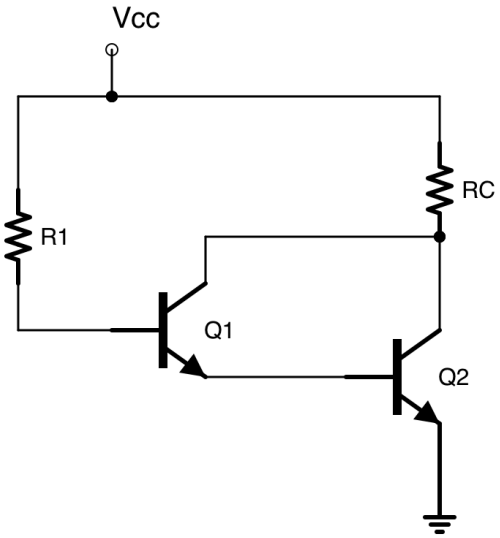


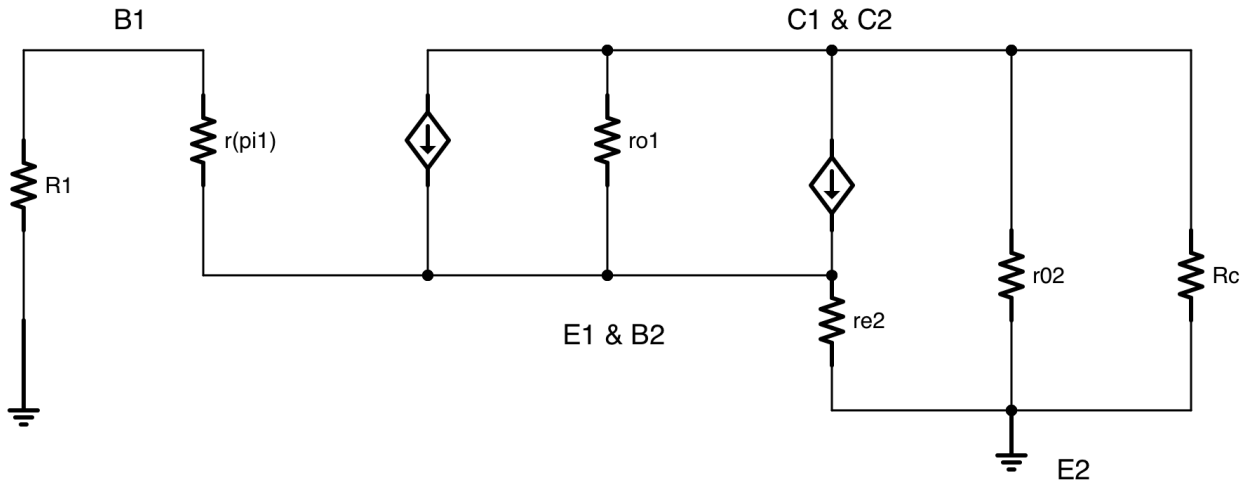


   b) [**1**] Determine the operating point, i.e., $I_{C,Q}$ and $V_{CE,Q}$. Here, the subscript Q indicates the respective values at the operating point.

Ans: $I_{C,Q}$ = 2mA and $V_{CE,Q}$ = 6V

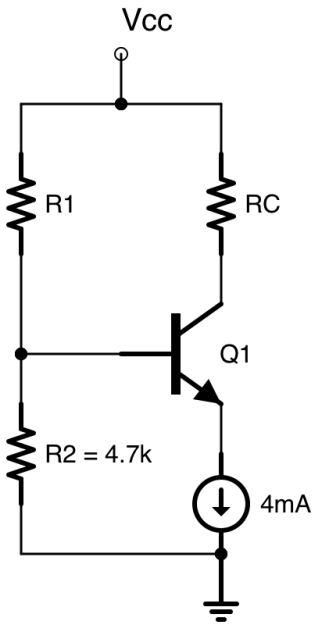
2. [**Total 4**] Draw the small-signal model for the following circuit. Use the π-model for transistor Q1 and T-model for Q2. Note: Indicate the circuit elements using the suffix 1 for Q1 and 2 for Q2, i.e., g_{m1} or g_{m2}. The circuit must be neatly drawn, and all elements must be properly labelled.



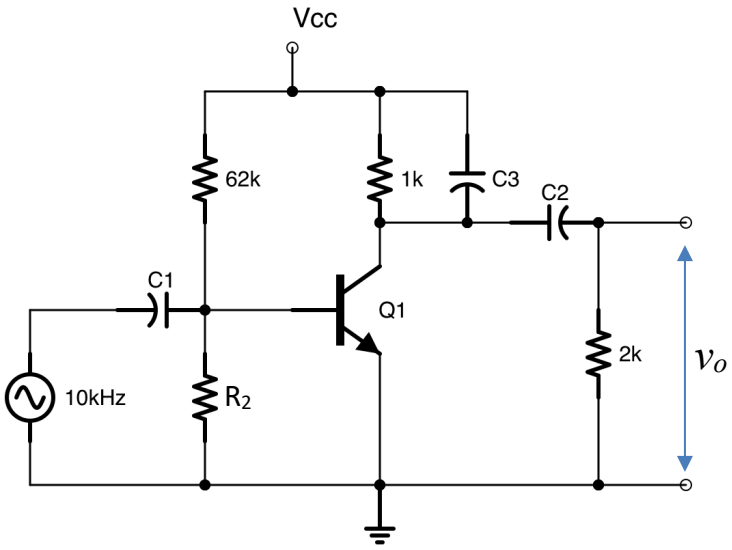


3. [**Total 3**] Consider the following circuit, which has a base current of I_{B1}. Assume the resistor R2 is changed from 4.7k to 3.0k, which sets a new base current I_{B2} in the circuit. Assume the transistor operates in the active region in both cases.
   Which of the following arguments is correct?
   Circle the correct one.

   i) $I_{B1} > I_{B2}$
   ii) $I_{B1} < I_{B2}$
   iii) $I_{B1} = I_{B2}$
   iv) All of the above
   v) None of the above

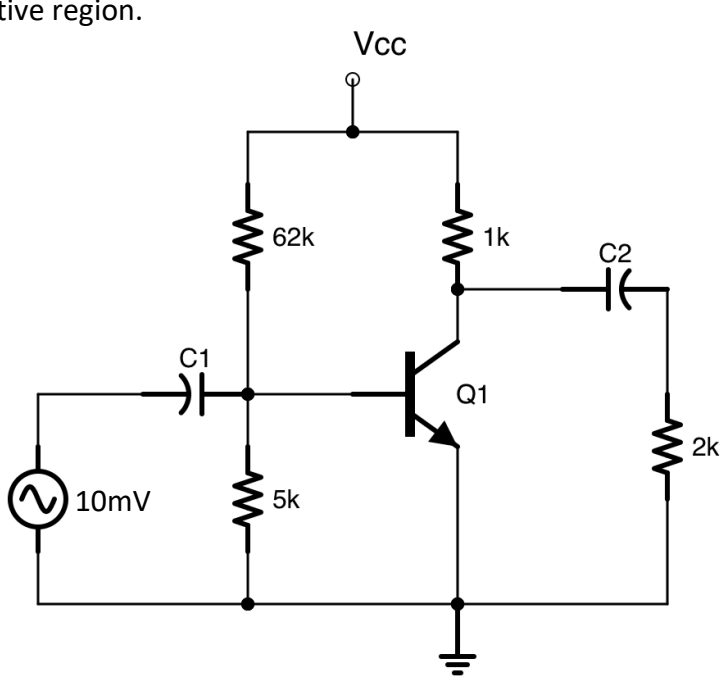


4. [**Total 3**] An ENEL469 student wanted to make CE amplifier circuit in his/her lab. The student mistakenly added the third capacitor, C3, as shown in the circuit below. The circuit without C3 gave a voltage gain of 120 and v_o = 0.6V. What will the new output voltage (v_o) be when C3 is added? The student did not disclose the value of R2.



Ans: $v_o = 0$

5. [**Total 5**] In the following circuit, V_{CC} = 10V, $V_{BE(on)}$ = 0.7 V, $V_{CE(Sat)}$ = 0.2V, V_A = 160V, and the internal resistance of the AC source is 200 Ω. The capacitor values are such that they are shorted for the AC signal. Determine the signal voltage that appears at the base, i.e., v_{be}. Assume the transistor remains in the active region.



$I_{(5k)} = \frac{0.7}{5000} = 140\mu A$ and $I_{(62k)} = \frac{12-0.7}{62000} = 150\mu A$

Thus, I_B = 150 – 140 = 10 μA

If so, $r_\pi = (V_T)/(I_B)$ = 2.5 kΩ

The input resistance seen by the source = 62kΩ // 5kΩ // (r_π)

= 62kΩ // 1.67kΩ

= 1.63kΩ

Since the internal resistance 200Ω and the input resistance 1.63kΩ are in series, the base voltage can be obtained by voltage division,

$$v_{be} = \frac{10 \times 10^{-3} 1.63}{(1.63+0.2)} = 8.91mV$$

Ans: v_{be} = 8.91 mV