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Ref No: EE/T/413/18/2017 (S)

BACHELOR OF ELECTRICAL ENGINEERING 4TH YR 1ST SEM. (SUPPLE) EXAM., 2017

SUBJECT: - PROCES INSTRUMENTATION & CONTROL

Time: Three hours

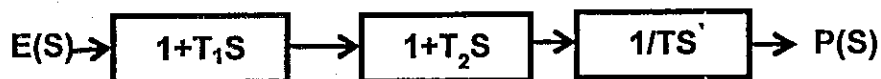
Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

PART I

Answer Question: 1 and any TWO from the rest:

1. **Answer any four :** 4×5=20
- a) Prove that the electrical resistance analogous for flowing fluid through a pipe is not linear.
 - b) Why interacting process may produce oscillation in process output?
 - c) Why non-interacting PID controller has better performance than interacting type PID controller?
 - d) Why dead time may cause instability for a given order process?
 - e) Why lifting gate control valve is used for flow control of fluid containing solid matters?
 - f) Why the transfer function of zero order hold system is considered in discrete controller?
2. a) Implement the following discontinuous controllers using op-amp circuits: 5+5+5
- (i) Single mode (ON/OFF) controller with dead zone.
 - (ii) Multi position controller
- b) Show that for PID controller, the phase of its output is a function of rate time and reset time for sinusoidal deviation.
- c) Indicate the mode of control action for the following input-output relation of continuous control mode and find the value of parameters.



Turn over]

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3. a) Explain how integral wind up effect can be eliminated using Clegg integrator? 5+5+5
- b) Realize a digital PI control rule following incremental form.
- c) State the significance of dead time. How it can be approximated in terms of poles and zeros.
4. a) Derive the expression between % flow and lift for lift for linear and equal percentage control valves. 5+6+4
- b) Distinguished between the operation of motorized linear and rotary electric actuator.
- c) What is meant by rangibility of control valve? How it is related to valve sensitivity?
5. **Write short notes on any three:** 5×3=15
- a) Pneumatic type sprint diaphragm actuator;
- b) Single seat and double seat control valves;
- c) Derivative kick in PD controller;
- d) RS-485 data communication;
- e) Relay auto tuner for tuning PID controller;
- f) Smith predictor.

Bachelor of Electrical Engg. 4th year, 1st Semester Supplementary Examination, 2017

**Process Instrumentation and Control
Part-II**

Time: Three Hours; Full Marks: 100 (50 Marks for each Part)
Use Separate Answer script for each part

Answer any *three* questions from this part.
Two marks for neatness

1. a) Enumerate the objectives of process control. 4+4 +8
 b) Explain why models for chemical processes often contain a delay element.
 c) An electrically heated metallurgical furnace with unit step input reached a steady state temperature of 1600 deg-C after about 6 hours. Temperatures measured 10 minutes and 50 minutes after switch on, were respectively 160 and 1040 deg-C. Assuming an ambient of 20 deg-C, fit a first order model –with delay for the plant.

2. An upright conical tank with its apex at the bottom has a height L (m) and a cross section A (m²) at the top, is fed from the top at a rate of q_i litres/second. The tank is connected to a water supply system through a valve such that the outlet discharge rate in litres/sec is given by the linear relation $q_o = kh$, where k is a constant and h is the instantaneous height of water level in the tank. 4+4+4+4
 a) Derive the nonlinear differential equation of the system with q_i and h as the variables.
 b) Derive the (nonlinear) differential equation of the system relating q_i as the input and the outflow rate q_o as the output variable.
 c) Linearize the differential equation relating q_i and q_o when the tank is 75% full.
 d) Derive the transfer function between h and q_i .

3. a) With appropriate diagrams, explain the physical significance of the terms *Proportional Band* and *Ultimate gain*. 4+(4+4+4)
 b) Given a first order plant with a time constant of 120 s and a delay of 20 s. (i) Determine the ultimate gain and P.C.F. (ii) Determine the Proportional controller setting to obtain 45 degree phase margin. (iii) Determine the gain margin.

4. a) Explain the significance of the *Reset Time* in PI control. 2+8+6
 b) Given a first order plant with a time constant of 18 s and a delay of 2.5 s, determine the P-I controller settings to obtain 45 degree phase margin.
 c) With example explain what is meant by feedforward control. Compare the relative advantages of feedback and feedforward control.

5. a) State the transfer function of a PID controller in product form and sketch its asymptotic Bode magnitude plot. (2+4)+(8+2)
 b) Given a first order plant with a time constant of 80 s and a delay of 10 s. (i) Determine the PID controller settings by Zeigler Nichols method. (ii) Determine the phase margin with the above controller.