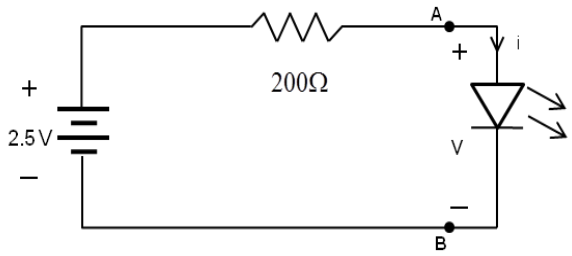
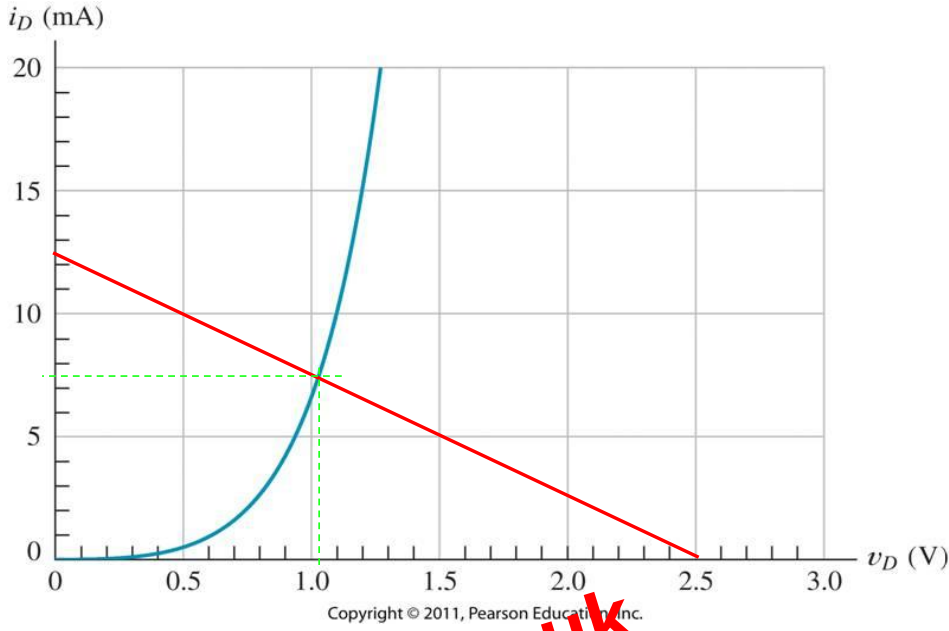
Problem 4: Find the current *i* and the voltage *v* across LED diode in the circuit shown on Fig. a) assuming that the diode characteristic is shown on Fig. b).





Determine the load line

Step 1: Find i_D if $v_D = 0$ V (short circuit)

$$i_D = \frac{2.5}{200} = 12.5\ mA$$

Step 2: Find v_D if $i_D = 0$ A (open circuit)

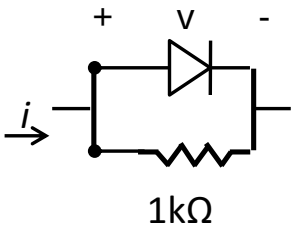
$$v_D = 2.5\ V$$

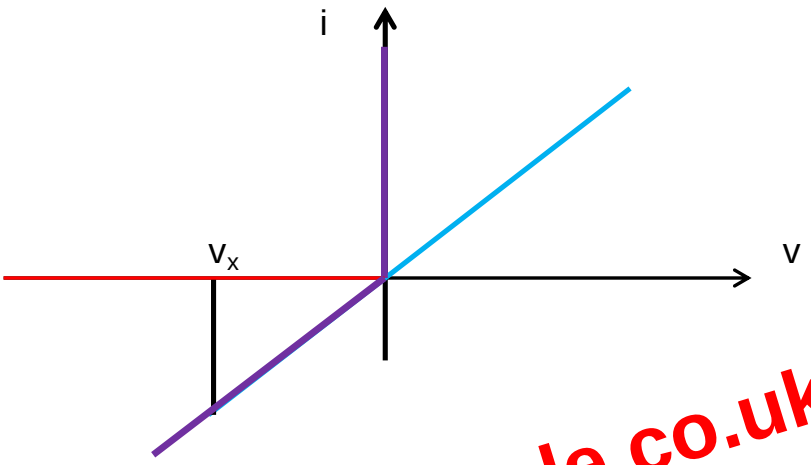
Draw load line. Intersection of load line and diode characteristic is the i and v across LED diode: $v \approx 1.02$ V and $i \approx 7.5$ mA.

Modeling a piecewise characteristic of a device

Problem 6

Sketch the transfer characteristic (v_o versus v_{in}) for the circuit shown in the figure below. Assume that the diode is ideal.



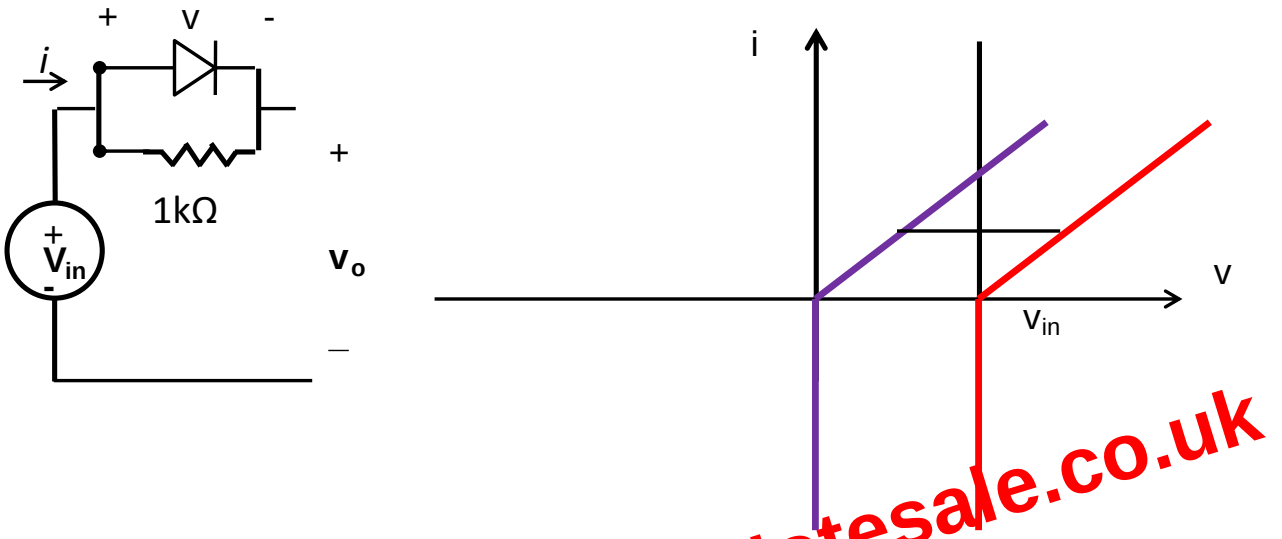


In a parallel connection currents are added for each constant voltage

Modeling a piecewise characteristic of a device

Problem 6

Add the voltage source.



In a series connection voltages are added for each constant current

Problem BJT P1: It has been found that in the circuit below V_E = 1V. If V_{BE} = -0.6V, determine: V_B, I_B, I_E, I_C, β, and α.

Soln (a): From KVL: $5V = I_E * R_E + 1V$

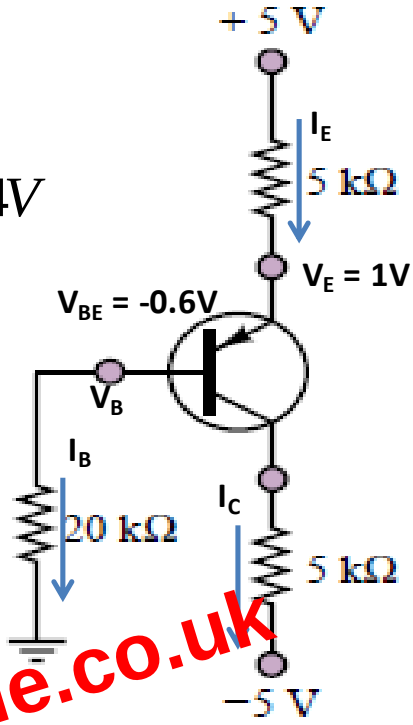
$$\Rightarrow \quad 4V = I_E * 5000 \quad \Rightarrow \quad I_E = 0.8mA$$

From KVL: $V_B = V_E - V_{EB} = 1 - 0.6 = 0.4V$

Ohm's law: $V_B = I_B * R_B$

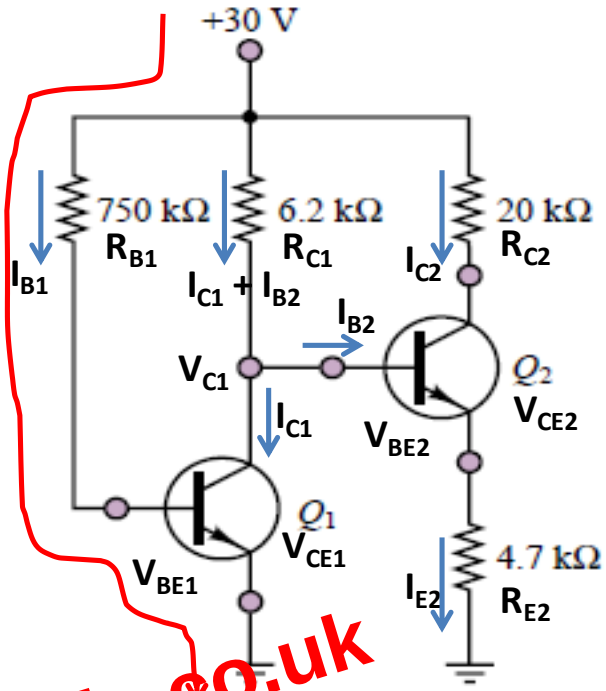
$$0.4V = I_B * 20k\Omega \quad \Rightarrow \quad I_B = 20\mu A$$

$$I_C = I_E - I_B = 0.78mA$$



$$\beta = \frac{I_C}{I_B} = 39 \qquad \alpha = \frac{I_C}{I_E} = 0.975$$

Problem BJT P2: - For the circuit below assume both transistors are silicon-based with β = 100. Determine: **a)** I_{C1}, V_{C1}, V_{CE1}. **b)** I_{C2}, V_{C2}, V_{CE2}.



- **Soln:**

  Assume $V_{BE} = V_{BE1} = V_{BE2} = 0.7V$

- **Part (a): -** Apply KVL along the path (red line).

$$-30 + I_{B1} * R_{B1} + V_{BE1} = 0$$

$$I_{B1} = \frac{30 - 0.7}{750 * 10^3} = 39.07\,\mu A$$

$$I_{C1} = \beta * I_{B1} = 3.907\,mA$$

- **Soln contd.:** Find the Q-point if the current gain, β_F = 125. We have R_C=29.41kΩ, and R_B=625kΩ, from previous calculations.
- Apply KVL along the path (red line).

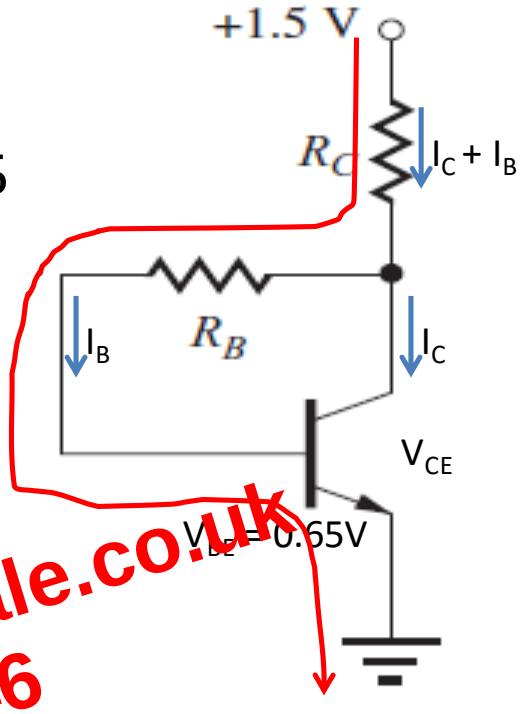
$$(I_C + I_B)R_C + I_B R_B + V_{BE} = 1.5$$

$$(\beta I_B + I_B)\,29.41k + I_B * 625k = 0.85$$

$$(126 * 29.41\,k + 625k)I_B = 0.85$$

$$I_B = \frac{0.85}{4.331*10^6} = 0.196\mu A$$

$$I_C = \beta I_B = 125 * 0.196 * 10^{-6} = 24.53\,\mu A$$



Problem Logic Gates P3: - **b)** Find the minimum POS form of the function above and draw a logic circuit representing the same.

- **Soln:-**
- For minimum POS – Minimize the logic function F’ and take inverse. That is consider locations with zero (0) and then invert the result.

		C		
	1	1	0	0
A	0	0	0	0
	1	1	0	1
	1	1	0	1
			D	

B

POS: F = (B + D’) . (A’ + B) . (C’ + D’)