CMR INSTITUTE OF TECHNOLOGY

USN | | | | | | | | | | |

Internal Assesment Test - II

Sub:	PROGRAMMABLE LOGIC CONTROLLERS							Code:	10EE752
Date:	03 / 11 / 2016	Duration:	90 mins	Max Marks:	50	Sem:	VII	Branch:	EEE

Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1	Explain branching and convergence with the help of Sequential Function Charts and Ladder Diagrams.	[10]	CO5	L4
2	Illustrate Conditional statements and Iteration Statements with supporting structured texts.	[10]	CO5	L3
3 (a)	Interpret Jumps within Jumps with supporting ladder diagram.	[06]	CO4	L2
(b)	Discuss the Response Time lag of a PLC with reference to internal relays and scan time.	[04]	CO4	L2
4	Write a note on Master Control Relay (MCR). Analyze any ladder diagram of your choice containing *two* MCRs and write the Mitsubishi code for the same.	[10]	CO4	L4
5	Show the separate systems for following applications. Draw the ladder diagram and explain its working. The system requirements are as follows: i) "4 Fire Sensors, 1 Stop Switch, 1 Alarm." Alarm should be continuously ON if any of the sensors detect the occurrence of fire and should be manually turned OFF using the Stop Switch. ii) "1 Start Switch, 1 Light Sensor, 1 Stop Switch." A work piece has been loaded into the correct position for some further operation. When the start contacts are closed then the output causes the work piece to move. This continues until a *light beam* is interrupted and resets, causing the output to cease. A *stop* button is available to stop the movement at any time.	[10]	CO6	L4
6 (a)	Name the types of timers and explain them with the timing diagram.	[06]	CO4	L1
(b)	Demonstrate a timer using TON Timer to get a pulsed Output, ON for 10 secs and OFF for 3 secs.	[04]	CO4	L3

Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1:	Describe the internal architecture and operating principles of PLC	1	1	3	2	3							1
CO2:	Identify the input and output devices for the custom requirement and the characteristics of it.	2	2	3	2	3							1
CO3:	Explain the processing of inputs and outputs by PLCs	2	2	3	2	3					1		1
CO4:	Modify and Develop ladder programs for the logical functions involving internal relays, timers, counters, shift register, sequencer & data handling.	3	2	2	1	3	3				2	1	3
CO5:	Create and Develop functional block diagram, instruction list, structured text and sequential function chart programs.	3	2	2	1	3	3				2	1	3
CO6:	Demonstrate the programs with reference to Mitsubishi PLC.	3	3	3	1	3	3				3	1	3

Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *Conduct investigations of complex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *Communication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*

CMR INSTITUTE OF TECHNOLOGY

USN | | | | | | | | | |

Internal Assesment Test - II

Sub:	PROGRAMMABLE LOGIC CONTROLLERS							Code:	10EE752
Date:	03 / 11 / 2016	Duration:	90 mins	Max Marks:	50	Sem:	VII	Branch:	EEE

Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1	Explain branching and convergence with the help of Sequential Function Charts and Ladder Diagrams.	[10]	CO5	L4

Selective branching is illustrated in Figure 6.15 and allows for different states to be realised depending on the transfer condition that occurs. Parallel branching (Figure 6.16), represented by a pair of horizontal lines, allows for two or more different states to be realised and proceed simultaneously. Figures 6.17 and 6.18 show how convergence is represented by an SFC. In Figure 6.17 the sequence can go from state 2 to state 4 if IN 4 occurs or from state 3 to state 4 if IN 5 occurs. In Figure 6.18 the sequence can go simultaneously from both state 2 and state 3 to state 4 if IN 4 occurs. As an illustration of the use of the above, Figure 6.19 shows part of a program represented by both its SFC and its ladder programs.

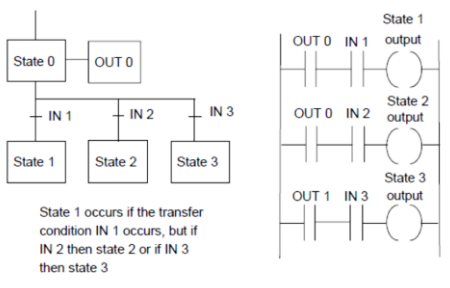


Figure 6.15 *Selective branching: the state that follows State 0 w depend on whether transition IN1, IN2 or IN3 occur.*

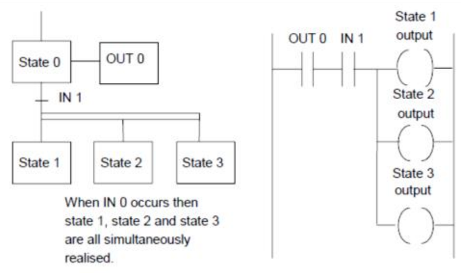


Figure 6.16 *Parallel branching states 1, 2 and 3 occur simultaneous when transition IN 1 occurs.*

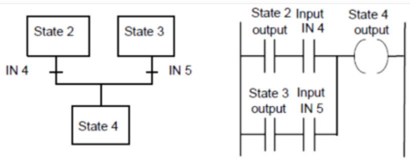


Figure 6.17 *Convergence: state 4 follows when either IN 4 or IN5 occur.*

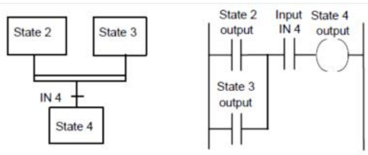


Figure 6.18 *Simultaneous convergence: when IN 4 occurs State 4 follows from either State 2 or 3.*

		Marks	CO	RBT
2	Illustrate Conditional statements and Iteration Statements with supporting structured texts.	[10]	CO5	L3

Conditional statements

IF ... THEN ... ELSE is used when selected statements are to be executed when certain conditions occur. For example:

```
IF (Limit_switch1 AND Workpiece_Present) THEN
Gate1 :- Open;
Gate2 :- Close;
ELSE
Gate1 :- Close;
Gate2 :- Open;
End_IF;
```

Note that the end of the IF statement has to be indicated. Another example, using PLC addresses,

is:
IF (I:000/00 = 1) THEN
O:001/00 :- 1;
ELSE
O:000/01 = 0;
End_IF;
So if there is an input to I:000/00 to make it 1 then output O:001/00 is 1, otherwise it 0.
CASE is used to give the condition that selected statements are to be executed if a particular integer value occurs else some other selected statements. For example, for temperature control we might have:
CASE (Temperature) OF 0 ... 40 ;
Furnace_switch :- On;
40 ... 100
Furnace_switch :- Off;
ELSE
Furnace_switch :- Off;
End_CASE;
Note, as with all conditional statements, the end of the CASE statement has to be indicated.

Iteration statements

These are used where it is necessary to repeat one or more statements a number of times, depending on the state of some variable. The FOR ... DO iteration statement allows a set of statements to be repeated depending on the value of the iteration integer variable. For example:

```
FOR Input :- 10 to 0 BY -1
DO
Output :- Input;
End_FOR;
```

has the output decreasing by 1 each time the input, dropping from 10 to 0, decreases by 1.
WHILE ... DO allows one or more statements to be executed while a particular Boolean expression remains true, e.g.:
OutputQ :- 0;
WHILE InputA AND InputB
DO
OutputQ =: OutputQ + 1;
End_WHILE;
REPEAT ... UNTIL allows one or more statements to be executed and repeated whilst a particular Boolean expression remains true.
OutputQ :- 0
REPEAT
OutputQ = OutputQ + 1;
UNTIL (Input1 = Off) OR (OutputQ > 5)
End_REPEAT;

3 (a)	Interpret Jumps within Jumps with supporting ladder diagram.	[06]	CO4	L2

Jumps within jumps are possible. For example, we might have the situation shown in Figure 8.4. If the condition for the jump instruction 1 is realised then the program jumps to rung 8. If the condition is not met then the program continues to rung 3. If the condition for the jump instruction 2 is realised then the program jumps to rung 6. If the condition is not met then the program continues through the rungs. Thus if we have an input to In 1, the rung sequence is rung 1, 8, etc. If we have no input to In 1 but an input to In 3, then the rung sequence is 1, 2, 6, 7, 8, etc. If we have no input to In 1 and no input to In 3, the rung sequence is 1, 2, 3, 4, 5, 6, 7, 8, etc. The jump instruction enables different groups of program rungs to be selected, depending on the conditions occurring.

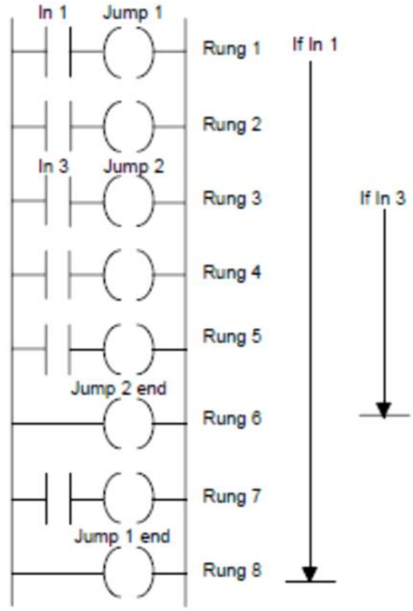


Figure 8.4 *Jumps within jumps*

(b) Discuss the Response Time lag of a PLC with reference to internal relays and scan time. [04] CO4 L2

The time taken between an input occurring and an output changing depends on such factors as the electrical response time of input circuit, the mechanical response of the output device and the scan time of the program. A ladder program is read from left to right and from top to bottom. Thus if an output device, such as an internal relay, is set in one scan cycle and the output has to be fed back to earlier in the program, it will require a second scan of the program before it can be activated. Figure 7.7 illustrates this concept.

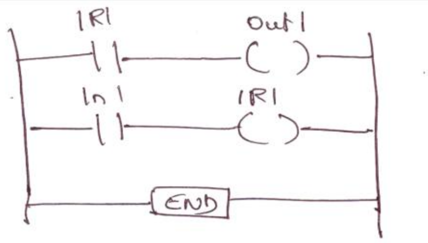


Fig.7.7 Response time lag arising from scan time.

4 Write a note on Master Control Relay (MCR). Analyze any ladder diagram of your choice containing *two* MCRs and write the Mitsubishi code for the same. [10] CO4 L4

When large numbers of outputs have to be controlled, it is sometimes necessary for whole sections of ladder diagrams to be turned on or off when certain criteria are realised. This could be achieved by including thecontacts of the same internal relay in each of the rungs so that its operation affects all of them. An alternative is to use a *master control relay*.

A program might use a number of master control relays, enabling various sections of a ladder program to be switched in or out. Figure 7.26 shows a ladder program in Mitsubishi format involving two master control relays. With M100 switched on, but M101 off, the sequence is:

rungs 1, 3, 4, 6, etc. The end of the M100 controlled section is indicated by the occurrence of the other master control relay, M101. With M101 switched on, but M100 off, the sequence is: rungs 2, 4, 5, 6, etc. The end of this section is indicated by the presence of the reset. This reset has to be used since the rung is not followed immediately by another master control relay. Such an arrangement could be used to switch on one set of ladder rungs if one type of input occurs, and another set of ladder rungs if a different input occurs.

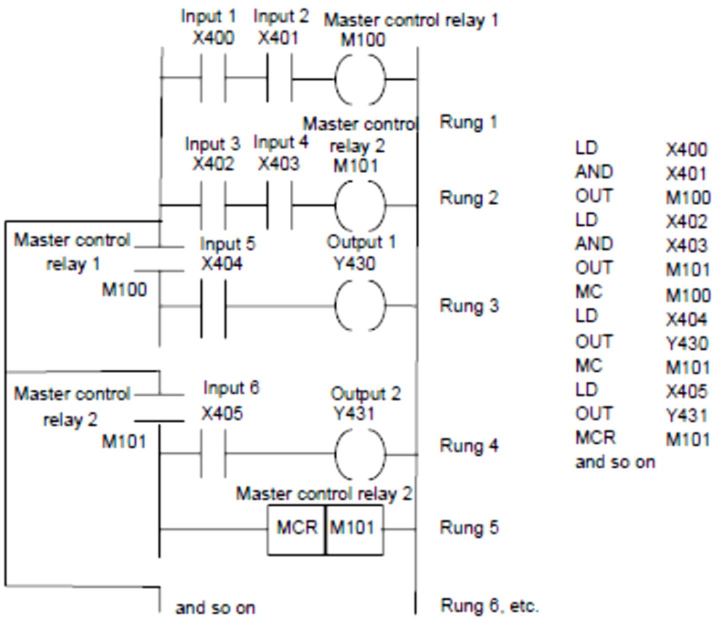
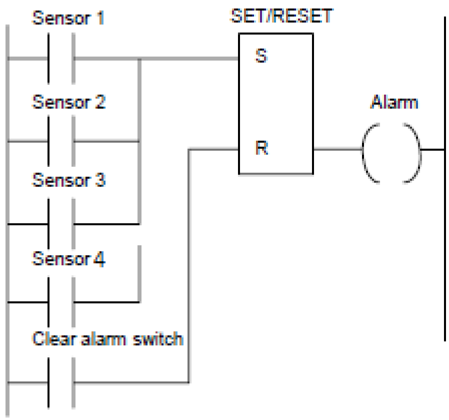


Fig.7.26 Two MCRs

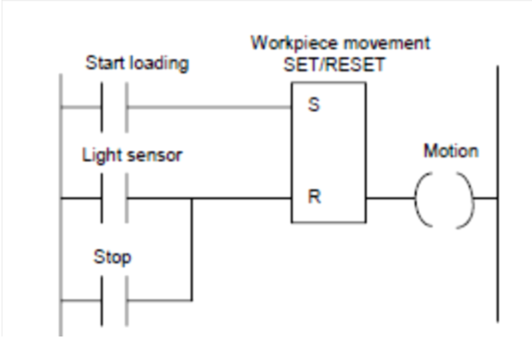
5 Show the separate systems for following applications. Draw the ladder diagram and explain its working. The system requirements are as follows: [10] CO6 L4

i) "4 Fire Sensors, 1 Stop Switch, 1 Alarm."
Alarm should be continuously ON if any of the sensors detect the occurrence of fire and should be manually turned OFF using the Stop Switch.



ii) "1 Start Switch, 1 Light Sensor, 1 Stop Switch."
A work piece has been loaded into the correct position for some further operation. When the start contacts are closed then the output causes the work piece to move. This continues until a *light beam* is interrupted and

resets, causing the output to cease. A *stop* button is available to stop the movement at any time.



6 (a) Name the types of timers and explain them with the timing diagram. [06] CO4 L1

9.1 Types of Timers

PLC manufacturers differ on how timers should be programmed and hence how they can be considered. A common approach is to consider timers to behave like relays with coils that when energized, result in the closure or opening of contacts after some preset time. The timer is thus treated as an output for a rung, with control being exercised over pairs of contacts elsewhere (Figure 9.1a). This is the predominant approach used in this book. Some treat a timer as a delay block that when inserted in a rung, delays signals in that rung from reaching the output (Figure 9.1b).

There are a number of different forms of timers that can be found with PLCs: *on-delay*, *off-delay*, and *pulse*. With small PLCs there is likely to be just one form, the on-delay timers. Figure 9.2 shows the IEC symbols. TON is used to denote on-delay, TOF off-delay, and TP pulse timers. On-delay is also represented by T–0 and off-delay by 0–T.

On-delay timers (TON) come on after a particular time delay (Figure 9.3a). Thus as the input goes from 0 to 1, the elapsed time starts to increase, and when it reaches the time specified by the input PT, the output goes to 1. An *off-delay timer* (TOF) is on for a fixed period of time before turning off (Figure 9.3b). The timer starts when the input signal changes from 1 to 0. Another type of timer is the *pulse timer* (TP). This timer gives an output of 1 for a fixed period of time (Figure 9.3c), starting when the input goes from 0 to 1 and switching back to 0 when the set time PT has elapsed.

The time duration for which a timer has been set is termed the *preset* and is set in multiples of the time base used. Some time bases are typically 10 ms, 100 ms, 1 s, 10 s, and 100 s. Thus a preset value of 5 with a time base of 100 ms is a time of 500 ms. For convenience, where timers are involved in this text, a time base of 1 s has been used.

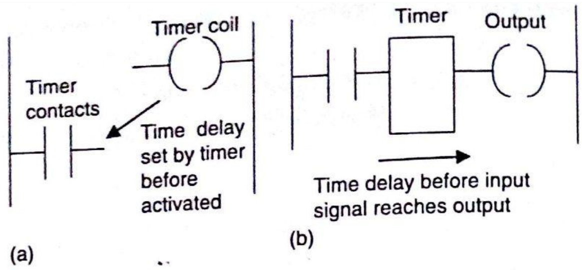


Figure 9.1: Treatment of timers.

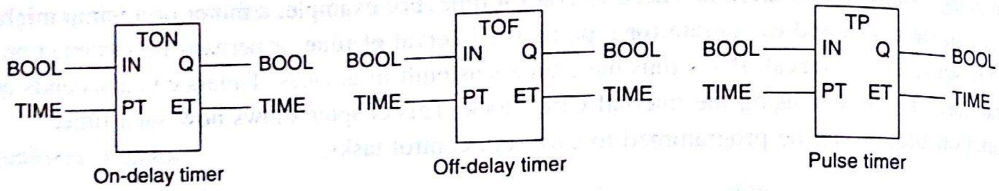


Figure 9.2: IEC 1131-1 standards: IN is the Boolean input. Q is the Boolean output. ET is the elapsed time output. PT is the input used to specify the time delay or pulse duration required.

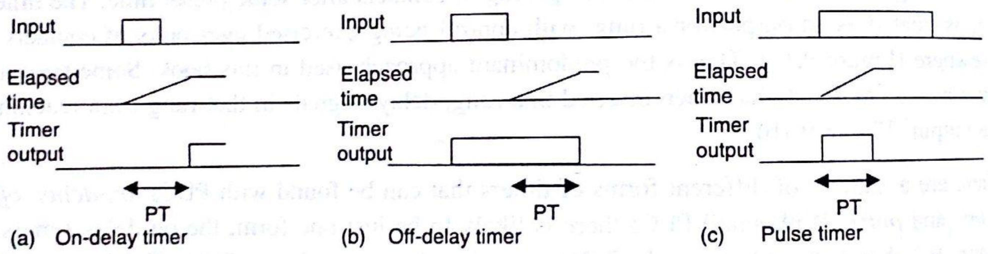


Figure 9.3: Timers: (a) on-delay, (b) off-delay, and (c) pulse.

9.2 On-Delay Timers

All PLCs generally have on-delay timers; small PLCs possibly have only this type of time Figure 9.4a shows a ladder rung diagram involving a on-delay timer. Figure 9.4a is typic of Mitsubishi. The timer is like a relay with a coil that is energized when input In 1 occu (rung 1). It then closes, after some preset time delay, its contacts on rung 2. Thus the outp occurs some preset time after input In 1 occurs. Figure 9.4b, an example of a possible Siemens setup, shows the timer to be a delay item in a rung, rather than a relay. When tl signal at the timer's start input changes from 0 to 1, the timer starts and runs for the programmed duration, giving its output then to the output coil. The time value (TV) outp can be used to ascertain the amount of time remaining at any instant. A signal input of 1 the reset input resets the timer whether it is running or not. Techniques for the entry of

(b) Demonstrate a timer using TON Timer to get a pulsed Output, ON for 10 secs and OFF for 3 secs. [04] CO4 L3

Figure 9.8 shows how on-delay timers can be used to produce an *on−off cycle timer*. The timer is designed to switch on an output for 5 s, then off for 5 s, then on for 5 s, then off for 5 s, and so on. When there is an input to In 1 and its contacts close, timer 1 starts. Timer 1 is set for a delay of 5 s. After 5 s, it switches on timer 2 and the output Out 1. Timer 2 has a delay of 5 s. After 5 s, the contacts for timer 2, which are normally closed, 162 *Programmable Logic Controllers* open. This results in timer 1, in the first rung, being switched off. This then causes its contacts in the second rung to open and switch off timer 2. This results in the timer 2 contacts resuming their normally closed state and so the input to In 1 causes the cycle to start all over again. Figure 9.9

shows how the above ladder program would appear in the format used with a timer considered as a delay, rather than as a coil. This might, for example, be with Siemens or Toshiba. When input In 1 closes, the timer T1 starts. After its preset time, there is an output to Out 1 and timer T2 starts. After its preset time there is an output to the internal relay IR1. This opens its contacts and stops the output from Out 1. This then switches off timer T2. The entire cycle can then repeat itself.

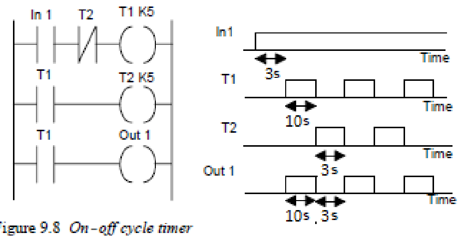
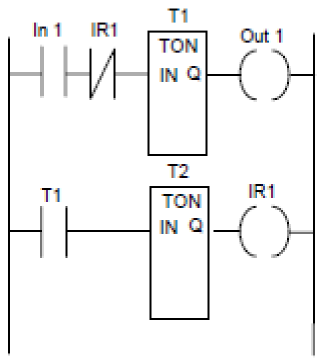


Figure 9.8 *On-off cycle timer*



Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1:	Describe the internal architecture and operating principles of PLC	1	1	3	2	3							1
CO2:	Identify the input and output devices for the custom requirement and the characteristics of it.	2	2	3	2	3							1
CO3:	Explain the processing of inputs and outputs by PLCs	2	2	3	2	3					1		1
CO4:	Modify and Develop ladder programs for the logical functions involving internal relays, timers, counters, shift register, sequencer & data handling.	3	2	2	1	3	3				2	1	3
CO5:	Create and Develop functional block diagram, instruction list, structured text and sequential function chart programs.	3	2	2	1	3	3				2	1	3
CO6:	Demonstrate the programs with reference to Mitsubishi PLC.	3	3	3	1	3	3				3	1	3

Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *Conduct investigations of complex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *Communication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*