Mittuniversitetet
MID SWEDEN UNIVERSITY

Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
ET084G	T101	2018-05-28

Kursnamn	Elektroteknik GR (A), Introduktion till styr- och reglert...
Provnamn	Skriftlig tentamen
Ort	Sundsvall
Termin	V18
Ämne	Elektroteknik

Arkiv

Exam in Introduction to Automatic Control (Introduktion till Styr- och Reglerteknik)

Course codes: ET084G

Date:	28th of May 2018, 3 hours
Examiner:	Stefan Haller
E-Mail:	stefan.haller@miun.se
Maximum achievable points:	100 (+6 bonus)
Minimum required points to pass (preliminary):	50
Aids (Hjälpmedel):	Simple Calculator Ordinary Dictionary

Instructions

- Do not write in red color
- Do not write on the backside of any paper, since your exam will be scanned
- The points for each question are mentioned on the right side in the box
- For every calculation, the way towards the result has to be clearly understandable
- Argumentation and justifications need to be clearly traceable
- The reasoning behind used equations should be explained
- The calculations shall be sufficiently complete to show how the final result was obtained
- Each task must be concluded with a clearly written answer
- Answer all questions
- Do not write any answer on question paper, expect of multiple choice questions (part 1)

Good luck!!!

1 Multiple Choice - 40 points

Choose the right answer(s). Each question has 2 points, **for every mistake 1 point is deducted. One or multiple answers could be correct. Not answering a question will not lead to any point deduction.**
The minimum score for this part is 0 (the summed result for this multiple choice part can not be negative). You may answer the multiple choice questions on the exam sheet. Please ensure that you return all papers that contain your answers!

1. Convert 0x9A to binary, $(9A)_{16} = (x)_2$ [2]
   - ○ 0b101011010
   - ○ 0b10011010
   - ○ 0b10010000
   - ○ 0b10110110
   - ○ 0b11011101

2. Convert 0x9B to binary, $(9B)_{16} = (x)_2$ [2]
   - ○ 0b11111101
   - ○ 0b10110110
   - ○ 0b00110101
   - ○ 0b10011011
   - ○ 0b10101110

3. Convert 0b101011110101 to decimal, $(101011110101)_2 = (x)_{10}$ [2]
   - ○ 2048
   - ○ 2940
   - ○ 3700
   - ○ 1023
   - ○ 2805

4. Convert 123 to hexadecimal, $(123)_{10} = (x)_{16}$ [2]
   - ○ 0x1D
   - ○ 0x3F
   - ○ 0x7B
   - ○ 0x70
   - ○ 0x0D

5. Which voltage level is used commonly in industrial applications for supplying programmable control equipment such as PLCs? [2]
   - ○ 12 V DC
   - ○ 1–10 V DC
   - ○ 188 V AC
   - ○ 24 V DC
   - ○ 0–10 V AC

6. Also analog current control signals are used in industry. Which type of current control signals are commonly used? [2]
   - ○ 4–20 mA
   - ○ 0–20 mA
   - ○ 4-20 MA
   - ○ 16 A
   - ○ 1–10 A

7. Which PLC output type is shown in figure 1? [2]
   - ○ Relay output
   - ○ Transistor output
   - ○ Transistor input
   - ○ Triac output
   - ○ MOSFET output

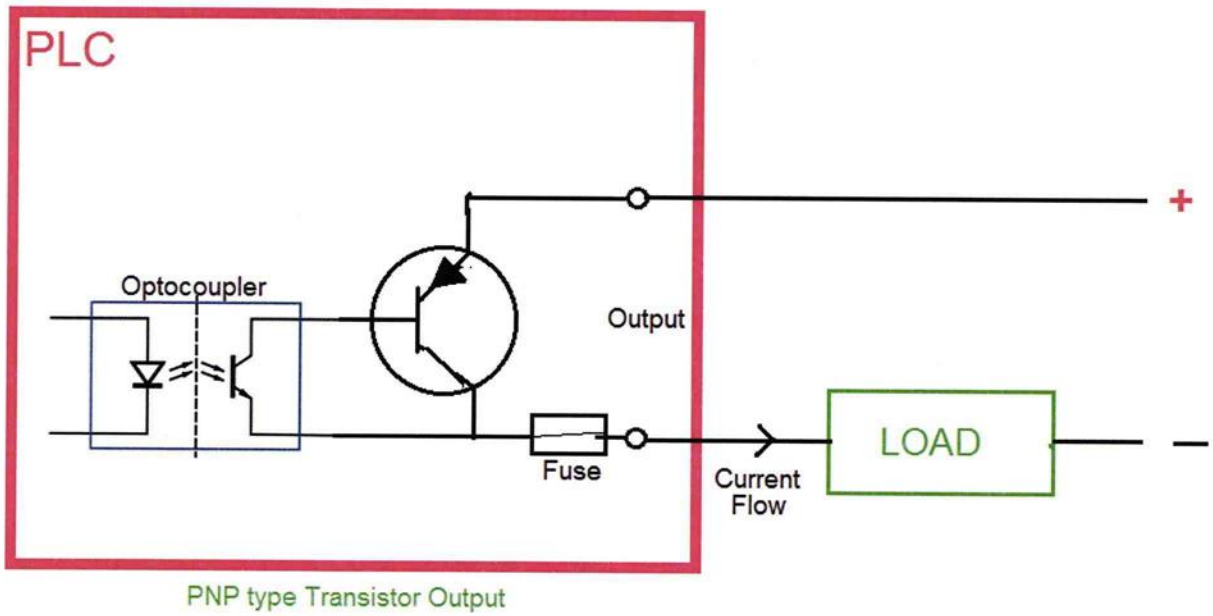

Figure 1: PLC output

8. The digital PLC output shown in figure 1 [2]
   - ◯ is a current source
   - ◯ is a current sink
   - ◯ can not handle DC current
   - ◯ is optically isolated
   - ◯ uses a relay

9. The truth table in table 1 represents which logical circuit? [2]

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

Table 1: Truth table

   - ◯ NAND
   - ◯ NOR
   - ◯ AND
   - ◯ OR
   - ◯ XOR

10. A sensor delivers an output signal of 4–20 mA which is proportional to the measured physical quantity, which type of input needs be used on a PLC? [2]
    - ◯ digital input
    - ◯ analog current input
    - ◯ analog voltage input
    - ◯ relay input
    - ◯ fieldbus input

11. Your colleagues are asking for help since they observed an unpredictable behavioral of their PLC program. While investigating the code, you observe that the memory bits %M0.4 and %M1.1 are used to store logic states. A memory function uses %MB0 to store the amount of packets passed by on a conveyor belt. After inspecting the code you suggest to solve the issue by [2]
    - ◯ resetting the PLC memory
    - ◯ downloading the program again
    - ◯ using %M0.1 instead of %M1.1
    - ◯ using %M1.4 instead of %M0.4
    - ◯ using %MB2 instead of %MB0

12. Which passive device can be used to convert a digital signal pulse width modulated signal to an analog signal? [2]

- ◯ SDC (Sensor to Digital Converter)
- ◯ ADC
- ◯ DAC
- ◯ RC filter
- ◯ XOR - Gate

13. What is the disadvantage of a PLC relay output? [2]

- ◯ Can only switch DC current
- ◯ Can only switch AC current
- ◯ Slower compared to a transistor output
- ◯ It is a mechanical device and thus limited amount of switching cycles
- ◯ Can not switch analog and digital signals

14. Which statement is true for a PT100? [2]

- ◯ It is a sensor that can be used to directly measure pressure
- ◯ Provides a negative temperature coefficient
- ◯ Can only be operated with AC current
- ◯ Has a nominal resistance of 100 Ω at 0 °C
- ◯ Has a nominal resistance of 100 Ω at 0 K

15. The device in figure 2 is used to measure [2]

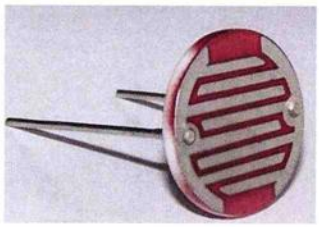

Figure 2: Measurement device

- ◯ temperature
- ◯ light intensity
- ◯ viscosity
- ◯ absolute pressure
- ◯ speed of light

16. What is the advantage of a regulator compared to a controller? 2

- ◯ The regulator is a controller with a closed loop
- ◯ The regulator uses a feedback
- ◯ There is no difference between a controller and a regulator
- ◯ Only a controller uses the current measured value as feedback
- ◯ A controller is a part of a regulator

17. Which type of device is shown in figure 3 and what is the absolute gain if $R1 = 2\,\text{k}\Omega$ and $RF = 20\,\text{k}\Omega$? 2

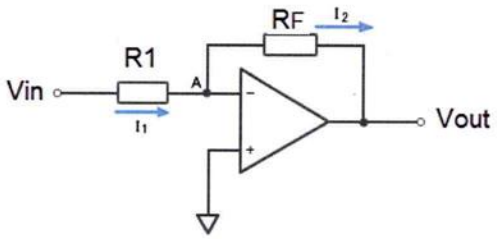

Figure 3: Device

- ◯ Wien bridge oscillator
- ◯ Inverting integrator
- ◯ Amplifier with a phase shift of 180°
- ◯ Inverting amplifier
- ◯ Gain of 10
- ◯ Gain of 20

18. A PID-regulator 2

- ◯ only requires a gain factor
- ◯ has a proportional function
- ◯ has a derivative function
- ◯ has a integrator function
- ◯ only uses a gain factor and integration time

19. In a Bridge circuit if $R1 = R2 = R3 = PT100$ the bridge is said to be 2

- ◯ in un-balance
- ◯ in a zero error state
- ◯ in balance
- ◯ in lead compensated mode

20. Mark the power supply and the CPU of the PLC shown in Figure 4 [2]

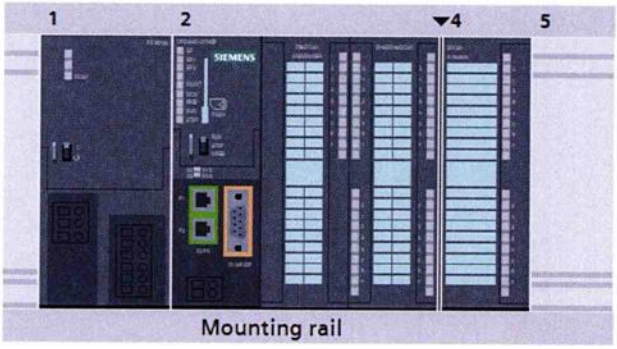

Figure 4: S7 PLC

2 SR-Latch - 15 points

Figure 5 shows a very efficient implementation of an SR-latch.

1. Derive the truth table for the latch, shown in table 2. [5]
2. Which condition of the truth table should be avoided for this SR-latch implementation? [2]
3. Why should this condition be avoided? Explain the behavioral when entering and leaving this condition. [3]
4. Create an SR-latch PLC program in Ladder Logic (LAD) that uses just one network. Do not use any predefined function block. [5]

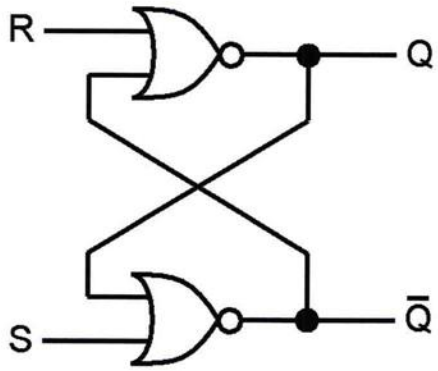

Figure 5: SR-latch

S	R	Q	Q'
1	0		
0	0		
0	1		
0	0		
1	1		

Table 2: SR-latch truth table

3 Elevator Safety - 10 points

Assume you have created a PLC program for an elevator. The elevator requires 2 driving signals for the motor to indicate the direction the cabin should move. Assume you have 2 memory bits (#drive_up) and (#drive_down) that represent the driving signals of your existing elevator PLC program. To ensure proper operation and guarantee the safety, at no point in time both driving outputs are allowed be activated simultaneously. Add the required logic between the memory bits (#drive_up), (#drive_down) and the PLC hardware digital output (%Q136.0 for up and %Q136.1 for down).

1. Use Ladder Logic (LAD) for this task. [5]
2. Use Function Block Diagram (FBD) for this task. [5]
3. Use Statement List (STL) for this task. [5 (bonus)]

4 PLC Scan cycle - 5 points

A PLC program is executed sequentially. However, the inputs and outputs are not read and updated instantaneously.

1. Sketch a typical PLC scan cycle (scanning), that contains the user program execution, write/update of outputs as well as reading of the inputs. [5]
2. What is the typical time span of a PLC scan cycle. [1 (bonus)]