

**SUBMISSION REQUIREMENTS:**

- This assignment is to be completed *individually*.
- You must print-out, complete and submit the **last page** of this booklet by the due date.

**ANALYSIS OF A LADDER DIAGRAM**

**ASSIGNMENT:** Given the ladder diagram of a control system shown on the next page that contains **EIGHT RELAYS (A, B, X, L, G, M, R, and T)** and **FOUR INDICATOR LAMPS (Amber, Blue, Green, and Red)**,

**Determine the exact series of events** that will occur within the control system if an operator **performs the following ordered set of steps:**

- Step #1** – The “Power Switch” is **Closed (switched ON)**
- Step #2** – **Pushbutton #1** is **PRESSED**
- Step #3** – **Pushbutton #1** is **RELEASED**
- Step #4** – **Pushbutton #2** is **PRESSED**
- Step #5** – **Pushbutton #2** is **RELEASED**
- Step #6** – **Pushbutton #1** is **PRESSED**
- Step #7** – **Pushbutton #1** is **RELEASED**

The answer for Step #1 is already completed for you on the submission page.

As each step is performed, you must **SPECIFY** (on the last page of this booklet):

- a) The **exact order** in which any of the system’s **field-coils (A, B, X, L, G, M, R, and T)** are either **energized (ON)** or **de-energized (OFF)** until “**steady-state**” operation (SS) is reached for that specific step.

**Only show CHANGES in the state of any field coil when a step is performed.**  
For example – if coil A is energized (A ON) during a step, then coil A should not appear again in the remaining lists of coil changes unless it becomes de-energized (A OFF).

Note – be sure to specify **SS** when “**steady-state**” operation is finally reached. (I.e. – when no further changes will occur.)

- b) The **status (ON or OFF)** of all four **indicator lamps (Amber, Blue, Green, and Red)** **after** the system reaches **steady-state (SS) operation** for that specific step.

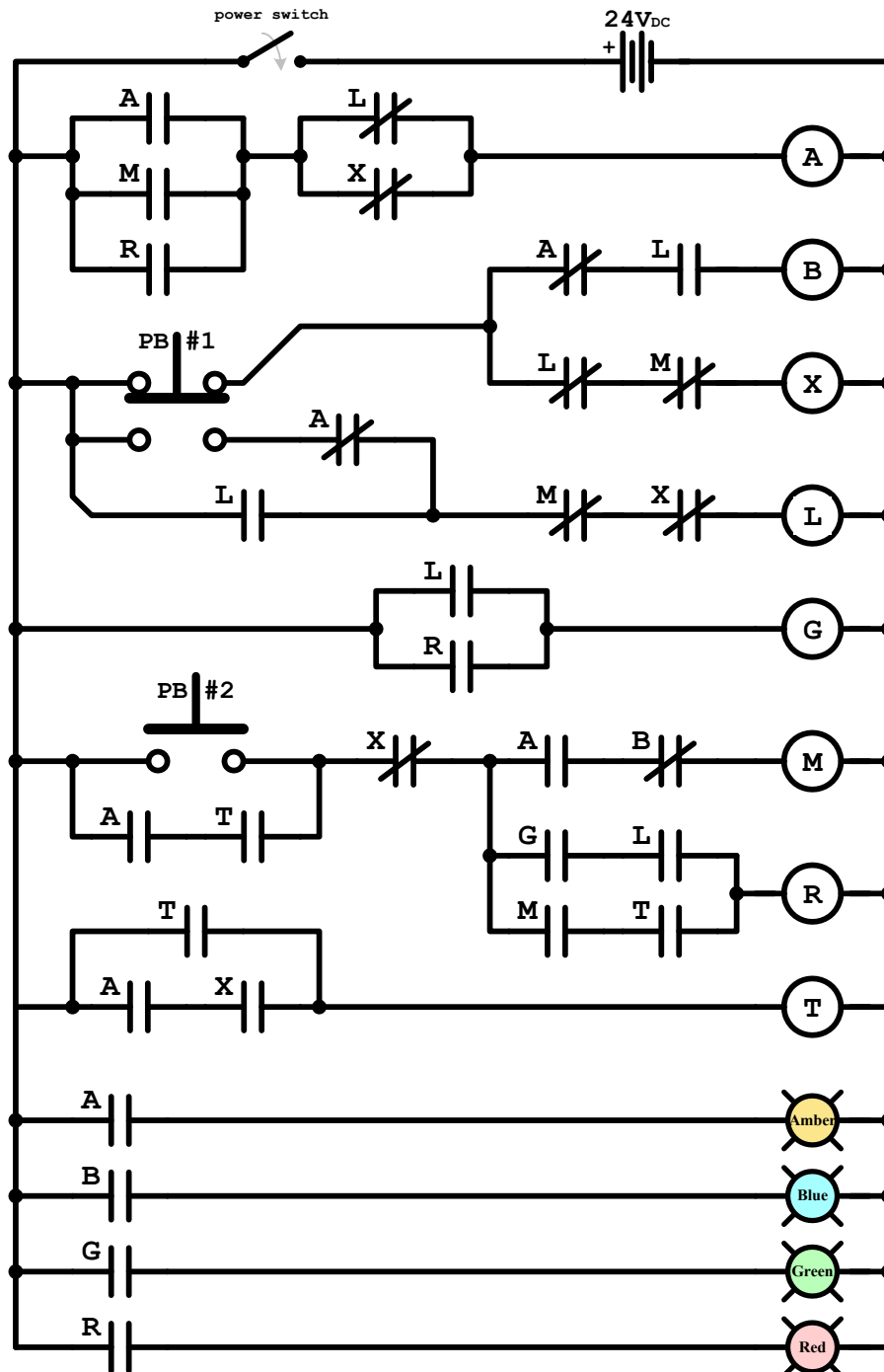
The following box contains an **EXAMPLE** of a set of answers for a single press and release of PB#1: (These are **NOT** the correct answers!)

Action	Field Coil Changes	“SS” denotes “Steady-State” (no further changes will occur)
<b>PB#1 Pressed:</b>	<u>    G ON    </u> → <u>    B ON    </u> → <u>    SS    </u> → _____ → _____	↙ ↘
<b>Indicator Lamp SS Status:</b>	Amber <u>    OFF    </u> Blue <u>    ON    </u> Green <u>    ON    </u> Red <u>    OFF    </u>	
<b>PB#1 Released:</b>	<u>    X ON    </u> → <u>    G OFF    </u> → <u>    A ON    </u> → <u>    SS    </u> → _____	↙ ↘
<b>Indicator Lamp SS Status:</b>	Amber <u>    ON    </u> Blue <u>    ON    </u> Green <u>    OFF    </u> Red <u>    OFF    </u>	

Once “SS” operation is reached, leave empty the remaining blanks (if any) provided for that step.

**The following guidelines must be followed when completing this assignment:**

- The **pressing** and the **releasing** of a specific pushbutton are considered two **independent steps**.
- Whenever a pushbutton is either pressed or released, assume that enough time will pass for the circuit to reach **steady-state conditions** before the next step is performed.
- Assume that there is a small **delay** between the time that a specific relay's field-coil is energized and the time that its contacts are actuated, and that there is a small **delay** between the time that a specific relay's field-coil is de-energized and the time that its contacts drop-out (return back to their normal position).
- Assume that all of the NO and NC contacts associated with a specific relay **transition simultaneously** (i.e. – from either OPENED→CLOSED or CLOSED→OPENED) when that relay's armature changes position.



**Only complete and submit THIS PAGE as your results for Lab Assignment 02.**

**ACTION**

**FIELD COIL STATUS CHANGES** (until steady-state operation is reached)

Step #1 **Switch Closed:**      X ON   →   SS   → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber  OFF     Blue  OFF     Green  OFF     Red  OFF 

*(Note that the answers for Step #1 have already been provided for you in the above spaces.)*

Step #2 **PB#1 Pressed:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

Step #3 **PB#1 Released:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

Step #4 **PB#2 Pressed:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → skip to next row

continued from  
previous row → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

*(Step #4 requires more blanks for the status changes of the field coils that would fit on one line.)*

Step #5 **PB#2 Released:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

Step #6 **PB#1 Pressed:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

Step #7 **PB#1 Released:**    \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_ → \_\_\_\_\_

Indicator Lamp SS Status:    Amber \_\_\_\_\_    Blue \_\_\_\_\_    Green \_\_\_\_\_    Red \_\_\_\_\_

**Hint – only ONE of the indicator lamps will be OFF after Step #7 is complete.**