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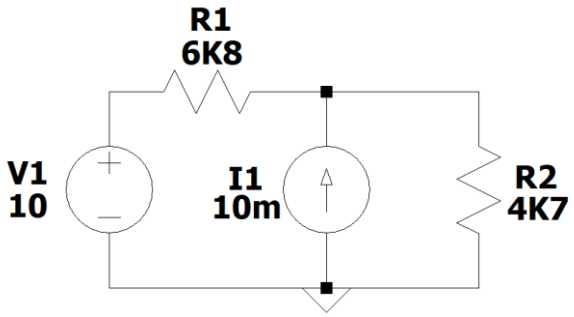
Digital Electronics Laboratory

Instructors
Mohammed Sameer Lubbad
Israa Hamdi Abu Rayya

Do the following simulations and obtain:

1. **Circuit 1: DC Operating Point Simulation**
    a. Screenshot of the **schematic**
    b. **Voltage** across **R1**
    c. **Current** of **V1**
    d. **Power** absorbed by **R2**



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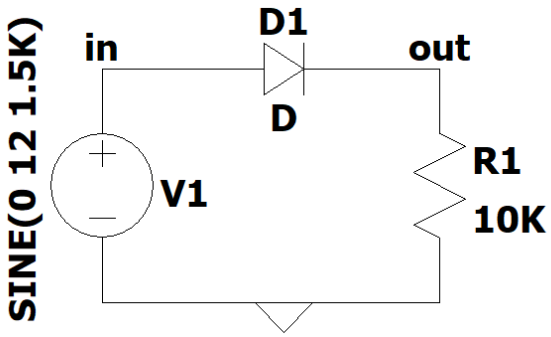
2. Circuit 2: Transient Response Simulation

a. Screenshot of the **schematic**
Sine-wave Source: Amplitude voltage: 12V, **Frequency:** 1.5KHz

b. Screenshot of the **output voltage** and **output power** for only 3 cycles.



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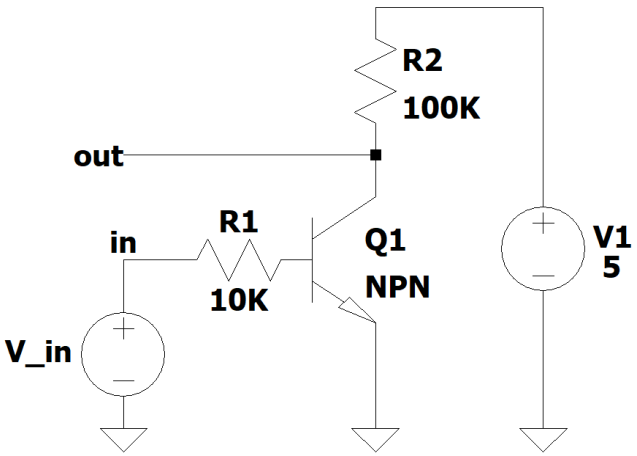
3. **Circuit 3: DC Sweep Simulation**
    a. Screenshot of the **schematic**
    b. Screenshot of the **output voltage** when the **input voltage** increases between -5V to 5V by 0.1V



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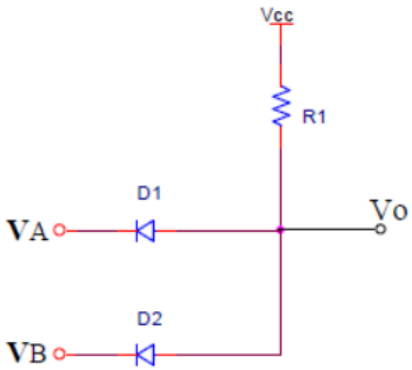
Experiment 2: Diode-Resistor Logic

Part 1: AND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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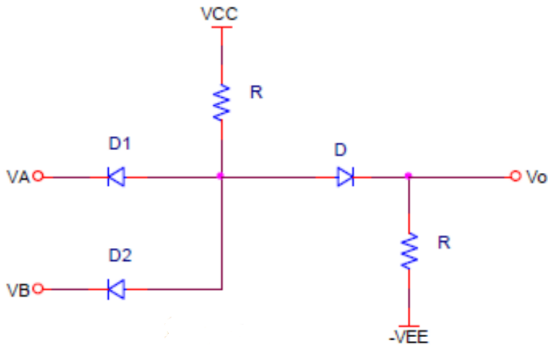
Part 2: Level-shifted AND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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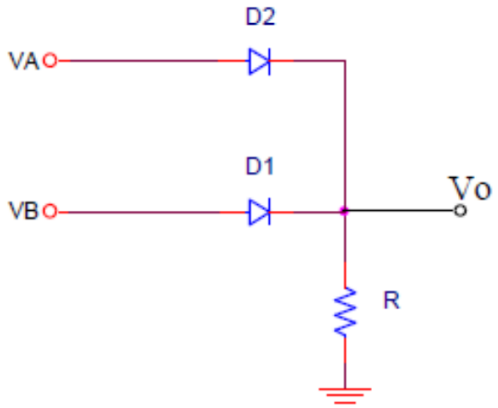
Part 3: OR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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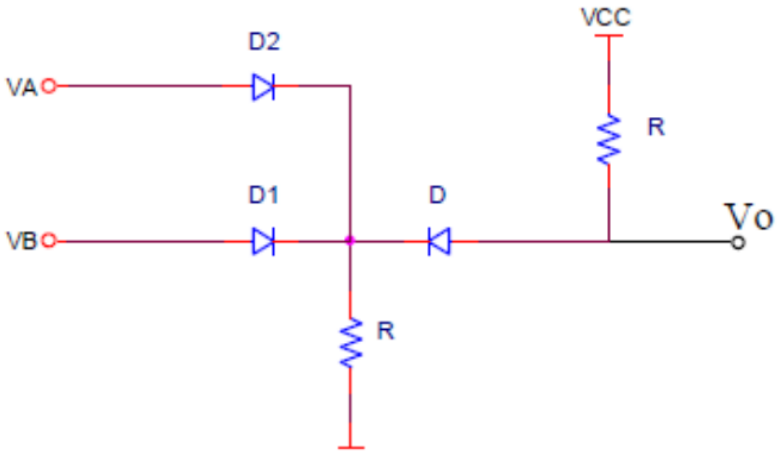
Part 4: Level-shifted OR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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Part 5: Comments

1. Compared to other logical circuits, what is the advantage of using DRL circuits?
2. What types of the logical gates we cannot implement using DRL circuits?
3. What are the benefits of using level-shifting in the gates?

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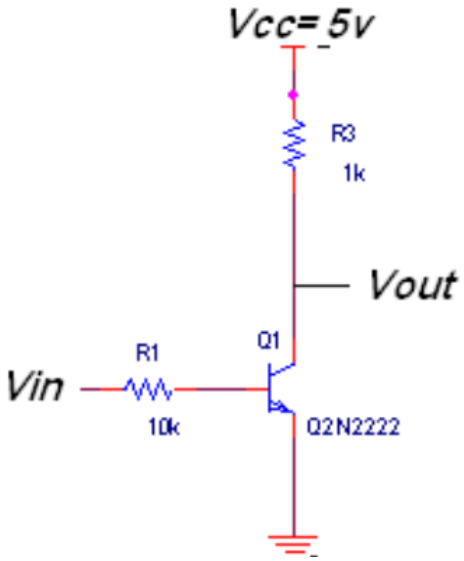
Experiment 3: Resistor-Transistor Logic

Part 1: RTL Inverter

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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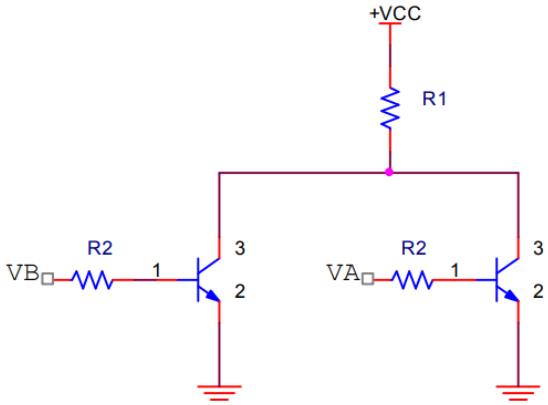
Part 2: RTL NOR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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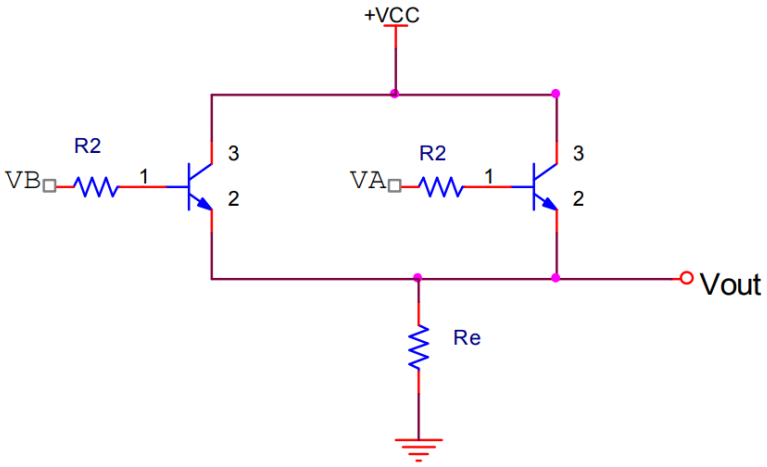
Part 3: RTL OR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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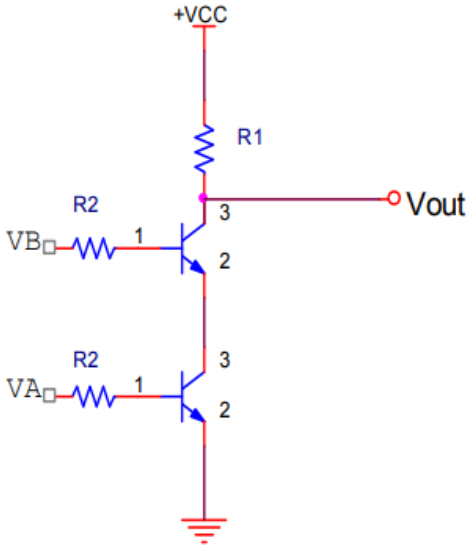
Part 4: RTL NAND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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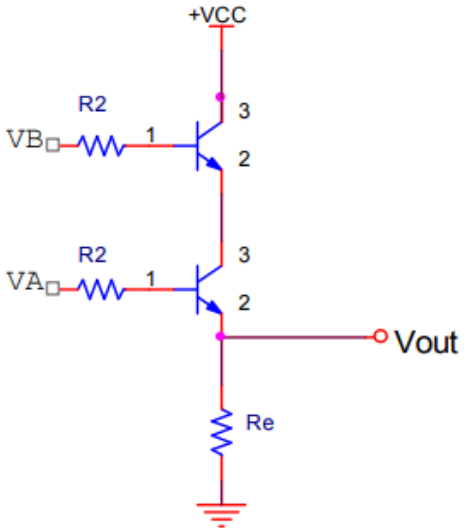
Part 5: RTL AND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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Part 6: Comments

1. What is the effect of changing the **collector resistor R_C** on the VTC? Justify your answer.
2. What is the effect of changing the **base resistor R_B** on the VTC? Justify your answer.
3. Suggest another way to implement OR/AND gate other than the mentioned previously.
4. Make a brief comparison between RTL gates and DRL gates.

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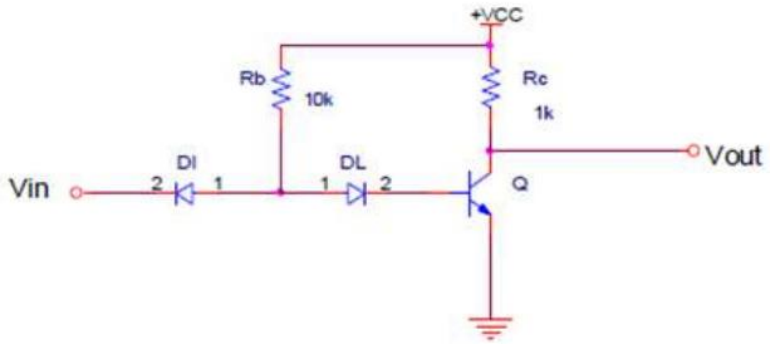
- **Comments** are very important. Describe it in your own words. **DO NOT COPY**.

Experiment 4: Diode-Transistor Logic

Part 1: DTL Inverter

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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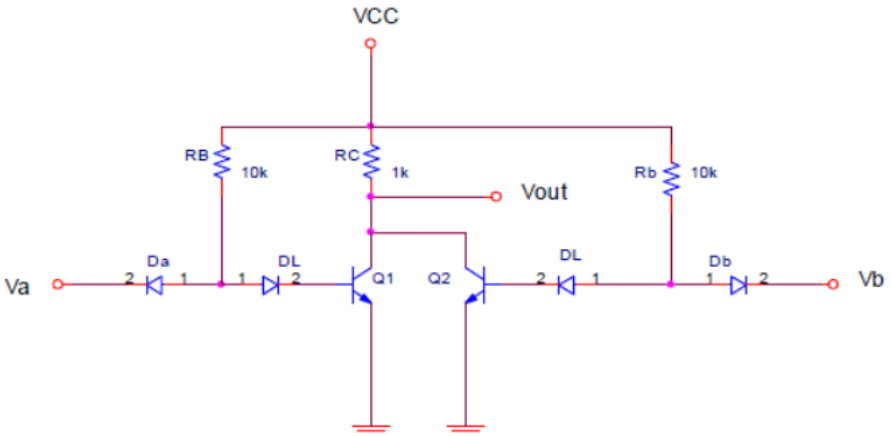
Part 2: DTL NOR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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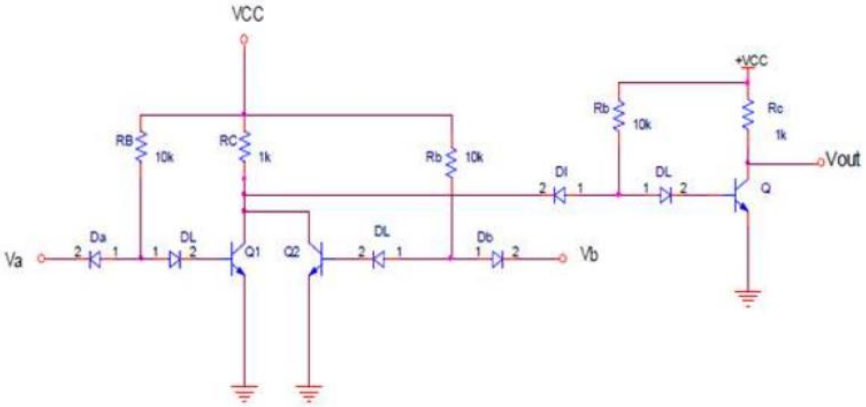
Part 3: DTL OR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
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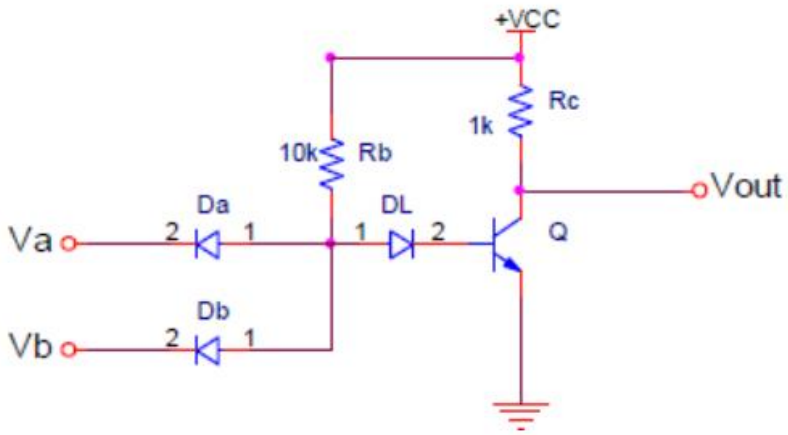
Part 4: DTL NAND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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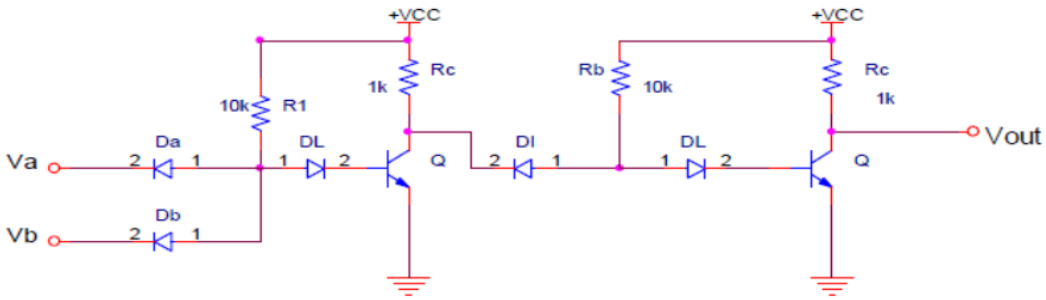
Part 5: DTL AND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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Part 6: Comments

1. What is the difference between DTL and RTL in terms of propagation delay response?
2. What is the difference between DTL and RTL in terms of VTC?
3. Make a brief comparison between RTL gates and DTL gates.

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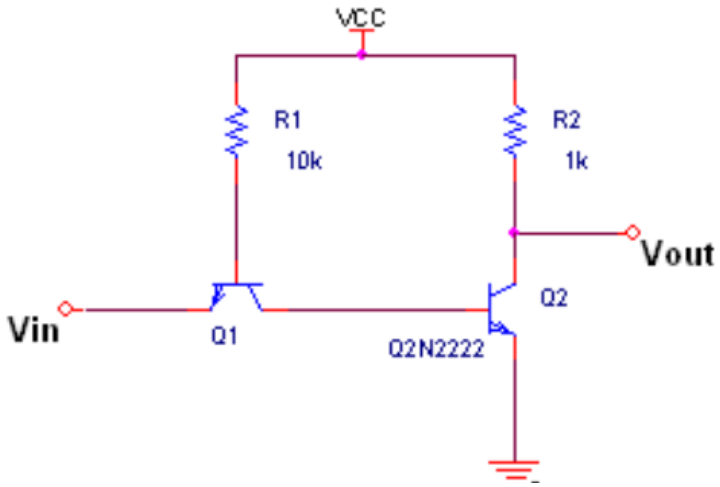
Experiment 5: Transistor-Transistor Logic

Part 1: TTL Inverter

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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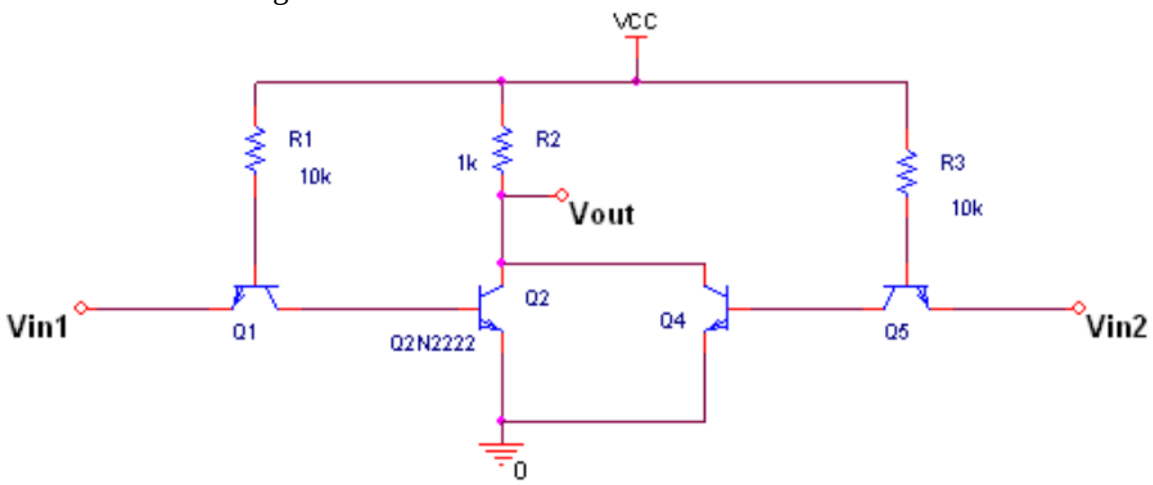
Part 2: DTL NOR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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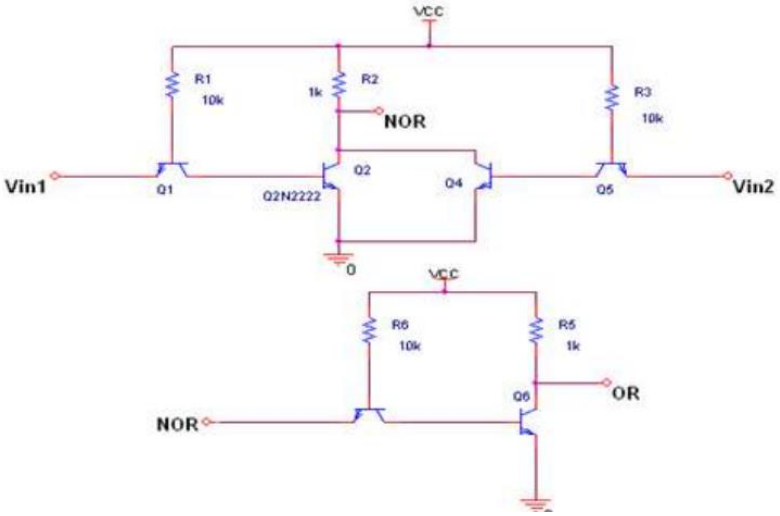
Part 3: TTL OR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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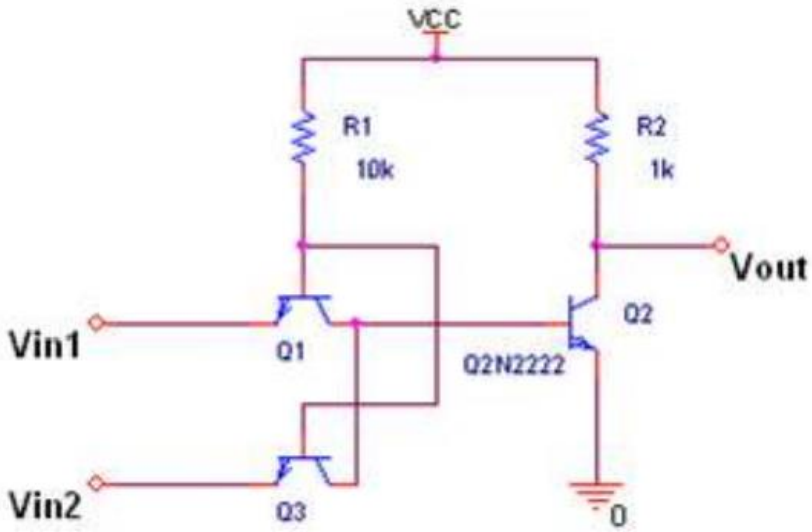
Part 4: TTL NAND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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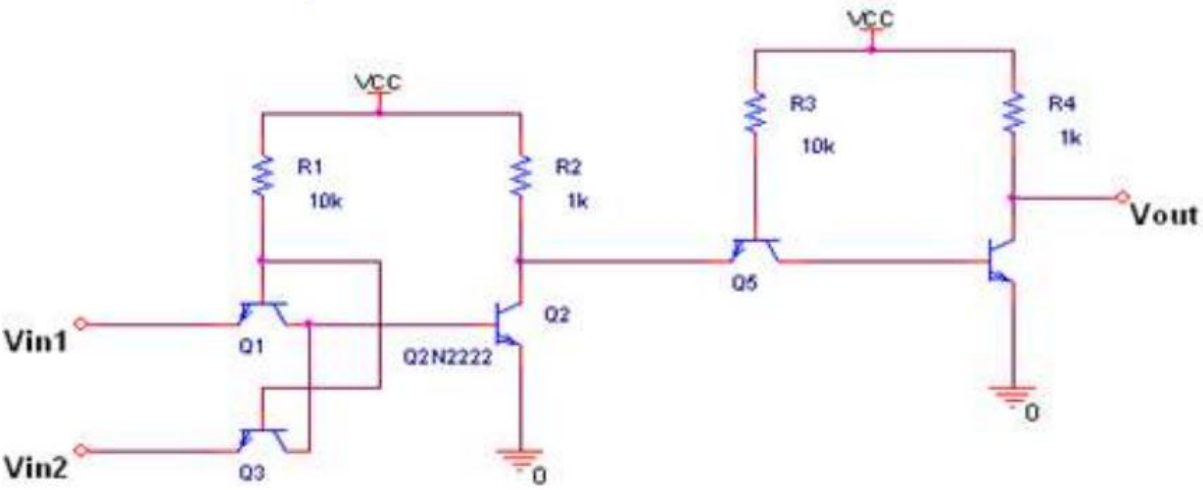
Part 5: DTL AND Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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Instructors
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Part 6: Comments

1. What is the difference between DTL and TTL in terms of propagation delay response?
2. What is the difference between DTL and TTL in terms of VTC?
3. Make a brief comparison between RTL gates DTL and TTL gates.

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Digital Electronics Laboratory

Instructors
Mohammed Sameer Lubbad
Israa Hamdi Abu Rayya

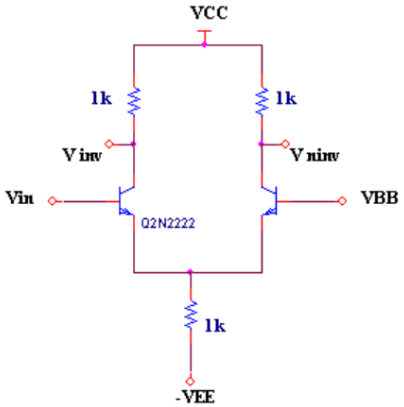
Important Hints:

- The simulation must be done **individually.**
- Simulation files must be **attached** to the assignment.
- You must mention the **names** of your colleague in **each** practical experiment.
- **Comments** are very important. Describe it in your own words. **DO NOT COPY**.

Experiment 6: Emitter-Coupled Logic

Part 1: ECL Inverter

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequency of Vin is 100Hz. Then deduce the **propagation delay response: Tphl, Tplh, Tp, Tr** and **Tf**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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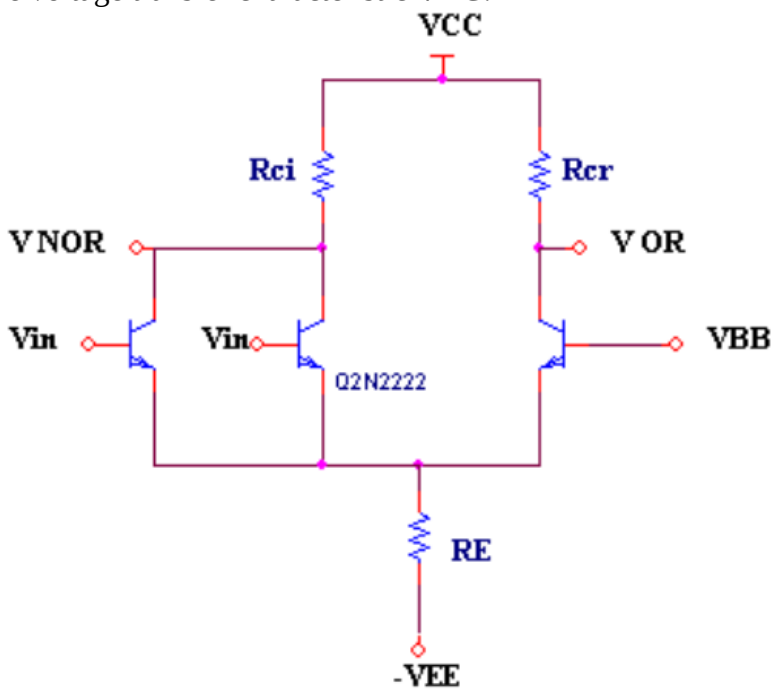
Part 2: ECL NOR Gate

- Simulation
  Simulate the following schematic in order to obtain
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**.



- Practical
  Build the previous schematic and obtain:
  - The **transient response** of the output voltage if the frequencies of A and B are 100Hz and 1KHz respectively. Then deduce the **truth table**.
  - The voltage transfer characteristic **VTC**: **VOH**, **VOL**, **VIH** and **VIL.**
  - Mention the **names** of your colleagues in this part.

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Part 3: Comments

1. What is the advantage of using ECL rather than other logic configurations?
2. What is the effect of changing V_{BB} on the VTC? Validate your answer with simulation.
3. What is the effect of changing R_E on the VTC? Validate your answer with simulation.