Mittuniversitetet
MID SWEDEN UNIVERSITY

Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
ET086G	T101	2019-01-16

Kursnamn	Elektroteknik GR (B), Styr- och reglerteknik
Provnamn	Skriftlig tentamen
Ort	Sundsvall
Termin	
Ämne	

Date: 2019-01-16 (3 hours)
Allowed aids: Calculator, Ordinary dictionary
Responsible Teacher: Mazhar Hussain, tel: 0101428748 (**E-mail:** mazhar.hussain@miun.se)

Number of tasks: 06

Number of pages: 10

Maximum points: 100 (50 points required to pass)

Instructions for submitted solutions:

- Rationale and justifications may not be so scarce that they become difficult to follow.
- 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.
- Answers can be written in English or in Swedish.

1. Choose the suitable answer.
Note: There will be no negative points for wrong answer.

1.1. "*For sudden or constant error controller's output is zero and it may even drive the process to instability*" This statement is true for which controller mode (1p)

- **a. ON/OFF mode**
- **b. Derivative mode**
- **c. Proportional mode**
- **d. Integral mode**

1.2. A velocity control, system has a range of 220 to 460 mm/s. If the set-point is 327mm/s and the measured value is 294 mm/s. what will be the error as percentage of span? (1p)

- **a. 13.75 mm/s**
- **b. 33mm/s**
- **c. -13.75%**
- **d. -13.75mm/s**
- **e. 10.1 %**
- **f. 13.75%**

1.3. Figure01 is a symbol of___ (1p)

Figure01

- a. **Heat Exchanger**
- b. **Pump**
- c. **Orifice tube used to create the pressure drop to determine flow rate**
- d. **Valve with actuator**

1.4. A control application where the load varies, which type of control structure is suitable? (1p)

- a. **Feed-Forward Control**
- b. **Ratio Control**
- c. **Cascaded Control**
- d. **Both the Ratio and Cascaded Control**

1.5. If the control Error E is more negative when the control signal increases, the action of the controller is said to be: (1p)

- a. **Reverse Acting**
- b. **Direct Acting**
- c. **Dynamic error**
- d. **D Action**

1.6. In a controller with *PID* or *PD controller,* if the Control Variable (*CV*) increases because of disturbance in the process (*for example a heating process*) then the *D component* forms a____________. (1p)

- a. **Negative manipulating variable to counteract the increase in Control Variable**
- b. **High gain to increase the control variable as much as possible**
- c. **Positive manipulating variable to support the increase in Control Variable.**
- d. **Stationary error to avoid oscillation**

1.7.If a system has many CURRENT VALUE's(PV) the system is called: (1p)

- a. **Dynamic system**
- b. **Multivariable system**
- c. **Close loop control system**
- d. **Open loop control system**
- e. **Ratio control**

1.8. Large proportional band makes the controller. (1p)

- a. **More sensitive**
- b. **Less sensitive**
- c. **Low cost**
- d. **Multivariable**

1.9. In a process if the change in control variable from 30% to 81% creates a change in speed (PV) from 120 rpm to 180 rpm what will be the process gain? (1p)

a. **1.17 rpm**
b. **0.8 rpm**
c. **1.17 rpm/ %**
d. **0.8 rpm/%**

1.10. The Output of the Process transfer function(Hp) is : (1p)

a. **Process variable PV**
b. **Error E**
c. **Set Point SP**
d. **Control Variable CV**

1.11. Closed loop systems are systems, which uses process variable (PV) as reference and therefore receive process variable as feedback. (1p)

a. **True**
b. **False**

1.12. The control variable output ($CV_{(t)}$) of an Integral mode controller, starting from the set point value is expressed with following equation. (1p)

a. $CV_{(t)} = K_p E + PV_{(E=10)}$
b. $CV_{(t)} = K_p E + CV_{(t=0)}$
c. $CV_{(t)} = K_i \int_0^t E\, dt + CV_{(t=0)}$
d. $CV_{(t)} = K_p \int_0^t E\, dt + CV_{(t=0)}$

1.13. Which of these expressions representing the transfer function of an open loop system? (1p)

a. $\frac{PV_{(s)}}{SP_{(s)}} = Hc_{(s)} Hp_{(s)}$
b. $\frac{PV_{(s)}}{SP_{(s)}} = \frac{Hc_{(s)} Hp_{(s)}}{Hc_{(s)} Hp_{(s)} + 1}$
c. $\frac{SP_{(s)}}{PV_{(s)}} = \frac{Hc_{(s)} Hp_{(s)}}{Hc_{(s)} Hp_{(s)} + 1}$
d. $\frac{SP_{(s)}}{PV_{(s)}} = Hc_{(s)} Hp_{(s)}$

1.14. A proportional-derivative (PD) controller provides better response stability than a PI controller, but it does not eliminate offset error. (1p)

a. **True**
b. **False**

1.15. In a Slow responding process when integral windup can happen? (1p)

a. **During the large disturbance**
b. **During manual tuning**
c. **During the start-up of the process**
d. **When integral gain is negative for a reverse acting controller**

1.16. **Control processes generally tuned under start up conditions, instead of operating conditions, so that the process variable is stable at an operating point when the process reaches to operating conditions.** (1p)

a. **True**
b. **False**

1.17. **An equation that describes a process in terms of response over time, as well as calculates the outcome of the process variable(PV) is called:** (1p)

a. **Process dynamics**
b. **Transfer function**
c. **Step response**
d. **Laplace transform**

1.18. **If the integral time *Ti* is 4 seconds what will be the integral gain *Ki*?** (1p)

a. **2 sec^{-1}**
b. **0.5 sec^{-1}**
c. **4 sec^{-1}**
d. **0.25 sec^{-1}**

1.19. **Which of these option represent controller's open loop transfer function:** (1p)

a. $Hc=\frac{CV}{E}$

b. $Hc=\frac{PV}{CV}$

c. $Hc=Hp$

d. $Hc=\frac{E}{PV}$

1.20. **If one has to use Discrete mode controller in a process then in order to reduce the cycling behaviour of the process variable:** (1p)

a. **Two position controller will be the best choice**
b. **Direct acting controller will be the best choice**
c. **Analog controller will be the best choice**
d. **Three position controller will be the best choice**

2. A process system (see figure02) has a first-order response with a time constant of 430 seconds and process gain of 1.

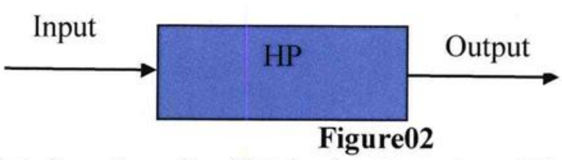

Figure02

a) Calculate how long it will take for the value of the output to be at 80% of the input if input changes to a unit step. (10p)

b) Calculate how long it will take the value of output (OUT) to be at 80% of input if the dead time is 3 minute. (5p)

3. **An integral controller is use for speed control of a conveyor belt with a set-point of 12rpm within a range of 10 to 15 rpm. The controller output is 22% initially. The integral gain is 0.15% controller output per second per percentage error. If the speed jumps to 13.5 rpm, calculate the controller output after 2s for a constant error.** (15p)

4. **In a tank filled with chemical, a proportional controller is in use to regulate the temperature, the controlled variable is a process temperature with a range of 50 to 130 °C and a setpoint of 73.5 °C. Under nominal conditions, the set-point is maintained with an output of 50%. Find the proportional offset error resulting from a load change that requires a 55% output if the proportional gain is:**
   a. **0.1** (5p)
   b. **0.7** (2p)
   c. **2.0** (2p)
   d. **5.0.** (2p)
   e. **What is your observation after calculating the results from a to d?** (4p)

5. **With the help of the response of process variable PV shown in the graph in** *APPENDIX 1*. **Determine the loop tuning constants using** *Ziegler and Nicole's closed loop tuning method.*

   a) **Determine the Ultimate proportional gain (*K_{PU}*).** (5p)
   b) **Determine the Ultimate period (*T_U*).** (5p)
   c) **Find the values the loop tuning constants of the Controller (P, PI and PID).** (10p)

6. Identify and write the names of the Symbolic notations shown in this process (see figure03). (15p)

Note: In APPENDIX 2, table T-2 and table T- 3 contain some symbolic names.

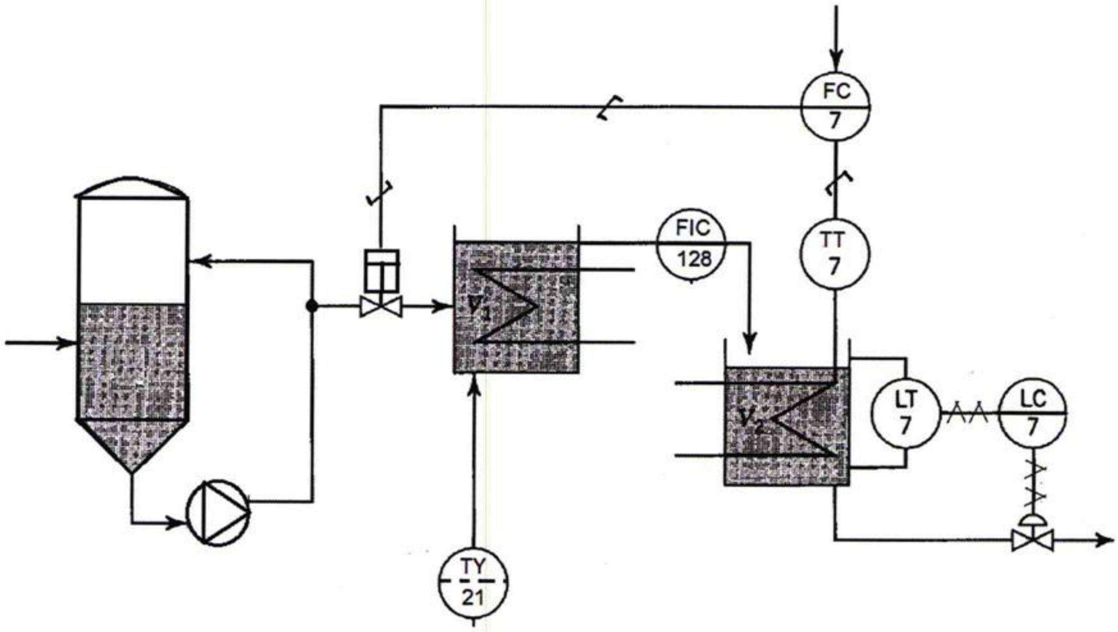

Figure03